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Estimating the direct use values of mangrove ecosystem: A case in Panguil Bay, Philippines

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Abstract

Valuing the mangrove ecosystem poses some challenges as it is underrated by the policymakers and in some cases, it is excluded as inputs to decision making. This study aimed to estimate the direct use values of the mangrove ecosystem in Panguil Bay in 2020. A mixed method of research was applied: quantitative techniques employed surveys involving 924 respondents to get the direct use values of the mangrove ecosystem; qualitative techniques made use of key informant interviews and direct observation. The direct use values of the mangrove ecosystem were obtained by getting the volumes of goods and services extracted from it multiplied by the market price less the operation costs. Results revealed that while respondents lived in mangrove swamps, their mangrove utilization was tempered by the strict implementation of the no-cutting of trees policy in Panguil Bay. Mainly uprooted mangroves or fallen branches battered by strong winds were utilized for house construction and repair. Only 0.32% of the respondents utilized mangroves for the construction of their houses with an estimated total direct use value of Php11,599.20 (USD 31.98) and only 0.22% used mangroves for the repair of their houses with an estimated total direct use value of Php P1,401.57 (USD 0.22). The total estimated direct use value of the fishery resources (Metapenaeus endeavouri and Scylla serrata) was sizable at Php456.96 (USD 9.14) per fishing day. An important implication is to strictly implement appropriate policies for the mangrove ecosystem to be a rich nursery for fishery resources.

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Introduction

Mangrove forests are among the most productive ecosystems in the world that are found in subtropical and tropical coastal regions. Literature shows that mangrove resources provide several benefits to the people and community (Farley *et al.*, 2010; Pascal, 2014; Abino *et al.*, 2014; Anneboina & Kumar, 2017). They provide both ecosystem goods and services to the fishermen for whom fishing in the mangroves is a source of livelihood, local families benefiting from firewood and construction materials, and real estate owners who are protected from coastal flooding. However, as the years go by and as the population increases, the area planted with mangroves has been decreasing due to some anthropogenic factors (Polidoro *et al.*, 2010; Wylie *et al.*, 2015; Baus, 2017).

People believed that mangroves are for all or are "public goods" and their utilization will provide welfare to them (Brander *et al.*, 2012; Summers *et al.*, 2012). They cut the trees for their economic benefits but sometimes neglect the future environmental impact. Most of all, people usually do not value the cost of mangrove products and services. Many scholars have also tried to give a valuation of ecosystem services. Mangrove valuation has already been practiced by many environmental economists as an instrument of sound environmental governance. Since its commencement, valuations are focused on Asia, particularly Southeast Asia. They are underrepresented in Africa, the Americas, and the Pacific (Vegh *et al.*, 2014).

Researchers have already given due consideration to the market values of goods and services in the mangrove ecosystem. Different locations have different direct values with various currencies. The direct benefits of the mangrove ecosystem were Rp.185,145,655,00 for Pulokerto Village in Indonesia. (Sina *et al.*, 2017) and Rp 29,521,280 for Sondaken Village, also in Indonesia (Mangkay *et al.*, 2013).

In the Philippines, Carandang *et al.* (2012) reported that the highest direct values per year were in the Banacon site in Bohol with PHP 33.368 million per year. In Balikpapan Bay, Indonesia, Lahjie *et al.* (2019) valued the direct benefits up to $0.933 per person a day for wood production and $1.43 per person a day for fishing.

Regardless of the different values brought about by the uniqueness of every geographical location, the implications would be the importance of the valuation of the mangrove ecosystem as inputs to decision-making. Like many other places in the country, Panguil Bay is rich in mangrove resources. However, hundreds of houses are built within the mangrove swamps and the number is increasing over some time. But with the strong implementation of the no-cutting of trees policy, the mangrove trees are now slowly being restored. However, people have not appreciated yet the value of mangroves as mangrove products are not given a price when they are utilized. Moreover, the researcher has not come across yet valuation studies, particularly the direct valuation of mangroves in Panguil Bay. Panguil Bay is a rich habitat for fish and crustacean species and has contributed significantly to the economic condition of the cities and municipalities along the bay. Hence, this research determined the direct use valuation of the mangrove ecosystem in Panguil Bay which can be a good input in formulating a model or framework for sustainable development.

Materials and methods

This study was conducted during a pandemic. The use of pencil and paper during interviews with the respondents of the study was minimized and this was replaced by utilizing the Kobo Toolbox application on android phones. The research hired local researchers to conduct the interview using the said app. Based on the IATF protocols, meetings and other gatherings were not allowed, thus, the researcher trained each of the interviewers or local researchers during his courtesy call to the barangay Chairs.

Research Design

The study employed a mixed method of research using both quantitative and qualitative techniques in collecting the data. A quantitative research method deals with quantifying and analyzing variables to arrive at the result of the study. In this study, the quantitative method was used to measure the direct use values of mangrove utilization. On the other hand, the qualitative technique was used in the analysis of the results of key informant interviews on the issues and concerns in the direct use of mangroves.

For the quantitative techniques to determine direct use values in the context of mangrove ecosystems, economic values were obtained, which included the value of mangrove utilization as a material, cordwood, and the value of selected fishery resources. The researcher made use of the formula used by Putranto *et al.*, (2018) and Susilo *et al.* (2016) in estimating the direct use values.

Par value of wood = (volume x quantity x selling price/m^3)

Where volume = the total board feet, assuming that the wood is cut but the actual utilization was not measured in board feet because these were only poles used for housing. Volume was instead measured in terms of board feet. The estimated operational costs of wood were taken from the study of Mangaoang (2013) of which operational costs of round timber harvesting were computed at 51.67% of the total revenue.

Par value of wood fuel = (bundle x quantity x selling price). In his study, findings show that the average production of firewood is 10 bundles per man-day. The operational costs of firewood were based on Mangaoang, (2013) which was computed at 90%. The researcher used the formula of Mangkay *et al.* (2013) to get the direct use value of mangrove crabs and shrimps as follows;

DUV = fishes value (data of catch fishes and fish selling price at the location). Where the data of caught fishes = quantity of crabs/shrimps in kilograms per caught multiplied by the existing market price at the location. The value in pesos per unit of goods and services provided by the mangrove environment was established to make the best estimate of direct-use values. In this study, the operational costs of catching fish and other species included the labor per man-day and costs of fishing gear and equipment used.

Locale of the Study

The study was conducted in Panguil Bay, the Philippines particularly in the City of Tangub in Misamis Occidental and, the municipalities of Kolambugan and Tubod in Lanao del Norte (Fig. 1). Panguil Bay is bordered by the provinces of Lanao del Norte in the east and Zamboanga del Sur and Misamis Occidental in the west (Israel *et al.* 2004). It is about 18,000 hectares with a coastline of 112 kilometers (70mi).

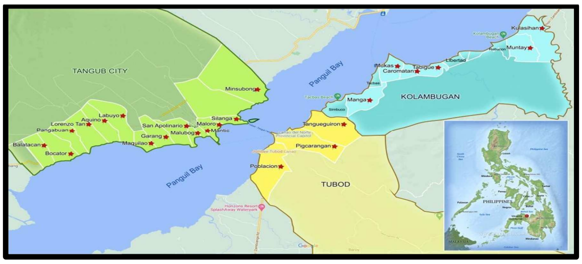

Fig. 1. Location of the study.

Research Instruments

A researcher-made questionnaire was employed for the direct use of the mangrove ecosystems. To apply a paperless collection of data and to expedite the analysis of information, the questionnaire was translated into the *KoBo Toolbox* application and was embedded in Android phones. KoBo Toolbox is a free open-source tool for mobile data collection, available to all. It allows the researcher to collect data in the field using mobile devices such as mobile phones or tablets (wwwkobotoolbox.org).

Sampling Design

This study purposively chose the coastal barangays with mangroves in the three study sites, namely: Tangub in Misamis Occidental, and Tubod and Kolambugan in Lanao del Norte. These areas are part of Panguil Bay. The sample barangays in the three coastal areas were identified through spatial random sampling using ARC GIS and GPS technology. This technology was also used by Kondo *et al.* (2014) in their health survey in a rural region of Guatemala. The main purpose of using digitalized sampling was to identify sample points for the assessment of community structures in the mentioned three areas.

The result of the digitalized sampling was also used as the basis for the selection of respondents. The sampling had identified 14 barangays in Tangub, three barangays in Tubod and only nine in Kolambugan. The aim of this sampling was more or less to get more than 50% of the identified barangays and 40% of the household population in each barangay who were residing at the mangrove swamps or areas as respondents of the study. The study had a total number of household respondents of 924. Tangub City had the highest number of respondents, a total of 479 (51.84%), Kolambugan had 255 (27.60%) and Tubod had 190 (20.56%) (Table 1).

Table 1. Respondents of the study.

City/Municipality	Sample coastal barangays	Estimated total number of households living in the mangrove areas*	Sample households (40% of the estimated total number)
Tangub City	11	1,195	479 (40.08%)
Tubod	3	475	190 (40.00%)
Kolambugan	5	640	255 (39.84%)
GRAND TOTAL	19	2,310	924 (40%)

*Estimates made by Barangay Chairs in the absence of a complete listing

Statistical Tools and Analysis of Data

The primary and secondary data that were collected from different sources were processed and analyzed using frequency, percentage distribution, and measures of central tendency, particularly the mean. Each unit of good or product from the mangroves was valued using the market price in the locality at the time of the conduct of the study.

Results and discussions

Direct Market Values of Goods and Services Derived from Mangroves

Mangrove wood and wood products

***A**s public knowledge, mangrove trees decades ago were used by the residents in so many ways such as charcoal making and construction of houses as roofs, walls, floors, fuel, and others. However, the use of mangroves dwindled due to the strong implementation of ordinances that prohibit the residents to cut mangrove trees.

Firewood

Table 2 presents the utilization of mangroves as firewood in 2020. The results revealed that only 6.38% (59) of the total respondents reported having utilized mangroves for firewood 2 to 3 times a day at an average consumption of one bundle per day.

The highest percentage of respondents (7.51%) who utilized mangroves as firewood was from Tangub.

Table 2. Utilization and Direct Use Value of mangroves as firewood by respondents, 2020.

Particulars	Tangub n=479	Tubod n=190	Kolambugan n=255	Total n=924
Percentage of respondents who used mangrove as firewood (%)	7.51% (n=36)	4.21% (n=8)	5.88% (15)	6.38% (59)
Number of times of using mangrove firewood daily, (mean)	3	3	3	3
Number of bundles of mangrove firewood used daily, (mean)	1.11	0.94	0.92	0.99
Production (bundles/man-day)	30	30	30	30
Total Revenue	P450	P450	P450	P450
Operational Costs	P405	P405	P405	P405
Direct Use Value (Pesos per day)	45.00	45.00	45.00	45.00

Note: the mangroves utilized by the respondents were only driftwoods.

According to the respondents, they did not cut the trees for firewood, instead, they used those that have fallen due to strong winds and other causes. There were instances that they used flotsam/driftwood or "*gapnod*", "*and*" because these were readily available, particularly during high tide, and more importantly, these are free of charge and easy to gather. These flotsams are the waste materials of fishing gear like bamboo. The respondents were used to collecting this kind of waste for their daily cooking of food.

However, assuming that they would buy the firewood from the market and put a price per bundle, they would value it at P13-15 per bundle. The price of firewood was taken from the *sari-sari* (small stores) stores selling the price of firewood in the area. The bundle of firewood comprised only a few pieces, as the storeowners considered the affordability of the consumers. Based on the computation of Mangaoang (2013) in Southern Leyte, each person can produce 10 bundles of firewood a day and the operational costs (labor and marketing) were 90% of the total revenue. But the bundle of firewood referred to in his study that cost P75.00 per bundle in 2013, was more or less 5 times bigger than in Panguil Bay.

Due to limited tools in firewood harvesting, a firewood gatherer (1 person per day) was estimated to be able to harvest 30 bundles of firewood two to three days a week at P15.00/bundle in 2020, resulting in total revenue of P450.00 assuming these were sold. The labor cost in the area was P331 per man-day (Wage Order No.RX-20, 2018) and the marketing cost of P74.00 was assumed per day, resulting in a total cost of_405. The marketing cost comprised of transportation or labor of transporting the firewood from the point of production to the store. The study of Mangaoang (2013) estimated that the direct use value of firewood is 10% of the total revenue, and this estimate was adopted in this study; thus the net direct use value of firewood was P45.00. The marketing cost of P74.00 was an assumption made to be able to compute a 10% direct use-value. The net Direct Use Value would be P45 per man-day or 10% of the total revenue. The average number of households in the study area was five. Since a household consumed one bundle of firewood per day at P15 per bundle, then consumed P5,400 or $108 (*the average value of the dollar in 2016 was rounded off to PhP50.00*) per year which was far lower than $325-$540 per household per year in Fiji (Greenhalgh *et al* 2018), but higher than the 42 dollars per household per year in Indonesia (Malik *et al*, 2015). Moreover, assuming that every person can produce 30 bundles in a day, he may have a daily total revenue of P450.00.

With operational costs of 90%, the direct use value for firewood in Panguil Bay was only P45.00 per day. However, picking driftwood was not done daily. This was usually done two to three days a week. Taking into consideration the average number of households in the study sites who used mangroves as firewood was 6.38% or 59, the sum of the direct use values of firewood amounted to PhP2,655 per day. With the assumption that the picking of driftwood was two to three times a week, the direct use value for one year for the 59 households reached PhP382,320.00.

This Fig. is higher than the results of the separate studies in Indonesia conducted by Jelita *et al.*, (2019), and Rosadi *et al.*, (2018) who found that the direct use values of firewood for their sample households were IDR 6,250,000 (PhP21,881.266; USD430.14) and IDR 9.860.000 (USD 677.99; PhP34,590.93), respectively, However, the difference in the Fig.s between Panguil Bay and the two studies in Indonesia is that the coverage of the study in Tamaw ayu village was only eight hectares with 30 informants and in Kwalang Besar village had only 15 samples. These two villages are equivalent to two barangays in Panguil Bay, Philippines.

As to the respondents' utilization of mangroves for the construction and repair of houses, the results show that there was only a very insignificant number of respondents (less than 1 percent) who utilized mangroves for the construction and repair of houses (Table 3 & 4). This was due to the strict implementation of the green laws of the land. The imposition of big penalties when caught halted and discouraged the residents' to cut trees.

Table 3. Utilization and direct use value of mangroves by respondents for the construction of their houses, 2020.

Particulars	Tangub n=479	Tubod n=190	Kolambugan n=215	Total n=924
Percentage of respondents who used mangrove for the construction of houses	0.21% (n=1)	0.53% (n=1)	0.39% (n=1)	0.32% (n=3)
Number of pieces (bdftbut)	1 (60 bdft)	5 (60 bdft)	2 (60 bdft)	8 (60 bdft)
Total value (Price per bdft = P50.00)	P3000	P15,000	P6,000	P24,000
Parts of the house where the mangroves are used	Post (round timber)	Post (round timber)	Post (round timber)	Post (round timber)
Operational costs (Mangaoang, 2013) 51.67% of TR	1,550.10	7,750.50	3,100.20	12,400.80
Direct use value	1,449.90	7,249.50	2,899.80	11,599.20

Note: the mangroves utilized by the respondents were only fallen trees.

Table 4. Utilization and direct use value of mangroves by respondents for the repair of their houses, 2020.

Particulars	Tangub n=479	Tubod n=190	Kolambugan n=215	Total n=924
a) Percentage of respondents who used mangrove for the repair of houses (%)	0.21% (n=1)	0.53% (n=1)	0	0.21% (n=2)
b) Number of pieces (mean, bdft)	1 (20bdft)= 20bdft	5 (20bdft) =100bdft	0	6 (20bdft) =120bdft)
c) Total Value (Price per bdft=P45)	900	2,000	0	2,900
d) Parts of the house where the mangroves are used	Post (round timber)	various	none	various
a) Operational costs (Mangaoang, 2013) 51.67% of TR	465.03	1,033.40	0	1,498.43
b) Direct use value	434.97	966.60	0	1,401.57

Note: the mangroves utilized by the respondents were only fallen trees.

However, when the key informants were asked about the utilization of wood and wood products, they confirmed that several years ago, particularly in the 1980s, '90s, and even in early 2000, it was a practice of the residents to cut mangroves for the construction and repair of houses. These were usually used as posts, floors, and walls. The persistent and diligent monitoring of the DENR and the local government units on the activities in mangrove swamps prompted the residents to follow the rules or else they would suffer the consequences as stipulated in their respective barangay ordinances.

Although there were very few who utilized mangrove trees for the construction and repair of their houses, their utilization of mangroves did not involve also the cutting of mangrove trees. They used only those trees that have fallen due to strong winds. The part used for posts was round timber an estimated 4-5 meters long with 3-4 inches in diameter with an estimated volume of 60 board feet while the other parts, usually the big branches, were used in other parts of the house as partitions/frames with an average of 20 board feet each. The branches were used as firewood. Accordingly, when the goods were not sold on the market (timber collected for firewood, etc), the value can be inferred from other market values or the nearest substitute (IUCN 2017). Since the nearest substitute for mangroves is mahogany, the researcher imputed the value of mangroves using the actual market price of mahogany in the locality ranging from P45 to 50 per board foot. The price was obtained from the lumber yards in the areas.

If we assume that one pole measures 60 board feet, then the pole was valued at P2,700.00 to P3,000.00. Other small timbers used for repairs in other parts of the houses were assumed to measure 20 cubic feet each at P45.00 per board foot. The operational cost of timber harvesting was based on the study of Mangaoang, (2013) which constitutes 51.67% of the total revenue. In the study sites, since only three respondents, or 0.32% used mangroves for the construction of houses, the estimated direct use values for the construction was only PhP11,599.20 in one year. On the other hand, only two respondents, or 0.21 percent used mangroves for the repair of houses, the estimated direct used value was only PhP1,401.57 for one year. The insignificant amount of the direct use values of mangroves for the construction and repair of houses was due to the strict implementation of the "no cutting of trees" policy in the bay.

The Philippine scenario is more or less the same with the other nations where cutting of mangroves is allowed if there is a permit from the government. In Gazi Bay in Kenya for example, only the concessionaire is allowed to cut trees, and only designated classes of poles are to be harvested (UNEP, 2011).

Nipa (Nypa fruticans) and Nipa Weaving

Utilization of nipa fruticans for roofing of houses

Nipa is the most useful mangrove that serves as a source of livelihood for the people living in coastal areas. People, especially women, consider *nipa* weaving as a contribution to family income.

Nipa shingles from the *Nipa fruticans* were utilized as roofing by almost half (44.16%) of the respondents (Table 5). The results indicate that the municipality of Tubod registered the highest number of users with 53.16% while Kolambugan and Tangub had only 41.57% and 41.75%, respectively. On the other hand, Tangub City had the highest volume of nipa utilization with an average of 265 shingles per household. Prices vary per shingle or bundle. Longer or bigger types of shingle commanded a high price in the market but the products were homogeneous. The usual farm gate price of *nipa* thatch in the area was P350-450 per bundle for small shingles and 500-700.00 per bundle for long shingles. Each bundle had 100 shingles. The prices were obtained from the Nipa weavers and middlemen. Nipa was observed to be more expensive in Kolambugan with an average of P6.02 per shingle.

Table 5. Utilization of Nipa fruticans for the roofing of houses, 2020.

Particulars	Tangub n=479	Tubod n=190	Kolambugan n=215	Total n=924
a) Percentage of respondents who used mangrove Nipa for roofing (%)	41.75% (201)	53.16% (101)	41.57 (106)	44.16% (408)
b) Number of pieces (mean±, sd)	265±190.6	230.54± 238.27	228.81±167.29	247.09±198.93
c) Price per shingle	5.02 ± 1.37	4.99±9.49	6.02±1.192	5.28 ±1.12

Cerio (2018) stated that nipa thatches were used by the impoverished residents because the price is much lower than the usually galvanized iron. On the other hand, using *nipa* as a roof was considered environment-friendly (Umar *et al.*, 2017).

Involvement of the Respondents in Nipa Production

Table 6 shows that among the 924 respondents, 114, or 12.34% were engaged in nipa shingle-making. The highest percentage was in Tubod with 15.26%. When the respondents were asked about the number of shingles they could finish in one day, they reported making an average of 66 thatches per day and they sold the products by a bundle of an average of P470 per bundle (1 bundle=100 thatches). As observed, most of the *nipa* weavers were women. But the chain of production also involved men, particularly in the harvesting of nipa. Similar to the observation of Cerio (2018) that thatch-making or shingle-making is a traditional livelihood among women in the coastal and mangrove village, nipa thatch or shingle-making is also a traditional livelihood of women in the study sites.

Table 6. Respondents who are involved in Nipa Thatching for Roofing.

Particulars	Tangub n=479	Tubod n=190	Kolambugan=215	Total/(Average) n=924
a) Percentage of respondents who were involved in Nipa thatching (%)	58 (12.11%)	29 (15.26%)	27 (12.56%)	114 (12.34%)
b) Number of shingles made per day (mean, sd)	61.46±48.75	73.10±39.03	69.63±28.89	(66.36±42.48)
c) Price per 100 shingles	400-500	443.10±123.09	496.30±19.24	(470.17±101.4)

Direct Use Value of Nipa Shingles Production

Unlike the mangrove trees, Nipa (*Nypa fruticans*) in Panguil Bay was owned by a few. These were taken care of by the so-called owners or assigned persons to manage the area. Nipa was harvested periodically (usually every three months) by a nipa leaves harvester, then passed on to the nipa shingle makers. In Tangub City, the nipa owner/caretaker offered a price of P1.20 per shingle (or P120 per 100 shingles for the nipa harvester (Table 7).

The same amount was offered to the nipa shingle maker. The total cost of producing a nipa shingle was P317.50. The nipa shingles were then sold by the owners/caretaker for P400.00-P500.00 per bundle (1 bundle =100 shingles). The prices of the finished product were more or less the same in all the areas in Tangub. The above data were validated on December 10, 2020. Owners, caretakers, and shingle-makers served as informants.

Table 7. Cost of producing shingles of *Nypa fruticans* in Tangub City, 2020.

Caretaker	Price of Nipa Shingles (*small= 1m* *Large – 1.5m)* 100 shingles = 1 bundle (Total Revenue, in PhP)	Labor Cost for collecting Nipa Leaves (per bundle of 100 shingles	Labor Cost for shingle making	Costs of bamboo sticks	Total operating cost (per bundle)	Direct use value
Caretaker A	P500/bundle	1.20 per shingle or P120/hundred shingles	1.20 per shingle or P120/ hundred	PhP70/ hundred	310	190
Caretaker B	600 per bundle	P150 hundred	PhP150/ hundred	PhP70/ hundred	370	230
Caretaker C	500/bundle	1.20 per shingle or P120/hundred	1.20 per shingle or PhP120/ hundred	P70/ hundred	310	190

On the other hand, key informant interviews were conducted with a few *nypa frutican* caretakers, nipa leaves collector and shingle makers, and other informants in Kolambugan and Tubod areas in December 15, 2020 (Table 8). According to Pablita Comarit of Manga, Kolambugan, the 100 shingles cost P700.00. Each shingle had a length of more or less 1.5 meters. On the other hand, Luzminda Dumalagan of Kulasihan, Kolambugan sold her nipa for P350.00 per bundle (100 shingles) with a length of 1 meter for each shingle (small) and P500-600 each bundle for bigger ones with more or less 1.5 meters length. She said further that the labor cost in obtaining a bundle of Nipa leaves (*bangan*) was P50.00; a bundle produced 50 to 60 shingles. The labor for shingle making ranged from P70-100 per bundle (100 shingles) or 7.00-10.00 for each shingle. The bamboo used in making the shingles cost P50.00 each (whole) and this produced 300-400 sticks; the cost of producing 100 pieces of sticks, labor included, was estimated at P50.00. On average, the shingles were sold at P550.00 per bundle with total operating costs of P394.45, resulting in a direct use value of P155.55 per bundle.

Table 8. Cost of producing shingles of *Nipa fruticans* in Kolambugan and Tubod, 2020.

Caretaker	Price of Nipa Shingles per bundle**	Labor for collecting Nipa Leaves (per bundle) PhP	Labor for shingle making (per bundle)	Costs of bamboo sticks (Per hundred) PhP	Total Operating cost (per 100 shingles)	Direct Use Value
A	350 (small) 500-600 (large)	50.00 (1 bundle =50-60 shingles)	P70-100 (1bundle =50 shingles)	50.00	290 350	60.00 150
B	700.00	100.00/bundle (40 shingles)	200	50.00	500	200
C	600.00	166.67*	200	50.00	416.67	183.33
D	500.00	166.67*	150	50.00	366.67	133.33
E	500.00	166.67*	150	50.00	366.67	133.33
F	500.00	166.67*	160	50.00	376.67	123.33
Mean	550.00	167.78	176.67	50	394.45	155.55

Notes: *100.00 per 3 sacks (each sack=20 shingles) =166.67
Length of small nipa shingle = 1m
Length of large nipa shingle = 1.5m
**1 bundle = 100 shingles

For the three sites under study, the average direct use value of *Nypa fruticans* was PhP181.53. Considering that there were 114 respondents or 12.34% who were involved in the production of nipa shingles, the direct use value for *nypa fruitican* in the bay was PhP20,694.42 per day. Nipa was available the whole year round but the harvesting was only quarterly. Considering that there were 30 days of work for producing nipa shingles in a quarter, the direct use value for one year would be PhP2,483,330.40.

Fish Species in Panguil Bay

The Bureau of Fisheries and Aquatic Resources (BFAR) Region X established fish landing areas in Panguil Bay. Among the three sites of this study, only Tangub City has two established fish landing sites such as those located in Barangay Maquilao and Pangabuan (*BFAR Region X, Cagayan de Oro City).* These areas were the sites where a collection of data on fish species was done. Figs. 2 and 3 depict the top 15 species of fish caught in the fish landing areas at Maquilao and Pangabuan in Tangub City in 2020. The results showed that in Maquilao, *Metapenaeus endeavouri* (Pasayan), *Arius maculatus* (Tagbangongo), *Scylla serrate (Alimango), GobY-001* (Tamasak, Bunog), *and Periophthalmodon schlosseri argentiventralis* were among the top 5 fish and crustaceans species caught from 2014-2017. While in Pangabuan, *Metapenaeus endeavouri (*Pasayan), *Scylla serrate (*Alimango)*, Johnius belangerii* (Dulama, Laya), *GobY_001* (Tamasak, bunog), *and Periophthalmodon schlosseri argentiventralis* were among the top five. It was noted that four species were common in the top five list for the two landing areas.

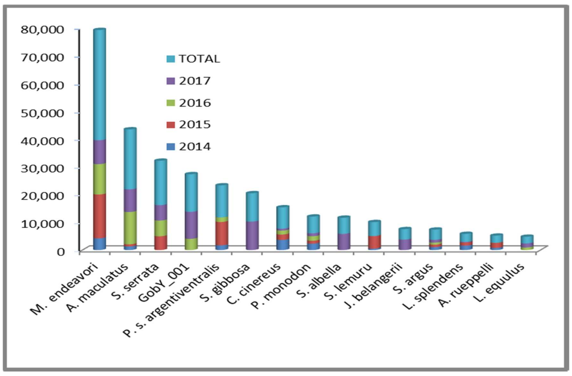

Fig. 2. Top 15 fish species caught in Maquilao, Tangub City Landing Area= (2014-2017) (Source: BFAR-Region X, Cagayan de Oro City).

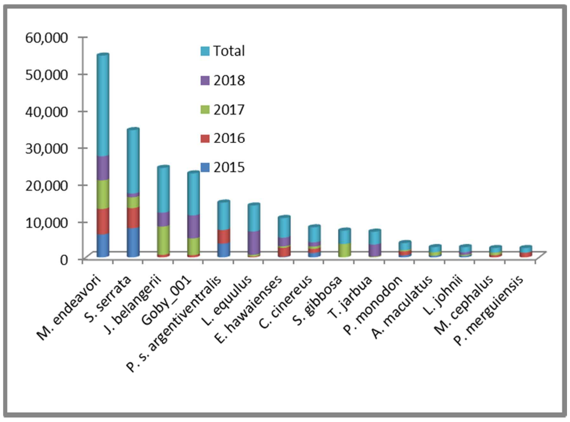

Fig. 3. Top 15 fish species caught in Pangabuan, Tangub City Landing Area (2015-2018) (Source: BFAR-Region X, Cagayan de Oro City).

Some of the aforementioned species inhabited the mangrove swamps during their juvenile stage. But others live there up to the maturity level. Mangroves play a very crucial role in the production of these species. *M. Endevori* with the local name *pasayan* was the foremost species produced in the two landing areas in Tangub City with an average of more or less 17,000 kilograms per year. *Sycilla Serrata* ranked second and third in the two landing areas in Tangub City such as Pangabuan and Maquilao, with more than 8,000 kilograms production per year. *Penneaus Monodon* is also abundant in Panguil Bay with more or less 2,000 kilograms produced per year in the two landing sites alone. With the average current market value (per information from the buyers from each locality) for 2020, *M. Endevori* (shrimps) could be valued at PhP3.4M, and crabs had an estimated value of PhP2.4M and the prawn could reach PhP1Mfor the two landing areas in Tangub City only.

These three species are the highest commercially known products in Panguil Bay. Their abundance made Tangub City and Panguil Bay known for being shrimp and crabs producers in the region. Tiger Prawn was one of the top five species captured or harvested in Northern Mindanao in 2018 with 14,600 metric tons (PSA, 2019).

Aside from the species mentioned above, some species captured in Tangub City, Panguil Bay inhabited along with the mangrove forests, estuaries of mangrove areas, and even inside mangals (mangroves) such as mudskipper (Zulkifli, 2012), *Arius maculatus* (Mazlan *et al*., 2008; Marceniuk & Menezes, 2007). Some studies confirm that several commercially and recreationally important reef-associated fishes utilized mangrove ecosystems during juvenile life stages (Amin *et al*., 2016; Savarro, 2015). The area of mangrove forests was found to have a real and positive effect on the production of shrimp and shellfish (Nagelkerken *et al*., 2008) but this was later found to not show a significant effect on total capture fisheries production (Hanifah and Eddiwan 2018).

Most species of fish have multiple habitats. The connectivity of these habitats has a significant effect on the diversity of species. Verhoeven (2016) pointed out that more than two-fifth of the fish species affected by the connectivity and size of mangrove forests were important reef community species with fishery value for fishermen. Species richness and abundance of fishes were significantly higher in coral reefs (234 species, 12,306 individuals) than in seagrass (38 species, 1,198 individuals) and mangrove (47 species, 2,426 individuals) habitats (Honda *et al.,* 2013). But fish densities were higher in mangrove mudflats than in non-mangrove habitats (Nip and Wong 2010). Olds *et al.* (2013) found out that Snappers (*Lutjanidae*) and rabbitfish (*Siganidae*) were more abundant on reserve reefs close to mangroves in all regions. However, the increasing levels of disturbances that indicate stress as a result of overutilization of mangroves by aquaculture farms or directly impacted by human visitation were reported to be factors of the decreasing pattern of fish abundance and diversity (Abroguena *et al*., 2012; Mallette, 2013). In the case of Panguil Bay, the denudation of mangroves for several years was the cause of the decreasing fish production. However, the rehabilitation of mangroves coupled with the strict implementation of the fishery policies in the local scene has gradually improved fishery production.

This study did not include the fish catch of fishers as it cannot be claimed that the volume of the fish catch was attributable solely to the mangroves.

Direct Use Values of Shrimps and Crabs

Shrimps and crabs are important fishery resources in Panguil Bay and are common bycatch of fishers. Table 9 presents the volume of shrimps caught by the fisher respondents. The results revealed that among the 528 fishermen-respondents, 360 or 68.18% have usually caught shrimps during their fishing activities. The catch of the fisherfolks was not shrimps only. Their fishing nets or gear can catch any species of fish and crustaceans, especially if they are using push nets and *bunsod.* There are instances that the fisherfolks did not have shrimps as by-catch because the shrimp's presence or abundance is dependent on the tidal season.

Table 9. Percentage of fishermen-respondents who caught shrimps along with other species during fishing**.**

City/ Municipality	No. of respondents who caught shrimps	Percentage of respondents who caught shrimps	The volume of catch per fishing day, inkg (Mean ±Sd)	Estimated Revenue from shrimps per fishing day (PhP) (Meankg x average market price)	Operating Cost of Catching shrimps (*Labor, operating costs, depreciation cost*)	Direct Use Value of shrimps per fishing activity per fisherfolk
Tangub (n=336)	255	74.4%	1.58 ±0.96	316	122.19	193.81
Tubod (n=30)	28	90.0%	1.89±5.21	378	119.85	258.15
Kolam-bugan (n=162)	77	50%	0.83± 0.61	167	119.85	47.15
Total (n=528)	360	67.8%	1.44±1.09	288	121.02	166.98

Note: n is the number of fishermen-respondent only.

Among the three areas in the study, the municipality of Tubod had the highest percentage of shrimp catchers with 93.3%. The fishermen caught an average of 1.44kg of shrimps per fishing effort in 2020 with the highest volume of catch reported in Tubod with 1.89kg. Usually, the catch was sold at the prevailing market price of P200.00 per kilogram. The price was obtained from the comprador or middlemen in the area. Each fisherman earned an average direct gross value of PhP288 per fishing activity for the shrimp catch alone. Subtracting the operational costs of PhP121.02 (average of PhP102.50 of labor and PhP18.52 depreciation cost)., the direct use value was computed at PhP166.98 per fisherman per fishing activity**.** However, there was only an average of 20 days a month that a fisher was able to catch shrimp, thus, with 360 fisherfolks who caught shrimps during fishing activity, the direct use value for one day would reach PhP14,427,072 for one 2020. The result was higher than in the two Subdistricts in Indonesia where the direct use value for shrimps was estimated at IDR2,748,200,000 (PhP9,644,551.82; USD 189,070.06) (Jelita *et al.*, 2019), and IDR 1.530.000 (PhP 5,373.48; USD 105.26) (Rosadi *et al.*, 2018). This implies that with this value, there is a need to do mangrove conservation and rehabilitation.

The operating costs were the labor and depreciation costs of equipment and fishing gear per fishing activity. Labor cost per day was based on the regional wage memorandum of PhP311/day (Wage order No. RX-18, 2016) for agricultural workers which continued to be the 2020 rate for Tangub and PhP304/day (2016 regional rate for agriculture sector) for Kolambugan and Tubod. The daily wage was considered the labor cost per day for catching the three groups of species (crabs, shrimps, and others species) during the day. Depreciation costs of fishing gear and equipment were similar for the different species caught by the fishermen-respondents. The costs of fishing gear and equipment per household were estimated at PhP40,000.00 including maintenance and operating costs with a lifespan of 2 years. The value was based on the Fishing Guide edited by Monteclaro *et al.* (2017) that the cost of gear construction and maintenance of fish corral at the maximum of PhP40,000, filter net (Tanggab) -15,000, Hila-hila or baling -PhP4,300, and push nets -PhP1,000.00. On the other hand, in the Panguil Bay area, the cost of non-motorized boats ranged from 5,000 to 10,000. Thus, the daily depreciation costs were estimated at PhP18.52 for each of the three groups. On the other hand, the labor cost for one day was also divided among the three main fishing products, namely: shrimps, crabs, and fish. The PhP311 daily wage in Tangub was also divided among the three products; the labor cost for each was PhP103.67. For this, the total operating cost of catching shrimps alone would be PhP122.19.

Catching shrimps was dependent on the tidal period. The volume of the catch was higher during high tide or what is known as *dakong dagat* (during new moon and full moon) and minimal during low tide which is referred to as *ayaay* (moon quarter) which occurs during the first and last quarter of the month. This finding is supported by Libini and Khan (2012) in their study on mangroves in Tamil Nadu, India, who found out that there were significant variations in a total catch during different lunar phases for shrimps caught by trawling. They said further that maximum catch per unit effort (CPUE) for gillnetting and trawling were recorded during the occurrence of the new moon while the catch was at a minimum during the appearance of the full moon quarter.

Three hundred fifty-eight or 67.8% of the fishermen-respondents reported having caught crabs during their fishing activity (Table 10). The fisherfolks were multi-producers as they usually caught a combination of crabs, shrimps, and fish species during fishing activities. There were instances that the fisherfolks chose only to catch a single species, say crabs, depending on the situation. Each fisherfolk caught an average of 1.37 kilograms of mangrove crabs which would earn P411.00 based on the prevailing market price of P300.00 per kilogram in 2020. Tangub registered the highest volume of crabs caught per fishing effort, amounting to 1.61kg. Although the crabs are classified in the market and each classification has a corresponding price, the average price was P300.00 per kilogram. The direct use value for crabs per day was estimated at PhP289.98 per fisherman per fishing day. Considering that not all day in a month fisherman catches crabs. Assuming that 20 days in a month a fisherman can catch crabs, and 358 fishermen usually caught crabs during fishing, the direct use value for crabs in the three study sites was estimated at PhP24,915,081.6 per year. This finding was very much higher than in Secanggang Subdistrict of Indonesia where the one-year direct use value for crabs was IDR 1,055,400,000 (PhP3,675,858.67; USD72,626.167) (Jelita *et al* 2019), and in Gerung Subdistrict with only IDR 60,000 (PhP210.62; USD4.12) (Rosadi *et al.*, 2018). The significant difference in the values may be due to the size of the study area where the two studies in Indonesia were conducted only in a village. The village was equivalent to one barangay in Panguil Bay. As part of their livelihood since childhood, with a strong confirmation by several fisherfolks in the area, mangrove crabs (*S. serrata*) were caught throughout the month and year. However, the volume of catch depended largely on the tidal water situation and moon phase.

Table 10. Percentage of fishermen-respondents who caught crabs (*as part of the many species*) during fishing activity, 2020.

City/Municipality	Fisherfolk-respondents F (%)	The volume of catch per fishing day Kg (Mean±Sd)	The estimated value of crabs per fishing day (PhP) (Meankg x average market price)	Operational Cost of Catching crabs (*Labor, operating costs, depreciation)*	Net Value of crabs per fishing activity per fisherfolk
Tangub (n=336)	250 (74.4%)	1.61±1.57	483	122.19	360.81
Tubod (n=30)	27 (90%)	1.31±4.87	393	119.85	273.15
Kolambugan (n=162)	81 (50%)	0.64±0.43	192	119.85	72.15
Total (n=528)	358 (67.8%)	1.37±1.09	411	121.02	289.98

This finding is corroborated with the studies of Shelley & Lovatelli., (2011) in Brazil and Nishida *et al.*, (2006). Specifically, Nirmale *et al.* (2012) in their study on the "Ethnoecology of *Scylla serrata* in Ratnagiri coast, Maharashtra; reported that mangrove crabs are caught in good numbers in high tide, particularly during the night time; and during new moon day, these crabs have more bodied meat than those caught on the full moon. However, Duarte *et al.* (2014) did not find the lunar phase as one of the strongest influences on the crab catch per unit effort (CPUE).

Issues and challenges in valuing the direct uses of mangroves

Mangrove resources were not usually valued explicitly even if these were used frequently by people. This was because people residing in the mangrove areas believe that the resources are for free. Before the full implementation of the policy of no cutting of trees, residents were free to use all the resources for their welfare and they never thought of valuing the benefits that they had gotten from the resources. A single mangrove tree (*Avecinnea, Rhizophora*) used as the post can be considered free if a resident was the one who cut and carried the resources for the construction or repair of his own house. Unless a resident sold what he cut, then it's time to value the resource based on his system of valuation and the prevailing market price. Nevertheless, direct valuation was done using the prices of the related products.

Although most of the respondents believed that mangrove resources were owned by the government, others claimed them as part of their territory. A *Nipa frutican,* for example, if this species grew near the house or territory of a resident and he/she took care of it, then he claimed ownership for it. He had the right to prune and sell the thatches. The value of *Nipa frutican* was based on the thatch, not the standing shrub. This study only focused on a small selection of ecosystem services based on the availability of market prices. Most other studies were also done based on the accessibility of measurement of values such as market prices (Himes-Cornel *et al.*, 2018).

Conclusions and recommendation

The use of mangroves was different two to three decades ago when the residents were free to cut trees for household use, particularly for firewood and construction and repair of houses. The direct use-value of mangroves as utilized for the construction and repair of houses in 2020 was very low which means the policy of no-cutting of trees is effective. This policy desisted people from using mangroves for shelter and other economic activities. People may have realized that mangroves can better serve their most important functions such as protection against typhoons and as nursery and habitat of juvenile fishery resources. Multi-habitat species such as *Metapenaeus endeavouri* and *Scylla serrata* are the top producing fishery products in the Panguil Bay where the mangroves could be a significant contributory factor for their production. On the other hand, the valuation of mangroves has not been practiced despite their perennial use. Valuation of resources is always neglected in planning and implementing restoration or rehabilitation programs. It is argued that knowing the values of all the mangrove resources could help environmental planners to formulate strategies for sustainable mangrove development. It is also argued that the absence of valuation of the natural resources in the ecosystem in the planning process for mangrove conservation and management would lead to a flawed policy. Weak policy results in poor implementation of projects, and this mirrors weak governance.

The following are the recommendations;

1) Since there is already strict monitoring of the policy of no cutting of trees, then, if in case the trees are cut due to strong winds or natural disasters, still these should be reported and to be valued based on the current market value. Doing this will help the decision-maker in the care and protection of mangroves. In consonance with this, an ordinance can be formulated by the City or municipality that the fallen trees or any mangrove trees that are cut due to both natural phenomena and anthropogenic activities shall be reported and valued.
2) Research on the extent of the contribution of mangroves to the production of fish and crustaceans in the mangrove areas may be conducted. This would help in valuing mangrove services.
3) Since the study deals with the environment, and the people, a more in-depth analysis through the use of the case study method is highly recommended in future research endeavors. In addition, different valuation techniques, such as contingent valuation, can be used in future research on valuing mangroves.

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