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Indirect-use and option values of mangrove forest ecosystem in Day-asan, Surigao City, Philippines

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Abstract

Mangrove is a wetland type of forest referred also as the tidally influenced swamp ecosystem within intertidal zone of tropical and subtropical latitudes (Tomlinson, 1986). This forest provides numerous direct and indirect benefits to people and environment. However, most of the benefits appreciated are focused on direct-use or marketed benefits making mangrove forests as undervalued resources today. This study aimed to asses the Indirect-use and Option Values of mangroves in Barangay Day-asan, Surigao City as components of forest economic valuation. The Replacement Cost and Contingent Valuation Methods were used in value determination. Survey showed that as to socio-demographic profile of the participants, there is a total of 451 households in Barangay Day-asan. Most of the participants were female (68.89%), married (34.07%) and attained secondary level of education (42.22%). Fishing is the very source of income among the local residents. The total Indirect-use value of mangrove forest of the study area is approximated at Php6239.15/hectare/per year valuated by means of Coastal Protection and Carbon Sequestration Values. The study revealed that mangrove forests in this coastal community provide considerable economic and environmental benefits, particularly as a source of family income, provision of quality air to breath and in protecting local communities from disasters associated with the climate change. Most of the residents agree to take part in mangrove conservation programs and initiatives with an average Willingness To Pay of Php594,115.20 per year as conservation funds for the sustainable management of the mangrove resources in their community.

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Introduction

The mangrove forest is a very important ecosystem that provides a variety of ecological and economic benefits. What composed of this marine tidal forest are trees, shrubs, palms, epiphytes and ferns (Tomlinson, 1986). Its existence as an ecosystem also offers coastlines protection and saves lives and property during natural hazards such as tsunamis, cyclones, storm surges and erosion. Mangroves provide also economic activities to the people aside from serving as the breeding, feeding and nursery grounds for many estuarine and marine organisms (Nagelkerken *et al*, 2008). Naturally, this type of vegetation is utilized for captive and culture of many fisheries products. The ecosystem also contains large deposits of some unexplored potentials for natural products that are essential for medicinal benefits, for salt production, apiculture, fuel and fodder, among others (Khairnar *et al,* 2019). In fact, many people in the Philippines generate income from mangrove resources. More than half of the Philippine's 1,500 municipalities and 42,000 barangays are dependent on these marine habitats for food and other goods and services (Primavera, 2000).

Mangrove provides a multiple use and wide variety ecosystem services and benefits. It is a significant vegetation that serves as coastal bio-shield since it plays a critical role in reducing the impacts of cyclonic storms, hurricanes and tsunami on human lives and properties (Danielsen *et al.,* 2005; Selvam, 2005). There are various ways that the regulating services of mangroves can mitigate the effects of climate change, particularly in serving as buffers against storms and flooding. Sea waves are attenuated by mangroves vegetation thereby reducing wave forces by an estimated 70-90% on the average (Macintosh, 2010). Undeniably, mangroves provide a wide range of vital ecosystem services, which have an equally wide range of value. Economists generally decompose the total economic value of ecosystems into direct-use, indirect-use and non-use values. Direct-use values refer to consumptive and non-consumptive uses that entail direct physical interaction with the mangroves and their services such as outputs of fish, fuel wood, recreation, and transport. Indirect-use values include regulatory ecological functions, which lead to indirect benefits such as flood control, storm protection, nutrient retention, nursery grounds for different species, and erosion control. Non-use values include existence and bequest values of mangroves (Bann, 1988). In Kosrae, Micronesia, an economic valuation study shows that mangroves on the island are worth between $666 thousand and $1 million per year (1996 prices) based on the net value of marketable products alone. Interestingly, the local people are willing to pay money which ranges from $1 million to $1.26 million per year just to protect and use mangrove swamps indefinitely (Naylor *et al*, 1998). Due to the many tangible and intangible benefits derived from mangroves, this ecosystem has been facing a lot of pressures and exploitation. In the Philippines, aaquaculture development, conversion of mangrove areas to ponds for production of shrimp, fish, and other aquatic resources, is a leading cause of mangrove loss (Garcia, K. B. *et al.*, 1988). For instance, between 1968 and 1983, 237,000 ha of mangroves were lost for pond construction, almost half of the total national mangrove area (Fernandez, 1978) at that time. Jayagoda (2016) claimed that mangroves have degraded continuously and about 25% of the original mangrove areas have been converted into fishponds, with an average rate of 5,000 hectares per year in the 1970's and early l980's.

Similarly, Agaloos (1994) and Primavera (2000) estimated that around half of the 279,000 hectares of mangroves lost from 1951 to 1988 were developed into culture ponds. Aside from depleting the mangroves, aquaculture also pollutes the mangrove ecosystem with effluents that affect the services that a healthy mangrove ecosystem serves. Pollution and problems are often left behind when the operation of aquaculture ceased (De la Torre and Barnhizer, 2003). Sadly, once the operation is halted, aquaculture operators shift to new locations containing a healthy mangrove ecosystem and thereby do the same cycle of resources depletion (Ellison, 2008). If this trend continues, mangrove areas in the country will be in serious threat. Although greater conservation and rehabilitation efforts have been in placed (Samson and Rollon, 2008), still it is

expected that the mangrove ecosystem in the country will continue to face degradation.

Notwithstanding the various benefits from mangroves, this type of ecosystem remains undervalued (Beitl *et al*, 2019; Salem and Mercer, 2012). There is a need to disseminate widely the salient role that mangroves play ecologically and economically particularly in the grassroots, policy makers and among key leaders in the community through highlighting the scientific studies on valuation of mangrove resources purposely to enhance awareness (Song *et al*, 2021; Khan *et al*, 2020) and elicit holistic conceptualization and implementation of coastal programs for the conservation of mangrove resources where local wisdom are purposely integrated (Hakim *et al*, 2017). Hence, this study was conducted with the primary view of assessing the Indirect-Use and Option Values of the mangrove forest in Barangay Day-asan, Surigao City, Philippines. The research output could contribute to the existing knowledge on ecosystem valuation, particularly on the ecosystem services provided by mangroves to people and communities. The information and result could serve also as a guide in assessing public support for conservation of the mangrove forest and as a supportive argument for the invaluable roles the mangrove forest play in maintaining biodiversity and environmental quality (Saka *et al,* 2015).

Material and methods

The Study Site

Barangay Day-asan, Surigao City in Philippines was chosen as the study site on the basis of having considerable tracts of mangrove forest approximately 403 hectares with majority of the residents generate family income from fisheries-related sources. Day-asan is renowned as the "Floating Village", since most of the houses in this community are built on mangrove areas. It is one of the 54 Barangays in Surigao City and has a total population of 1,986 in 451 households (Barangay Day-asan Profile, 2020).

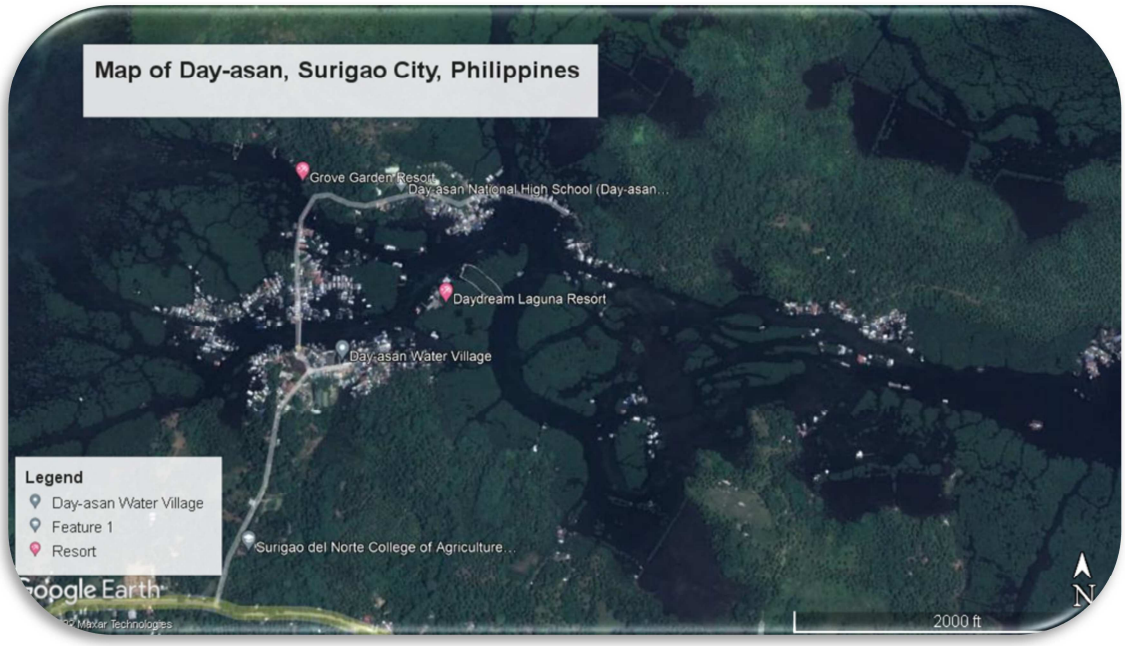

Fig. 1. Map of Barangay Day-asan, Surigao City, Philippines.

Study Framework

This study assesses the Indirect-use and Option Values of the Mangrove forest to the community residence in the coastal Barangay of Day-asan, Surigao City, Philippines. The Input-Process-Output framework approach provides the schematic structure and variables of the study.

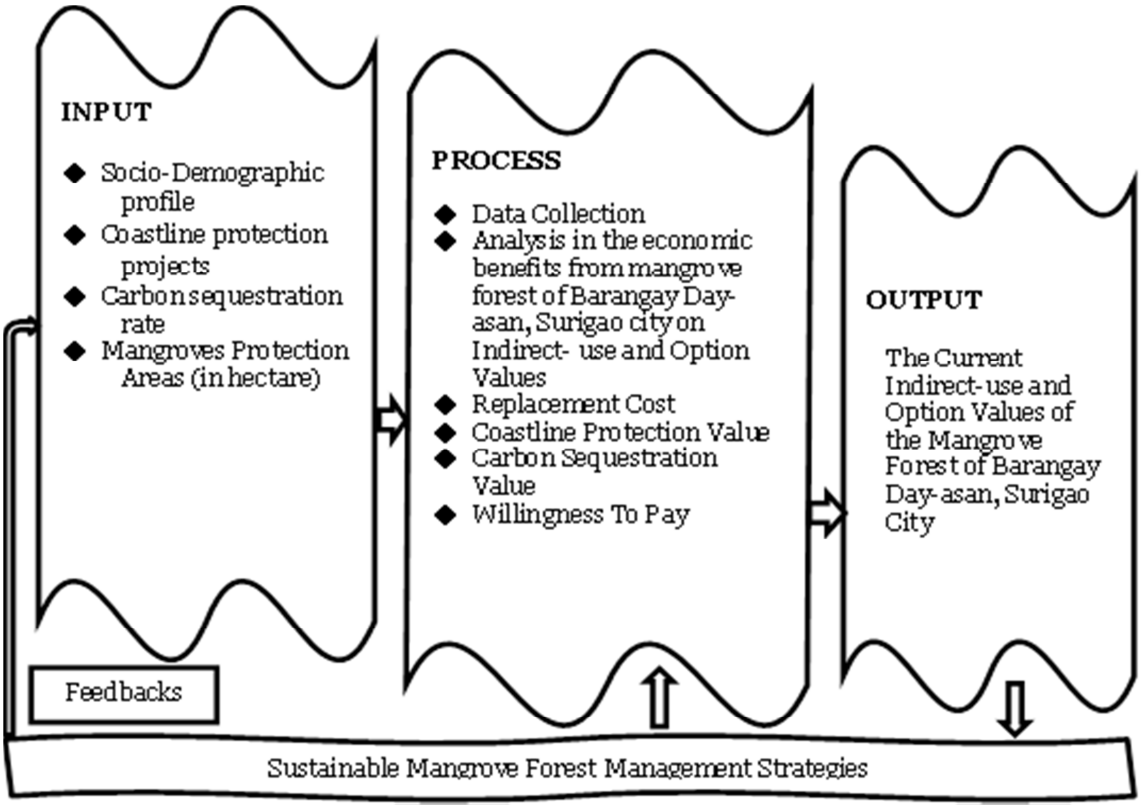

Fig. 2. The Study Framework

Research Design, Sampling and Data Collection Techniques

This study used the Quantitative modality of research using descriptive research-survey type. The researchers considered the appropriateness of this design because the study involved data gathering through a face to face interview with the participants, guided by a structured questionnaire. There were 135 research participants of this study representing the 451 community households of Barangay Day-asan, Surigao City. They were selected randomly which has constituted a total of 30% of the total barangay Households (Barangay Day-asan Profile, 2020). Only those 18 years old and above regardless of gender, educational attainment and religious affiliation were considered in the selection of the participants.

This study relied much on the responses of the participants both from community residents, Department of Public Works and Highways (DPWH)-Surigao del Norte and the Carbon Sequestration Value (CSV) from the study of (Navarro, 2020). The researchers personally conducted a face to face interview to ensure better results and accuracy of the gathered data. The researchers conducted first a courtesy call to the Barangay Captain and its council to request permission from the Barangay in relation to the conduct of the study and the identification of participants as well. Upon approval from the Barangay Council, the researchers personally administered the interview of the participants. The objectives of the study were explained first before the interview was started. The orientation program on Biodiversity was also conducted to ensure that all the statements were fully understood using a Surigaonon dialect of the study barangay.

Data Analysis

The data collected were tabulated to facilitate the data analysis and the subsequent interpretation of the results. The Replacement Cost method substitutes the particular ecosystem goods and services with artificial or man-made products and infrastructure or technologies. This method is considered as a substitute for mangrove resource and ecosystem values, despite of having partial estimates only that it represents (Bann, 1998). The calculation of the Coastline Protection Value (CPV) was estimated using Malik *et al* (2015) formula.

To calculate the total Indirect Value/Benefits of mangrove forest of barangay Day-asan, the Coastal Protection Value (CPV) and Carbon Sequestration Values (CSV) were adopted using the formula stated below:

CPV= CL(m)*CAPM(Php)*Total Area of Mangrove (Ha).

The cost of alternative project was determined from DPWH-Surigao del Norte 1st Engineering District using the cost of a concrete Sea Wall project.

CSV= CSR*PCM*Total Mangrove Area (Ha)

The Carbon Sequestration Rates of the study site was taken from the study of (Navarro, 2020) to determine the current value of the mangrove ecosystem services based from the current Biomass content of the mangrove forest of barangay Day-asan. The CPV and CSV were added together in order to estimate the Total Indirect-benefits of the mangrove forest of the Barangay under study.

In estimating the Option Value of the mangrove resources in the study site, the Contingent Valuation Method (CVM) was used. The Option Values refer those individual's willingness to pay (WTP) in order to ensure that the goods and services can still be utilized by future generations. Option Values are considered insurance values by which people assign values to risk aversion in the face of uncertainty (Consolacion, 2017; King, 2020). The Option Value of mangroves was estimated using the formula:

Option Value = Average WTP * Total Number of Households.

Results and discussion

Socio-demographic Profile of the participants

The socio-demographic profile of the study area shows that there are 451 households in Barangay Day-asan, Surigao City, Philippines with an average household size of 5. Most of the participants were female (68.89%) and married (34.07%), with age ranges from 26 to 45 which constitutes a share of 48.14% from the total population. As to educational attainment, most of the participants attained the secondary level of education at 42.22%, while fishing is very source of income among the local residents wherein 45.74% generates income from fishery related sources. The socio-demographic fig.s of Barangay Day-asan suggest that since this community is coastal in nature, it population is increasing and education needs to be accessed by all to cope with economic and environmental challenges necessary to sustain the community developmental initiatives in this heavily relying community on mangrove resources or fishery-based livelihoods as sources of family income.

Indirect-use Value of Mangrove Forest

Table 1. Coastline Protection Value (CPV) of Mangrove Forest per Hectare/Year in Barangay Day-asan, Surigao City.

Mangrove area	Coastal length (m)	Coastline Protection Cost per meter(Php)	Coastal Protection Value (Php) (length*CP Cost)	Coastal Protection Value/yr/(Php) (Project Life: 15 yrs.)	Coastal Protection Value/ha/yr (Php)
Day-asan, Surigao city	222	100,000.00	22,200,000.00	1,480,000.00	3,672.45

Note: Breakwater construction cost per meter=Php100,000(Source: DPWH-Surigao City)

Total mangrove area in Day-asan = 403 hectares (Source: Barangay Profile 2020)

Shown in Table 1 is the Coastline Protection Value of the mangroves in Barangay Day-asan, Surigao City. In this study, the Replacement Cost method was adopted to assess the coastline protection function of mangroves which was calculated specifically using the construction cost of a breakwater project from the Department of Public works and Highways (DPWH). The unit cost of constructing this project is 100,000/linear meter of coastline. The replacement cost to protect the shoreline in barangay Day-asan is approximately at Php3,672.45 per hectare per year. The study shows how important the mangrove forests play in protecting people's lives and properties (Othman, 2004) in the absence of the costly concrete

shoreline protection projects like breakwater projects and Tsunami walls. The study of Mendoza and Alura (2001) depicts that in areas without mangroves, coconut trees were uprooted due to wave action during storms. However, this does not occur in coastal areas where there are strips of mangroves (Macintosh, 2010; Barbier, 2016).

The study conducted by Harada *et al* (2002) demonstrates that mangroves are of the same effectiveness as concrete seawall structures in reducing waves due to tsunami that hit houses behind the forest. A six-year old mangrove in Moresu forests of 1.5 km width reduced the sea waves by 20-fold, from 1-m high waves in the open sea to 0.05 m at the coast. The advantage of mangrove trees as a natural breakwater is that they are perennial, unlike the concrete breakwater which has short-lived protective capabilities. If mangrove forest is kept intact in Barangay Day-asan, it will continue to function as a natural wind and breakwater.

CPV= Coastline Length (m) * Cost Alternative Project(Php)/Project Life(15)
(Source: Malik, 2015)

Mangrove forests are important features of coastline protection, with significant roles in stabilizing shorelines, preventing flooding, and serve as windbreak and buffer against waves and storms (Gunawardena *et al*, 2005). Areas along the coasts with no mangrove cover are susceptible to severe erosion and storm surge (Barbier, 2016). The coastline mangrove cover along the coastline should be preserved to protect the shore. Thus, storm protection and shoreline stabilization functions of the mangroves have indirect-use value to coastal communities through reducing property damage (Othman, 2004).

Table 2. Carbon Sequestration Value of Mangrove in Barangay Day-asan per Hectare/Year.

Mangroves Area	Carbon Stock Value tCOe2/ha	Carbon Stock Value tCO2e (Php)	Carbon Stock Value tCO2e/ha/year (Php)
Day-asan, Surigao City	684.46	206,878,035	2,566.73

Note:

A. Carbon Stock Value (CSV)=Total Carbon Stock*Php750tCO2e * Total Mangrove Area:
Barangay Day-asan = 403 Hectares.

B. Carbon Stock Value/ha/year= CSV Total/Total Mangrove Area/Mangrove Age.

C. Mangrove age in Barangay Day-asan is estimated at 200 yrs (Source: Barangay Profile, 2020).

Table 2 shows the Carbon Sequestration Value of mangrove forest in Day-asan, Surigao City. The mangrove forest holds the carbon stock with approximately 147.39MC/Ha or 540.92.13t CO2e/Ha (Navarro, 2020). In this study, the adopted price was Php750 or US $ 50 ($40-80) per ton of CO2e (World Bank, 2017) for estimation purposes only. This result implies that the indirect-use value of mangroves per hectare per year in terms of carbon sequestration in Barangay Day-asan at Php2,566.73 is a very noteworthy fact since this shows the significant ecological function of mangrove forest in sequestering waste carbons deposited in the atmosphere and storing it in the biomass during the photosynthetic process (Lal, 2008). In Banacon Island in Bohol, Philippines, best illustrates the carbon sink potential of mangroves due to their vigorous condition enabling the forest vegetation in storing vast amounts of carbon Camacho *et al.* (2011). In barangay Day-asan scenario, losing of a single hectare of mangrove forest due to any unsustainable resource utilization practices means a reduction of the carbon sequestration capability of mangroves at a very significant rate. People in Day-asan enjoy the bounty of fresh air due to forest ecosystems surrounding the whole coastal community. This is the truth that must be widely known to everybody as to how valuable the mangroves are in filtering the air that people breaths daily. Interestingly, mangroves allocate proportionally more carbon below ground, and have higher below-ground content compared to above ground carbon mass than terrestrial forests (Alongi, 2014).

There is a 3.67 rate conversion factor of carbon stock into carbon dioxide Sequestration (Ahmed *et al*, 2017; Lomoljo, 2017). So, mangrove plantations really provide substantial benefits in controlling regional climate change by stabilizing atmospheric carbons.

The Indirect-use values are benefits derived from the ecosystem functions, such as the mangrove's functions for shoreline protection, breeding ground for fish and shellfish species, carbon sequestration, habitat for birds and other wild animals and biodiversity conservation. These are values derived from resources and services that are not consumed (IUCN, 2007). In this study, the Total Indirect-use values of the mangroves forest in Barangay Day-asan, as valuated through Coastal Protection Value (CPV) and Carbon Sequestration Value (CSV) is Php6,239.18 per hectare per year. This denotes the tantamount role of the mangroves in this area that have been provided to the people and the community in the form of a not consumed resources and environmental services of the mangrove as an ecosystem. With these valuable economic and environmental benefits provided by mangroves, this scenario indeed, calls for concerted efforts among the public and private sectors to rally behind the efforts of the Philippine government to rehabilitate and conserve the mangrove resources in the country.

Option Value of Mangroves

Table 3. Support Availability of the Participants to help Biodiversity in Barangay Day-asan.

Willingness to Support Biodiversity	Frequency	Percentage (%)
Yes	126	93.33
No	9	6.67
Total	135	100

Data shown in Table 3 disclosed that the majority of the participants at 93.33% agree to help the biodiversity of mangrove in Barangay Day-asan, while the 6.67% the participants have no enough money to help biodiversity. This implies the wide range of support from community households to take part in the biodiversity conservation of the mangrove vegetation in their Barangay. This indicates further a wider understanding among the local people on the importance of mangroves and further denotes a higher success of any mangrove conservation programs/initiatives that may be implemented in the future (Beger *et al*, 2015).

Table 4. Participants' Willingness To Pay (WTP) Per Month for the Conservation of Mangroves in Barangay Day-asan, Surigao City.

WTP (Php)	Frequency * 126	Total WTP (Php)/Month
10 to 20	28	3,528.00
21 to 40	13	1,638.00
41 to 60	23	2,898.00
61 to 80	10	1,260.00
81 to 100	24	3,024.00
101 to 500	17	2,142.00
501 to 1000	5	630.00
1000 above	6	756.00
Total		15,876/135= 117.60

Table 4 shows the WTP for the conservation of the mangroves in Barangay Day-asan discloses that at a range of Php10 to 20, there are 28 or 21% of the participants who are willing to allot monetary contribution to help biodiversity conservation of the mangroves. Around 18% also agree to spare Php81-100 while approximately 17% of them are eager to provide Php 41-60 per month. Interestingly, there is 8% willing to share at least Php500.00 per month just to conserve the mangroves resources in their community. The average WTP of the participants in barangay Day-asan is Php117.60. The study shows a high positive response despite of the reality that most of the participants belong to low income bracket in this community. This is supported by studies which claim that individuals who fished near the mangroves area perceived the greater benefits than those who are fishing from non-mangrove areas and are normally of high willingness to pay for the conservation of the mangroves (Walton *et al,* 2006). Although some of the participants believe in a negative perception, with common belief that it is the government's responsibility to finance such resource conservation management initiatives and the other reason is that they have the confidence that rehabilitation of mangroves will take place of its own and without the participation of the community residents.

Table 5. The Option Value of the Mangrove Forest in Day-asan, Surigao City.

Data Used for the Calculation of Option Value	Day-asan (n=135 Households Participants)
No. of Respondents Willing To Pay	126(93.33%)
No. Of Respondents Not Willing To Pay	9(6.67%)
Total No. Of Households willing to pay (no. Of respondents /n*Total # of HH)	421
Average Household Willingness to pay (Php) per month	117.60
Option Value /HH/year (Php)	1,411.20
Option Value of Mangrove/Year (Php)	594,115.20
Option value of Mangrove/Ha/Year/(Php)	1,474.23

Note: Day-asan has a total of 403 hectares of mangrove and 451 Households (HH) (Barangay Profile, 2020).

Table 5 shows that the Option Value of mangroves in barangay Day-asan, Surogao City has an average of 126 (93.33% of the population) participant-households showed their willingness to pay per month, while only 9 (6.67%) respondents have disclosed that they are not willing to pay. This calculates an average of household of willingnes to pay per month of Php117.60 or a Total Option Value of mangrove forest per year at Php1,411.20. The support of the community households is not just demonstrated in answering " Yes" whenever asked if they are willing to help the biodiversity conservation of the mangroves in their Barangay. As depicted in Table 5, the community WTP, indeed translates the economic value of the mangrove forest in Day-asan to a certain degree. At Php1,474.23 per hectare per year, this is a very tangible contribution from the community itself to conserve mangroves which can be a better complement already to the logistical consideration of any mangrove related projects that will be implemented in this coastal Barangay.

Conclusion

The study concludes that the majority of the residents of Barangay Day-asan, Surigao City are heavily dependent from resources they get from the mangrove forest in the area. The mangrove vegetation indeed provide coastal protection to people and properties at the same time functions its natural role in sequestering atmospheric carbons which altogether form as the Indirect benefits derived from mangrove forest. Interestingly, the community residents are more willing to conserve the mangrove vegetation as they consider it is one of the best sources of their food, income, a natural source of fresh air that they breathe and the source of formidable protection against natural disasters like typhoon and tsunami, in lieu of the very expensive concrete shoreline protection structures. There is really a need of holistic interventions and biodiversity conservation programs in order to successfully rehabilitate and conserve the mangrove forest ecosystem i barangay Day-asan, Surigao City, Philippines.

Recommendations

Based on the results of the data gathered during the survey, the researchers propose these recommendations.

1. The Barangay Local Government Unit is enjoined to declare the critical portions of the mangrove forest within Day-asan as Marine Protected Areas (MPAs).
2. The people who commit violations of environmental laws, specifically to the mangrove forest shall be subjected to criminal prosecution.
3. Local Government Unit (LGU) is encouraged to regularly conduct seminars/information drive related to Mangrove benefits and Environmental Awareness programs to the community to provide them with timely needed knowledge on the various economic and ecological benefits from mangrove forests.

References

Agaloos BD. 1994. Re-afforestation of mangrove forests in the Republic of the Philippines. In: Proceedings international tropical timber organization workshop: development and dissemination of re-afforestation techniques of mangrove forests. Japan Association for Mangroves, Japan pp. 75-98.

Ahmed N, Bunting SW, Glaser M, Flaherty MS, Diana JS. 2017. Can greening of aquaculture sequester blue carbon? Ambio **46,** 468-477.

Alongi DM. 2014. Carbon cycling and storage in mangrove forests. Annual Review of Marine Science **6,** 195-219.

American Museum of Natural History. 2013. Mangrove threats and solutions. http://www.amnh.org/explore/science-bulletins/bio/documentaries/mangroves-the-roots-of-the-sea/mangrove-threats-and-solutions.

Bann C. 1988. The Economic of Mangroves: A Manual for Researchers Economy and Environment Program for Southeast Asia. pp 24-28.

Barangay Profile. 2020. Barangay Local Government Unit (BLGU) of Barangay Day-asan, Surigao City Profile 2020. Accessed February **2,** 2020. pp 10.

Barbier EB. 2016. The protective service of mangrove ecosystems: A review of valuation methods. Marine Pollution Bulletin **109(2),** 676-681. https://doi.org/10.1016/j.marpolbul.2016.01.033.

Beger M, McGowa J, Treml EA, Green AL, White AT, Wolff NH. 2015. Integrating regional conservation priorities for multiple objectives into national policy. Nat. Commun **6,** 8208. DOI: 10.1038/ncomms9208.

Beitl CM, Rahimzadeh-Bajgiran P, Bravo M, Ortega-Pacheco D, Bird K. 2019. New valuation for defying degradation: Visualizing mangrove forest dynamics and local stewardship with remote sensing in coastal Ecuador. Geoforum **98,** 123-132. https://doi.org/10.1016/j.geoforum.2018.10.024

Brown WH, Fischer AF. 1920. Philippine Mangrove Swamps. Brown WH, editor. Minor products of Philippine forests I, Bureau Forestry Bull **zz,** 9-125.

Camacho DM Jr, Ambi FM. 2011. Tree biomass and Carbon Stock of a Community-managed mangrove forest in Bohol, Philippines. Forest Sci Tech **7(4),** 161-167.

Consolacion FA. 2017. Economic Valuation of Selected Mangrove Forest Ecosystems Along Macajalar Bay, Misamis Oriental. Masteral Thesis. MSU-IIT, Iligan City.

Danielsen F, Sorensen MK, Olwig MF, Selvam V, Parish F, Burgess N, Hiraishi T, Karunagaran VM, Quarto A, Suryadiputra N. 2005. The Asian Tsunami: A Protective Role for Coastal Vegetation. Science **310,** 643.

De la Torre I, Barnhizer D. 2003. The blues of a revolution : the damaging impacts of shrimp farming. Industrial Shrimp Action Network, Tacoma, WA.

Ellison AM. 2008. Managing Mangroves with benthic biodiversity in Mind: Moving beyond roving banditry. J Sea Res **59,** 2-15.

Fernandez PM. 1978. Regulations and their Impact on mangroves areas for aquaculture the Philippine experience. Workshop proceeding on the conservation of mangrove areas to aquaculture, Iloilo pp 78-84.

Garcia KB, Malabrigo PL, Gevaña DT. 2014. Philippines' Mangrove Ecosystem: Status, Threats and Conservation. In I. Faridah-Hanum, A. Latiff, K. R. Hakeem, & M. Ozturk (Eds.), Mangrove Ecosystems of Asia (pp. 81-94). Springer New York. https://doi.org/10.1007/978-1-4614-8582-7_5.

Gunawardena M, Rowan JS. 2005. Economic Valuation of a Mangrove Ecosystem Threatened by Shrimp Aquaculture in Sri Lanka. Environmental Management **36(4),** 535-550.

Hakim L, Siswanto D, Nakagoshi N. 2017. Mangrove Conservation in Java: The Ecotourism Development Perspectives. The Journal of Tropical Life Science Open Access Freely available online **7(3),** 277-285, DOI: 10.11594/jtls.07.03.14.

Harada K, Imamura F, Hiraishi T. 2002. Experimental Study on the effect in reducing tsunami by the coastal permeable structures. Final Proc. Int. Offshore Polar Eng. Cont. USA, 652-658.

Jayagoda DD. 2016. Community-based Mangrove Forest Management in Association with Sustainable Tourism in Puerto Princesa City of the Philippines. International Journal of Sustainable Future for Human Security **3(2),** 23-30.

Khairnar SO, Solanki BV, Junwei L. 2019. Mangrove ecosystem - its threats and conservation. Aquafind, College of Fisheries, Ocean University of China, Qingdao, Shandong, Peoples Republic of China.

Khan MF, Rahman A, Giessen L. 2020. Mangrove forest policy and management: Prevailing policy issues, actors' public claims and informal interests in the Sundarbans of Bangladesh. Ocean & Coastal Management **186,** 105090. https://doi.org /10.1016/j.ocecoaman.2019.105090.

King S. 2020. Option, Insurance and Bequest Values in Ecosystem Accounting. 6. Ecosystem Assessment and Policy Support, UNEP-WCMC. Pp 1-6.

Lal R. 2008. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. Science **304(5677),** 1623-1627. https://doi.org/10.1126 /science.1097396.

Lomoljo NH. 2017. Carbon Stock Assessment of Mangrove Forests Along Macajalar Bay, Misamis Oriental, Philippines. Mindanao State University-Iligan Institute of Technology. Master's Thesis pp, 45-60.

Macintosh DJ. 2010. Coastal Community Livelihoods: Implication of intact ecosystem services. Paper presented at the 2010 Katoomba Meeting XVII held June 23-24, 2010 in Hanoi Vietnam. http:/www.ecosystemmarketplace.com/documents/acrobat/K17/Don%20Macintosh.pdf.

Malik AR, Fensholt R, Mertz, O. 2015. Economic Valuation of Mangroves for comparison with commercial Aquaculture in South Sulawesi, Indonesia. Forests **6(12),** 3028-3044, DOI: 10.3390 /f6093028.

Mazda Y. 1997. Mangrove as a coastal protection from waves in the Tong King delta,Vietnam. Mangrove Salt Marshes **1,** 127-135.

Mendoza A, Alura D. 2001. Mangrove structure on the eastern coast of Samar Island Philippines (pp 423-425). In: DE Stott, RH Mohtar, GC Steinhard (eds) Sustaining the Global farm. Selected papers from the 10th International Soil Conservation Organization Meeting held May 24-29, 1999 at Purdue University and the USDA-ARS National Soil Erosion Research Laboratory.

Navarro RJ. 2020. Above-ground Biomass and Carbon Stock Estimation of Mangrove Forest Ecosystem in Dya-asan, Surigao City, Philippines. Undergraduate Thesis. Surigao State College of Technology - Mainit Campus.

Naylor R, Drew M. 1998. Valuing mangrove resources in Kosrae, Micronesia. Environment and Development Economics **3(4),** 471-490. https:// doi.org /10.1017 /S1355770X98000242

Negelkerken I, Blader S. 2008. The Habbit function of mangroves for terrestrial and Marina fauna: a review. Aqu Bot **89(2),** 155-185.

Othman MA. 2004. Value of mangroves in coastal protection. *Undefined*. https:/ /www.semanticscholar .org /paper/Value-of-mangroves-in-coastal-protection-Othman/16167bbde5dee471a7d673d1dec3e0f9db820fde

Primavera JH. 2000. Development and conservation of the Philippine mangroves: institutional issues. Ecol **35,** 91-106.

Punay E. 2013. CA Junks Petition vs. Php 14 billion reclamation. http://www.philstar.com/metro/2013/05/04/938120/ca-junks-petition-vs-p14-b-reclamation-project. Accessed 8 May 2013.

Saka MS, Jimoh O, Ajewole OI. 2015. Willingness to Pay for Environmental Service Functions of Mangrove Forest in Uzere, Delta State, Nigeria. Journal of Resources Development and Management. ISSN 2422-8397 An International Peer-reviewed Journal Vol. 16.

Samson MS, Rollon RN. 2008. Growth performance of planted mangroves in the Philippines: revisiting forest management strategies. Ambio **37(4),** 234-240.

Selvam V. 2005. Impact assessment for Mangrove and Shelterbelt Plantations by Tsunami for Tamil Nadu Forestry Project. Report submitted to the Japan Bank for International Cooperation, New Delhi.

Selvam V. 2007. Trees And Shrubs Of The Maldives. ISBN: 978-974-7946-94-9 © FAO Regional Office for Asia and the Pacific. Printed by Thammada Press Co., Ltd., Bangkok.

Song AM, Dressler WH, Satizábal P, Fabinyi M. 2021. From conversion to conservation to carbon: The changing policy discourse on mangrove governance and use in the Philippines. Journal of Rural Studies **82,** 184-195. https://doi.org/10.1016/ j.jrurstud.2021.01.008

Tomlinson PB. 1986. The Botany of Mangroves. Cambridge (UK): Cambridge University Press. pp419.

Walton ME, Samonte-Tan M, Primavera JH, Edwards-Jones G, Vay LL. 2006. Are mangroves worth replanting? The direct economic benefits of a community-based reforestation project. Environmental Conservation **33(4),** 335-343. https://doi.org/10.1017/S0376892906003341.

World Bank. 2017. *Carbon Pricing*. Retrieved 14 October 2022, from https://www.worldbank.org/en/results/2017/12/01/carbon-pricing.