International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Economic Valuation of the Mangrove Forest Ecosystem in Zamboanga City, Philippines

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ABSTRACT

BACKGROUND: Mangrove forests are considered one of the most productive and biologically diverse ecosystems in the world. The purpose of conducting this economic valuation study of the mangrove forest ecosystem is to ensure the effective use of mangrove resources by raising the public and decision-maker's awareness of the potential use and benefits of mangroves to the community and the environment.

OBJECTIVES: This study assessed the total economic value of the mangrove forest ecosystem in Zamboanga City, Philippines by taking into account the direct use values of mangroves (for example; shrimp value, crab value, and mollusks value), indirect use values of mangroves (for example, the fish value obtained from the nursery and breeding grounds potential of mangroves, coastal protection value of mangroves which include sediment trap for erosion prevention and mangrove protection from strong waves and flooding, and sequestering carbon in the atmosphere), and the people's willingness-to-pay and willingness-to-work for the option value of the mangrove forest (for example; future potential direct use and indirect use of mangroves).

SAMPLE: A research survey was conducted to the mangrove beneficiaries (for example, fisherman, crab and shrimp seeker, shellfish/mollusks picker) of Barangay Mampang, and Barangay Talon-Talon, Zamboanga City.

METHODS: Data was collected in April 2022. The market price method was used to calculate the direct use value of mangroves. Replacement cost and Benefit transfer methods were used to assess the indirect use value of mangroves. While the Contingent valuation method was used to determine the option value of mangroves by assessing the willingness-to-pay and willingness-to-work of the respondents for the mangrove conservation and protection program.

RESULTS: The total economic value of mangroves in Barangay Mampang and Barangay Talon-Talon, Zamboanga City amounts to 1,559,918.88 United States Dollars/year. The direct use value of mangroves reached 661,703.47 United States Dollars/year from the operational costs and market prices of the various fishery resources provided by the mangrove forest. While the Indirect use value of mangroves reached 881,524.30 United States Dollars/year obtained from the potential of mangroves to provide nursery, feeding, and breeding grounds for fish, protect the coast from flooding and storm surges, and sequester carbon dioxide in the atmosphere. The average willingness-to-pay of the respondents for the mangrove conservation and protection program is 8.16 United States Dollars/household/year. Their mean willingness-to-work is 6 labor days/month, equivalent to 184.86 United States Dollars/year in monetary terms at the local wage rate. The total option value of mangroves obtained by adding the amount willing-to-pay and amount willing-to-work of the respondents reached 22,296.11 United States Dollars/year.

CONCLUSION: Mangrove Forest benefits the coastal communities by providing nursery, feeding, and breeding grounds for fishery resources, protecting coastal communities from strong waves, and flooding, and sequestering carbon in the atmosphere. To sustainably maintain the provision of goods and services provided by the mangroves, participation in cash or in kind of the beneficiaries are essential as part of the mangrove conservation initiatives in Zamboanga City. The researchers of the study recommend the policymakers, and the local government unit of Zamboanga to use this economic valuation study as a reference in implementing mangrove conservation programs and developing policies concerning the effective use and management of mangrove resources.

KEYWORD: Contingent valuation method; Direct use value (DUV); Indirect use value (IUV); Mangroves; Option value (OV); Total economic value.

1. Introduction

Mangrove forests are considered one of the most productive and biologically diverse ecosystems in the world. They are considered a natural resource which has various potentials and benefits for human life. Benefits derived from a natural resource can be divided into two main components known as Use value and Nonuse value (Azmi, 2014). Use value components of mangroves are comprised of direct use value (DUV) (e.g., shrimp, crab, mollusks, firewood, timber, and charcoal), indirect use value (IUV) (e.g., nursery and breeding grounds, coastline protection, seawater intrusion prevention, and carbon sequestration), and option value (OV) (e.g., agricultural, leisure, pharmaceutical, water use, habitat, and species) (Emerton et al. 2003; Bann, 2016). While the non-use value of mangroves includes existence value (e.g., cultural value and aesthetic value) (Vo et al. 2013). People must invest in protecting the mangrove forest ecosystem because they provide these valuable goods and services that are essential not only in sustaining the lives and livelihoods of millions of people along the world's coast, but also in real economic terms. Philippines, an archipelagic country comprised of more than 7,000 islands and has one of the world's longest coastlines stretching up to 36,289 kilometers (km). Because of its geographical location, mangrove diversity in the country is relatively high, comprising 50 percent (%) of the total mangrove species in the world (Garcia et al. 2013; Buitre et al. 2019). These mangrove species are found in mangrove rich areas in the Philippines, such as Zamboanga City. Zamboanga City is a province of Zamboanga Del Sur in Western Mindanao which ranks 8th in the list of the provinces with majority of mangrove extent (Long & Giri, 2011). Mangrove forests occupy the south-eastern sides of the city. They safeguard the city from major coastal dangers such as tropical storms and extreme flooding. Coastal communities strongly depend on mangroves as a source of food and livelihood. However, despite the benefits provided by the mangroves to the coastal communities in Zamboanga City, mangroves are under pressure due to uncontrolled harvesting/cutting, water pollution, overexploitation of mangrove resources, and conversion of mangroves for shrimp and fishpond aquaculture. The continued pressure on mangroves may lead to mangrove loss and destruction which may affect the consumption and livelihood of coastal communities. Considering this problem, it is indeed important to educate the community and give them awareness about the function and potential of mangroves. One of the efforts to do this is to calculate the total economic value (TEV) and benefits of the mangrove forest ecosystem. The calculation will be used as a reference in mangrove utilization as part of an effort to conserve the mangrove forest ecosystem (Rumahorbo et al. 2019). According to studies, mangrove forests in the Philippines are affected from habitat destruction and degradation because the economic value of their benefits and services is not

fully measured and accounted in policy making and management decisions. The importance of better valuation is vital to help ensure that these coastal habitats are recognized and protected (Losada et al. 2017). To date, economic valuation study in the Philippines is only limited to these two areas: Palawan in Northern Luzon and Bohol in Central Visayas. Research on economic valuation study in the Philippines are only limited because most mangrove research study focus on other research areas, such as conservation and management, biodiversity, ecology, and biogeography. Thus, to fill in the gap, this study wishes to conduct a comprehensive assessment of the total economic value of mangrove forest ecosystem in less studied areas such as Zamboanga City, in Western Mindanao, Philippines. The study will consider not only the marketed direct use value of mangroves, but also the indirect use and option value of mangroves. By summing up all the values, an estimation of the total economic value of the mangrove forest ecosystem in Zamboanga City can be determined. The study aimed to assess the total economic value of mangrove forest ecosystem in Zamboanga City. Specifically, it aims to: 1) Calculate the direct use values of mangroves (e.g., shrimp value, crab value, and mollusks value) using the market price method; 2) Calculate the indirect use values of mangroves (e.g., fish value obtained from the nursery and breeding grounds potential of mangroves, carbon sequestration value of mangroves, and coastal protection value of mangroves) using market price, replacement cost, and benefit transfer method; 3) Determine people's perspective, willingness-to-pay (WTP) and willingness-to-work (WTW) for the option value of the mangrove forest (e.g., future potential direct use and indirect use of mangroves). This study has been carried out in Barangay Mampang and Barangay Talon-Talon, Zamboanga City, Philippines in 2022. To the researcher's knowledge, no published article focused on assessing the total economic value of mangrove forest ecosystem in Zamboanga City, Philippines.

2. Materials and Methods

2.1 Study area

The study was conducted in Zamboanga City, located in Western Region of Southern Mindanao, Philippines. Zamboanga City is the third largest land area in the Philippines under the province of Zamboanga del Sur, which ranks 8th in the list of provinces with most of the mangrove extent. The study focused on the mangrove forests in Zamboanga City located in Barangay Mampang and Barangay Talon-Talon (Fig. 1).

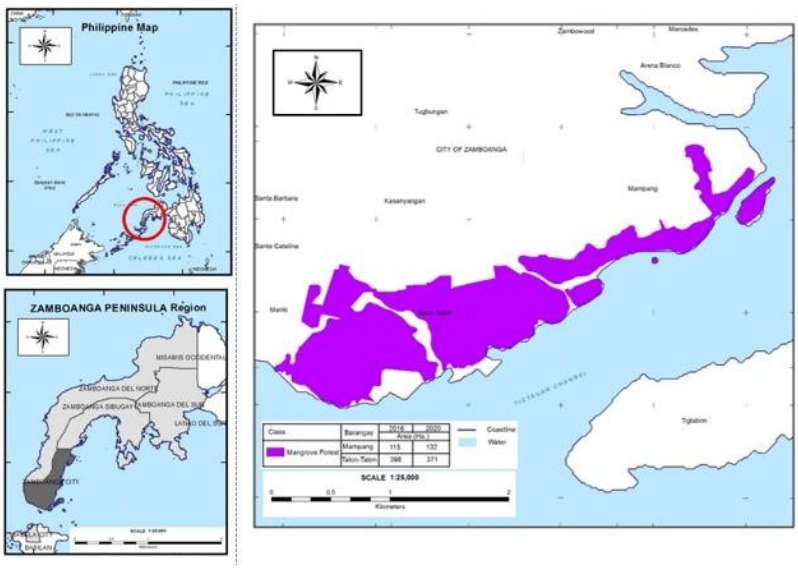

Fig. 1: Geographic location of the study area of the mangrove sites in Zamboanga City, Philippines

As per the digitized map of the DENR-National Mapping and Resource Information Authority, the total mangrove area in the two barangays is 503 hectares (has). There were 5 recorded species of mangroves in the two barangays, namely: *Rhizophora mucronata, Rhizophora stylosa, Rhizophora apiculata, Avicennia marina, and Sonneratia alba.*

2.2 Data collection

Data on the direct use value, indirect use value, and option value of mangroves were collected by conducting household survey to the mangrove beneficiaries in Purok VII, Km. 8 Barangay Mampang and Logoy Grande Road, Barangay Talon-Talon. Prior to the conduct of the survey, a permit was secured from the Office of the City Agriculturist of Zamboanga and the Barangay Chairman of Mampang and Talon-Talon. The survey data was collected for 4 days in April of 2022 from 9:00 in the morning to 1:00 in the afternoon. Participants were selected by a purposive sampling method (a non-probability sampling technique where respondents are selected based on the purpose of the sample). Qualified respondents are 18-59 years' old and belong to either of the following category: fisherman, crab and shrimp seeker and shellfish/mollusks picker who are currently residing near the mangrove sites of the Barangays. For this study, 70 members of the Mampang Seaweed Planters Association (MASEPLA) and 45 respondents from the Subanon tribe in Barangay Talon-Talon volunteered to participate in the survey. Each respondent is a representative of their respective household. They were given 15-20 minutes (mins). to answer the prepared research questionnaire.

2.3 Data analysis

For the direct use value of mangroves, all data needed for the calculation was obtained through the household survey using the prepared research questionnaire. Calculation of Direct use value was based on the mangrove goods (e.g., fishery products) directly collected/harvested by the coastal communities within the mangrove areas only (fishery resources from seagrass, coral reefs and those cultured from the ponds are not included for valuation). Crab, shrimp, mollusks, including the indirect use benefits of mangroves as provider of fish (obtained from its potential as a nursery and breeding grounds) was calculated using the market price method. For the extracted fishery resources sold in the market, the study considered the average production costs of each resource (costs of obtaining the products and costs for the sale of the products, in United States Dollar (USD) value). Each respondent was asked to provide the price of the various fishery resources they sell per kilogram (kg) (price refers to the annual (year (y)) average price of each resource). For efficient analysis and computation, the value of each fishery resource such as fish, crab, shrimp, and mollusks were grouped based on the types of species obtained by each household. The direct use value of mangroves was calculated by applying the market price method using Eq. 1 (Malik et al. 2015; Bann, 2016).

(Fish value (FV), Crab value (CV), Mollusks value (MV), Shrimp value (SV):

FV; CV; MV; SV = Production (kg/y) × Price (USD/kg) − Production cost (USD) (1)

Carbon sequestration value, and coastal protection value which falls under the Indirect use value of mangroves was estimated by using the benefit transfer method and replacement cost method using the formulas presented in the succeeding discussions (Malik et al. 2015; Bann, 2016). For the estimation of the carbon sequestration value of mangroves, the value is estimated by using transferring rates of carbon storage of mangrove base from the study carried out by the United States Agency for International Development (USAID) last 2017. The study calculated the projected carbon benefits of mangroves from

avoided deforestation (deforestation rate = 0.8%). The study found out that for the year 2022, the annual benefit is 16,514 tCO_2 (tons of Carbon dioxide). The total mangrove area in the two barangays is 503 has as per the digitized map per google earth satellite imagery. The mangrove forests in Barangay Mampang and Barangay Talon-Talon have a carbon sequestration rate of 32.83 tCO_2/ha/y. For the price of carbon credits, it was based on the real time pricing of carbon credits retrieved from https://carboncredits.com/carbon-prices-today. The study adapted the carbon credit of Australia which amounts to USD 35.25. To relate the carbon credit value to the mangrove context, the study adapted the carbon credit price of Australia, because compared to other countries (e.g., European Union, California, New Zealand, and South Korea) who are also imposing carbon credits, Australian mangrove forests comprised of more than half of the world's mangrove species, which consists of 41 species of mangroves from 19 plant families. Lin et al. (2021) indicated that mangrove forests with greater species diversity can store more carbon. Carbon sequestration value (CSV) of mangroves in Barangay Mampang and Barangay Talon-Talon was determined by multiplying the carbon sequestration rate to the total mangrove area and the price of the carbon market. The CSV of mangroves was estimated using Eq. 2 (Malik et al. 2015; Bann, 2016):

CSV = carbon sequestration rate (tCO_2 /ha/y) x total area of mangrove (ha) × (2)

Price of carbon market (USD/$tCO2$)

For the benefits of mangroves as sediment trap and coastal protection, the value was obtained using the replacement cost method, by determining the cost of constructing a breakwater, specifically a rubble concrete revetment (spread type 1) (a type of flood control and slope protection structure) with a height of 3.00 meter (m). The flood control and slope protection structure are designed to safeguard the coastal communities, river-bank areas, and infrastructures against frequent small floods, increasing sea levels, and storm surges. This engineered structure for this study is a replacement/alternative to the ability of mangroves as coastline protector. The data on the estimated construction cost was obtained from the Department of Public Works and Highways (DPWH). According to the DPWH, for region IX, the estimated cost of constructing a rubble concrete revetment is USD 312.93 per linear meter. The data for the actual coastline length of Barangay Mampang and Barangay Talon-Talon was requested from the Department of Environment and Natural Resources – Biodiversity Management Bureau (DENR-EMB) which was approximately 10,000 m. The calculation of the coastal protection value (CPV) of mangroves was estimated using Eq. 3 (Malik et al. 2015; Bann 2016).

CPV = coastal length (m) × cost of breakwater construction (USD) (3)

The study also calculated the capitalization cost of construction since constructing a rubble concrete revetment is expected to produce an economic benefit beyond one year. The study considered the initial costs of construction, expected lifespan of the structure, annual maintenance expenses, and the discount rate. For the initial costs of construction, the study adapted the value generated from multiplying the coastal length (m) to the estimated cost of construction (USD) with a lifespan of a breakwater structure reaching 30 - 50 years (Appelquist et al. 2016). For the annual maintenance expenses, according to Heberger (2009), during the course of the project, the maintenance costs for engineered riprap-revetment can range from 2% to 4% of the construction costs annually. Hence, the social discount rate of 10% was utilized which was adapted from the National Economic and Development Authority (NEDA). Equivalent annual cost (EAC) for the construction of rubble concrete revetment was first calculated by computing for the annuity factor using Eq. 4 (Kenton, 2020).

$$\text{Annuity factor} = 1 - \frac{1}{\frac{(1+r)^t}{r}} \quad (4)$$

Where; r = Cost or capital (also called the discount rate)
t = number of periods
After computing for the annuity factor, the next step was to divide the initial costs of construction to the annuity factor, while adding in the maintenance cost.
Calculation of the equivalent annual cost (EAC) was computed using Eq. 5 (Kenton, 2020).
EAC = Initial costs annuity factor + Annual Maintenance cost (5)
Option value of mangroves was estimated by using the contingent valuation method (CVM) (Barbier, 1989). Using the dichotomous-choice referendum format, respondents were asked for their willingness-to-pay for the mangrove conservation and protection program to ensure the future potential direct use and indirect use benefits of mangroves. A hypothetical market scenario was presented to each respondent, highlighting the current state of the mangroves, and the possible circumstances that might happen if mangroves are loss. To get the mangroves back to its current healthy state, a supposed trust fund for the conservation and protection of the mangrove forest ecosystem will be created. The trust fund will be managed by a council of stakeholders which includes the mangrove beneficiaries of the barangays, the government agencies (Department of Agriculture and Department of Environment and Natural Resources), Local Government Units, and Non-Government Organizations. They will administer the activities that will be supported by the fund, all of which are directed to the conservation and protection of the mangrove forest ecosystem. Considering the different issues/threats to mangroves, and the need to conserve and protect it, the respondents were asked if they are willing to vote for a legislation that will create the trust fund if the passage requires all mangrove beneficiaries to contribute at least USD 8.91 – USD 17.81/household/year. For those respondents who are not willing to contribute for the set fees, the respondents were given the option to state the amount that they are willing-to-pay. Prior to asking the respondents on the amount that they are willing-to-pay for the mangrove conservation and protection program, the respondents were also asked on their preferred mechanism to collect the fee and the basis of charging the fee. The average willingness-to-pay is calculated by summing up the individual value of willingness-to-pay of each respondent and dividing it to the number of respondents.
The average of willingness-to-pay was computed using Eq. 6 (Barbier, 1989; Rumahorbo et al. 2019).

$$\text{OWTP} = \frac{\text{WTP}_{\text{Total}}}{\text{N}} \quad (6)$$

Where;
$OWTP$ = Average Willingness-to-pay for Option value
$WTPTotal$ = The total willingness-to- pay of all respondents
N = Number of respondents
After getting the Average of WTP for the option value, the next step was to convert the results of the $OWTP$ into the population WTP by multiplying the $OWTP$ value to the total number of households. The population WTP was calculated using Eq. 7.
Population WTP = OWTP x Total number of households (7)
For the assessment of the willingness-to-work of the respondents for the option value of mangroves, the average wage rate of time (WRT) was used to value the opportunity cost of time (Arbiol et al. 2013). The average WRT was also calculated by summing up the willingness-to-contribute labor or willingness-to-work of the respondents. The respondents of Barangay Mampang and Barangay Talon-Talon were expected a wage rate of USD 5.64 (which is the minimum wage rate for 8 working hours in Zamboanga

City). The yielded value was divided to the total number of respondents. Average WRT was calculated using formula (8) by Arbiol et al. (2013):

$$\text{Average WRT} = \frac{\sum[\text{WTCL}_i \text{ x } W_i]}{N} \quad (8)$$

Where;

$WTCLi$ = Willingness to contribute labor (WTCP) or Willingness to work by respondents i

Wi = expected wage of respondent

N = total number of respondents in the sample

To test the validity of the results, the willingness-to-pay and willingness-to-work responses were related to the socio-economic and demographic characteristics of each respondent. Thus, the study conducted a logistic regression analysis using the Microsoft excel software to describe and explain the relationship between one dependent binary variable (e.g., amount willing-to-pay / amount willing-to-work), and one or more independent variables (e.g., Income, Age, Gender, Education, and Number of dependents). A dichotomous-choice format was used where fixed alternative questions are provided and can only be answered by Yes or No. The responses of the respondents are denoted as 1 for agreement and 0 for disagreement. Each respondent belongs to one of two groups: willing-to-pay/work and not willing-to pay/work. The result of the logistic regression was used to determine the different factors that affect the response of the respondents. Table 1 showed the list of different variables used for analysis and its corresponding definition. Certain questions were also prepared to assess the understanding and awareness of the respondents on the current condition of the mangroves in the environment.

Table 1: Different variables used for analysis and its definition

Type of variable	Variables	Description
Dependent variable	WTP	Willingness-to-pay – an indicator variable indicating the willingness-to-pay of the respondents for the mangrove conservation and protection program. Taking the value of 1 for their willingness-to-pay, and 0 for their unwillingness-to-pay.
	WTW	Willingness-to-work – an indicator variable indicating the willingness-to-work of the respondents for the mangrove conservation and protection program. Taking the value of 1 for their willingness-to-work, and 0 for their unwillingness-to-work.

Independent variable	**Inc**	**Income – the monthly income of the household. Taking the value of 1 if the respondent falls in the category of POOR (income below USD 195.19/month), and 0 if the respondents fall in the category of LOW INCOME, BUT NOT POOR (income of USD 195.19/month to USD 390.37/ month)**
	Age	Age – an indicator variable indicating the age of the respondents. Taking the value of 1 if a respondent is in the late middle age and late adulthood age (ages 45-65 years old and older), and 0 if otherwise.
	Gender	Gender – an indicator variable indicating the gender of the respondents. Taking the value of 1 for male, and 0 for female.
	Educ.	Education – an indicator variable indicating the level of education obtained by each respondent. Taking the value of 1 if respondent reached at least high school level, 0 if otherwise.
	NOD (<18 years old)	Number of dependents – an indicator variable indicating the number of dependents in each household. Taking the value of 1 for respondents having a child/dependent below 18 years old, and 0 if otherwise.

For the first set of questions, the respondents were asked what for them is the important problem the government must solve. Respondents were given the following options: *Mangrove destruction due to aquaculture development*, *Mangrove destruction due to land development*, *Coastal water pollution*, and *Deforestation of mangroves for firewood*, *timber*, *charcoal*, and *fuel*. For the second set of questions, respondents were asked to rate the importance of each benefit and services of mangroves (provider of fishery and forestry resources, recreational value, flood, erosion and salinization prevention, biodiversity conservation, and benefits for future uses (e.g., pharmaceutical use)). Furthermore, the respondents were tasked to give their idea on the possible factors that might affect the existence of mangroves in their barangays. Respondents were given the following options:

Agriculture, aquaculture, overexploitation of mangrove resources, coastal water pollution, and climate change.

The total economic value of mangrove ecosystem was assessed by adding the Direct Use Values (crab, shrimp, and mollusks), Indirect Use Values (fish value obtained from the potential of mangroves as nursery and breeding grounds, carbon sequestration value, and coastal protection value), and Option Value (willingness-to-pay and willingness-to-work for the future potential direct use and indirect use of mangroves) per hectare of mangrove forests.

Total economic value (TEV) was calculated using Eq. 9 (Rumahorbo et al. 2019)

TEV = DUV + IUV + OV (9)

Where:

DUV = Direct use value

IUV = Indirect use value

OV = Option value

3. Results and Discussions

3.1Direct use value of mangroves

Table 2 showed the socio economic and demographic data of the respondents.

Table 2: Socio economic and demographic data assessment

Level	No. of respondents	%
Educational attainment		
Elementary level	61	53.04
High School level	45	39.13
College level	9	7.83
Total:	115	100
Occupation		
Seaweed farmer	66	57.39
Fisherman	19	16.52
Laundrywoman	4	3.48
Security guard	1	0.87
Plain housewife	10	8.7
Laborer	1	0.87
Tricycle driver	1	0.87
Mollusks/crab seeker	4	3.48
Warehouse man	1	0.87
Sari-sari store owner/vendor	4	3.48
Housekeeper	1	0.87
Care giver	1	0.87
Barangay worker	1	0.87
Construction worker	1	0.87
Total:	115	100
Monthly income range (USD)		
Poor (Below USD 195.20)	100	86.96
Low Income-But not poor (USD 195.20 – USD 390.37)	15	13.04
Total:	115	100
Number of Dependents (<18 years old)		
1-3 children	48	41.74
4-6 children	13	11.30
7 and above children	2	1.74
Total:	115	100

A total of 53.04% (61 out of 115 respondents) of the respondents in Barangay Mampang and Barangay Talon-Talon are elementary graduates, while 39.13% (45 out of 115 respondents) of the respondents reached high school level, and only 7.83% (9 out of 115 respondents) of the respondents were able to finish college. Aside from being the beneficiaries of mangroves in their respective barangays, the 66

respondents are seaweed planters, while others have alternative occupation aside from planting seaweed. They worked as fisherman, laundrywoman, security guard, laborer, tricycle driver, warehouseman, sari-sari store owner, food vendor, housekeeper, caregiver, barangay worker, and construction worker in regular working days. Results showed that 86.96% (100 out of 115 respondents) of the respondents are categorized as *Poor*, with monthly income below USD 195.20/month. While only 17.25% (15 out of 115 respondents) of the respondents fall into the category of *Low income-But not poor*, as they earn USD 195.20 – USD 390.37 monthly. Furthermore, it also showed that a total of 54.78% (63 out of 115 respondents) of the respondents still have dependents below 18 years old. Thus, their monthly income is limited and shared with the other members of the household to budget for their food, monthly bills and to sustain the needs of their dependents. As per the study's preliminary findings, all the 115 respondents are confirmed mangrove beneficiaries from Barangay Mampang and Barangay Talon-Talon. 41.74% (48 out of 115) of the respondents have made a living in the mangroves for more than 20 years. They visit the mangrove area on a weekly basis with their friends and family to capture various species of crab, shrimp, and mollusks which they utilize for livelihood and food consumption. This finding conformed to the study of Muckherjee et al. (2014) and Himes-Cornell et al. (2018) where they found out that mangroves indeed provide many ecosystem goods that are essential in sustaining the livelihoods and welfare of the poor and marginalized people. Tides transport nutrients and marine organisms into the mangrove swamps. During low tide, coastal dwellers collect species of mollusks across the tidal flats. While at high tide, species of juvenile shrimps move into the mangroves to feed (Vance et al., 1996). The mangroves serve as their nursery ground before they migrate to deeper water when they become adolescents. On the other hand, crab species dig deep burrows in the mangroves (SAD, 2016). These crabs live in the burrows in the base of the mangrove trees where they are usually caught (Ng et al. 2011). Mollusks of different kinds, including oysters and mussels are also supported by mangroves. These species attached themselves to the roots of the mangroves and the lower parts of the mangrove trunks, where they are usually harvested and found (DENR, 2013). Using traditional equipment such as nets, crab traps, and scoops, the respondents capture different species of crabs which include the Mangrove crab or Mud crab *(Scylla serrata)* locally known as "*alimango*", Orange mud crab *(Scylla olivacea)*, Green mud crab *(Scylla paramosain)* and blue swimming crab *(Portunus pelagicus)* which is often termed as "*alimasag*." These crabs can be sold at higher prices depending on their type and size. The prices of crab range between USD 8.03 to USD 10.71 per kilogram. Shrimp is also an abundant resource that people of Barangay Mampang and Barangay Talon-Talon harvest in the mangrove area. Available species of shrimp found in the mangroves are Giant tiger shrimp *(Penaeus monodon)*, Tiger shrimp *(Penaeus semisulcatus)*, Indian white shrimp *(Penaeus indicus)*, "*Bulik/sugpo*" *(Penaeus japonicus)*, and White shrimp *(Penaeus merguiensis)* commonly called as *"putian."* These shrimps are sold for USD 6.25 to USD 9.82 per kilogram. Mollusks on the other hand, are also recognized by the residents as a common resource that they usually obtain from the mangrove area. Tahong (*Perna viridis)*, Oyster (*Crassostrea rhizophorae*), and other kinds of molluscan species such as Litob (*Anadara antiquata)*, Sisi (*Saccostrea cucullata*), Parus (*Quidnipagus palatam*), Bibi (*Oliva oliva*), and Sabilan (*Terebralia sulcata*) are usually harvested in the mangrove areas. Compared to crabs and shrimps, mollusks are sold at much lower prices, which can only be bought at USD 0.89 to USD 2.14 per kilogram. According to the respondents, their average production per day is 1-3 kilogram for shrimp, and crab, and a maximum of ½ - 1 kilogram for mollusks. The extracted fishery products are sold to the neighborhood, while those products that are not bought by the consumers are used for their own food consumption. Income generated by the respondents from the shrimp, crab, and molluscan products per

month depends on the number of productive days. Those who capture fishery products on a regular basis can generate higher income compared to those who harvest seldom in a month. No data on the amount of production cost is set for those respondents who are just selling the products to their neighborhood (not in the commercial markets) and those whose fishing boat has no engine and doesn't require fuel to function. Table 3 showed the net use value of crab, shrimp, and mollusks obtained by the residents of Purok VII Km. 8, Barangay Mampang and Logoy Grande Road, Barangay Talon-Talon in the mangrove areas.

Table 3: The value of crab, shrimp, and mollusks

Barangay	Product	Household users (n=115)	Net use value (USD/y)	Net use value/household (USD/y)	Net use value (USD/ha/y) (ha = 503)
Mampang and Talon-Talon	Crab	87	296,484.05	513.41 – 17,610.12	589.67
	Shrimp	86	326,142.75	561.50 - 33,920.73	648.65
	Mollusk	105	39,174.69	32.08 – 2,463.86	77.90
Total value			661,703.47		1,316.10

Table 3 indicated that the highest benefit of direct use value from crab, shrimp, and mollusks in Barangay Mampang and Barangay Talon-Talon was obtained from shrimp production amounting to USD 326,142.75 /y or USD 648.65/ha/y. This finding does not conform to the study of Malik et al. (2015), because compared to other available fishery products, shrimp species are highly traded in the Philippine market (Macusi, 2022). This may be one of the reasons why shrimp production obtained the highest benefit of direct use value in Zamboanga City, Philippines compared to South Sulawesi, Indonesia (Malik et al. 2015). Calculation of the total DUV in terms of fishery products of mangroves in Barangay Mampang and Barangay Talon-Talon, Zamboanga City reached a total of USD 661,703.47/y or USD 1,316.10/ha/y. Based on the testimonies of the respondents, during the early 1970's and 1980's, depletion of mangroves increased due to the high demand for mangrove products. Cutting and harvesting of mangroves became uncontrollable, and some areas were converted to fishponds and salt beds. The residents, most especially the fishermen experienced a major reduction in the supply of fishery products. Even the mangrove mud and shores produced fewer species of crabs, edible shells, and mollusks which makes it difficult for coastal dwellers to find food for their daily meal. The loss of the mangroves affects the livelihood and food supply of the coastal communities. However, everything turned out differently when the rehabilitation and management projects of mangroves began in the early months of 1990. Coastal communities were given a new hope again as the mangrove forests provided them with a new source of income. Local fishermen observed an increased in their income because of the variety of fishery species available in their fishing ground. Crabs of different species which were non-existent for the past years are now abundant in the mangrove areas. Edible shells and mollusks are available for harvest to serve as a daily viand. The results of the assessment for the direct use value of mangroves in terms of crab, shrimp, and mollusks indeed conformed to the research conducted by IUCN (2017) that mangroves can generate food supply and income particularly for the poor and vulnerable communities. On the other hand, for the data on the forestry value of mangroves, this study found out that respondents from Barangay Mampang and Barangay Talon-Talon do not harvest mangroves anymore to produce firewood, timber, and charcoal. The survey

showed that each respondent is already aware that cutting mangroves is strictly prohibited by law. This law is under Section 4 of the Republic Act (RA) 7161 and Section 43 of the Presidential Decree (PD) 705, otherwise known as the Revised Forestry Code of the Philippines, which banned the clear-cutting operations of all mangrove species in all mangrove swamps in the Philippines for coast protection purposes. This finding conformed to the economic valuation study conducted by Carandang et al. (2013). This goes to show that as responsible citizens of the Philippines, the residents of Barangay Mampang and Barangay Talon-Talon, Zamboanga City, as well as those from Kamuning, Palawan, and Banacon, Bohol, are already aware of the law which prohibits the cutting of all mangrove species for all purposes, even in mangrove plantations established with community efforts and public funds (Carandang et al. 2013). As per the testimonies of the respondents, they are already oriented by the assigned government agencies that anyone who will be caught violating the said laws and act is subject to criminal offenses and penalties as stated in the Revised Forestry Code of the Philippines.

3.2 Indirect use value of mangroves

One of the important indirect use services of mangroves is its ability to provide nursery, breeding, and feeding grounds for commercial fishes (Sundararaju, 2019). Mangroves as a rich nutrient feeding ground, provide food supply for the growing youngsters through the accumulation of bacteria and mangrove tree detritus. Its tangled web of above-ground roots serves as a nursery and breeding habitat for marine life and protects juvenile fishes from predation to larger animals. When the mangrove refuge is no longer required, the fishes venture out to the reefs and the open ocean. In this way, mangroves act as an essential source to restock the fish in the ocean (IUCN, 2017). Results revealed that the residents of Purok VII, Km. 8 Barangay Mampang, and Logoy Grande Rd. Barangay Talon-Talon captureddifferent species of fish such as Samaral *(Siganus guttatus),* Langaray *(Ambassis Interrupta),* Mulmul *(Scaridae),* Talakitok *(Caranx ignobilis),* Lapu-Lapu *(Epinephelus sp),* Bangus *(Chanos chanos),* Tilapia (*Oreochromis niloticus),* and Danggit *(Siganus vermiculatus)*. These fish were sold at different prices depending on the type of species. Prices range from USD 2.14 to USD 7.13 per kilogram. In capturing these fish products, traditional fishing gears such as fishing nets and fishing rods were used by the residents. The fish capture is scheduled differently for each of the respondents in the two barangays. Results showed that 38.57% (27 out of 70 households) of the respondents in Barangay Mampang claimed that they are fishing for about 9 to 11 months annually. The remaining months are used to repair the fishing boats and other fishing equipment. While 68.57% (48 out of 70 households) of the respondents revealed that they are fishing every month, except when sea conditions are not good and defined by high waves and strong winds due to typhoons. For the respondents of Barangay Talon-Talon, 66.67% (30 out of 45 respondents) of the respondents don't have fishing schedule during weekdays because respondents engaged in alternative work such as seaweed farming, housekeeping, caregiving, rendering labor, selling goods, doing household chores, and taking care of their children. While 33.33% (15 out of 45 respondents) of the respondents go fishing on a regular basis. They prefer fishing during high tides due to the abundance of fishery resources in the mangrove area. Fishing during high tides is preferable as it does conform to other research which claimed that marshy land turns into a rich fishing ground during high tides because many fishes move in to feed among the mangrove roots. According to the respondents, their average production per day is 1-3 kilogram for fish. The extracted fish species are sold to the neighborhood while those resources that are not bought by the consumers are used for their own food consumption. Income generated by the respondents from fish products per month depends on the number of productive days. Those who capture

fish on a regular basis can generate higher income compared to those who harvest seldom in a month. No data on the amount of production cost is set for those respondents who are just selling the fishery resources to their neighborhood (not in the commercial markets) and those whose fishing boat has no engine and doesn't require fuel to function. Table 4 showed the net use value of fish obtained by the residents of Purok VII Km. 8, Barangay Mampang and Logoy Grande Road, Barangay Talon-Talon in the mangrove areas.

Table 4: The value of fish

Barangay	Product	Household users (n=115)	Net use value (USD/y)	Net use value/household (USD/y)	Net use value (USD/ha/y) (ha = 503)
Mampang and Talon-Talon	Fish	96	149,527.60	149.16 – 8,930.39	297.28

Table 4 showed that the net use value of fish obtained from the potential of mangroves as a nursery, breeding, and feeding ground amounts to USD 149,527.60/y or USD 297.28/ha/y. As an efficient provider of nursery, feeding, and breeding grounds for fishes, this study confirmed that mangroves contribute to a significant part of providing highly valued seafood resources which support the livelihood of coastal communities, particularly fishermen who depends on the sea and the mangrove forests for living. Hence, the conservation and restoration of mangrove forests would greatly benefit fishery sector across the world (IUCN, 2017). Aside from the potential of mangroves to provide fishery supply by providing nursery, feeding, and breeding ground for fishes, its benefit as a carbon sequestrator is also considered an important indirect use services of mangroves (Rumahorbo et al. 2019). According to NSO (2010), global temperatures will continue to increase for decades to come, owing in major part to greenhouse gases emitted by human activity. Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities such as burning of coal, oil, and gas. Carbon dioxide at high levels causes climate change by trapping heat, which may contribute to respiratory disease from smog and air pollution. Global climate change has already had observable effects on the environment causing extreme weather, food supply constraints, increasing wildfires, extreme drought, sea level rise, melting glaciers and warming oceans which may harm animals, ruin the places they live, and inflict damage on people's livelihood and communities (Zlatanova, 2022). Effective climate change intervention will require a combination of emission reductions and atmospheric carbon removals. Hence, natural carbon sinks must be protected, improved, and restored as a political priority. Mangroves are natural carbon sinks as they have a high capacity for carbon storage. This is why they are often called as the "Nature's Carbon Storehouse" and the "Lungs of the Seas" (Wootliff, 2010; CIFR, 2020). According to the study conducted by the US Forest Service and university scientists in 2011, mangroves sequester four times more carbon than tropical rainforest around the world, because in the mangrove forests, when plant matter decomposed, they are covered by the soil submerged under water, thus slowing down the rate of decomposition and boosting the carbon storage. Based on the assessment, Barangay Mampang and Barangay Talon-Talon have a total annual carbon benefit of 16,514 tCO_2 (USAID, 2017), which is equivalent to 32.83 tCO_2 per hectare of mangrove area. With a carbon market price of $35.25 adapted from Australia, the economic valuation

study was able to determine the carbon sequestration value of mangrove forest in the two barangays (Table 5).

Table 5. The carbon sequestration value of mangroves

Products	Barangay	Total Indirect Use Value	
		USD/y	USD/ha/y
Carbon sequestration	Mampang Talon-Talon	395,146.58	785.58

The study confirmed that mangroves in Barangay Mampang and Barangay Talon-Talon have a high value as a carbon stock provider reaching USD 395,146.58/y or USD 785.58/ha/y. The high carbon sequestration value of mangroves in this study conformed and relates to the study of Jakovac et al. (2020) indicating that the blue carbon in mangroves represents one of the highest values of carbon stocks per hectare and could indeed play a crucial role in climate change mitigation, which is very timely and relevant in today's environmental situation, as we are facing environmental crisis due to the observable effects of climate change and global warming. Another interesting service of mangroves is its ability to protect the coastline from natural catastrophic events such as storms, hurricanes, and cyclones. As a coastal defender, mangroves are also called the "Guardians of the coast" as it protects the coastal communities from harm by preventing erosion, and reducing the impacts of waves, storm surges and high winds (Sivaramanan, 2016; Fahmy, 2020). For instance, if the mangrove trees are tall enough, the leaves and branches of the forest canopy will aid to minimize wave energy. Storm surge depths may be lowered by just 5-50 centimeter per kilometer width of mangroves, yet a minor reduction in water level can already significantly prevent flooding in low-lying areas behind the mangroves. In addition, mangroves can also decrease damage to neighboring infrastructure because the dense mangrove forest canopies prevent further development of winds and swell waves (Spalding et al. 2014). All these characteristics of mangroves are considered vital to reduce the damage to property and loss of life. The coastal protection value of mangroves in this study was determined by calculating the capitalization cost of constructing a rubble concrete revetment (spread type 1) with an initial cost of USD 2,670,825.34 for approximately 10,000-m coastline length. Operating and maintenance expenses per year were assumed to be 2% of the estimated cost of construction, amounting to USD 53,416.51 with a social discount rate of 10%. Findings on the total coastal protection value of mangroves obtained from the capitalization cost of constructing a rubble concrete revetment are shown in Table 6.

Table 6: The Coastal protection value of mangroves

Products	Barangay	Total indirect use value	
		USD/y	USD/ha/y
Coastal protection	Mampang and Talon-Talon	336,630.82	669.25

Indirect use value of mangroves in terms of coastal protection amounts to USD 336,630.82/y or USD 669.25/ha/y. This result confirmed that mangrove forest in the two barangays have a relatively high value

in terms of coastline protection. If we try to analyze from a larger perspective, building seawalls consume millions to billions of pesos in the Government's national budget. Thus, if we look to nature for the solution, we can save a lot while helping the environment. Hence, protecting and saving mangrove forest must be one of the top priorities of the government because these forests can be an effective and inexpensive alternative as a coastline protector. The high monetary value of mangroves in terms of coastline protection conformed to the research of the Nature Conservancy (2017) where they emphasized the importance of better valuation of mangroves, as it can serve as a powerful natural defense against flooding and erosion and can even protect the people and property from damages caused by the effects of storms, tides, and sea level rise.

On the other hand, findings of the study revealed that most of the respondents in Barangay Mampang and Barangay Talon-Talon regard coastal water pollution as the most important problem that the government must solve and prioritize (Fig. 2).

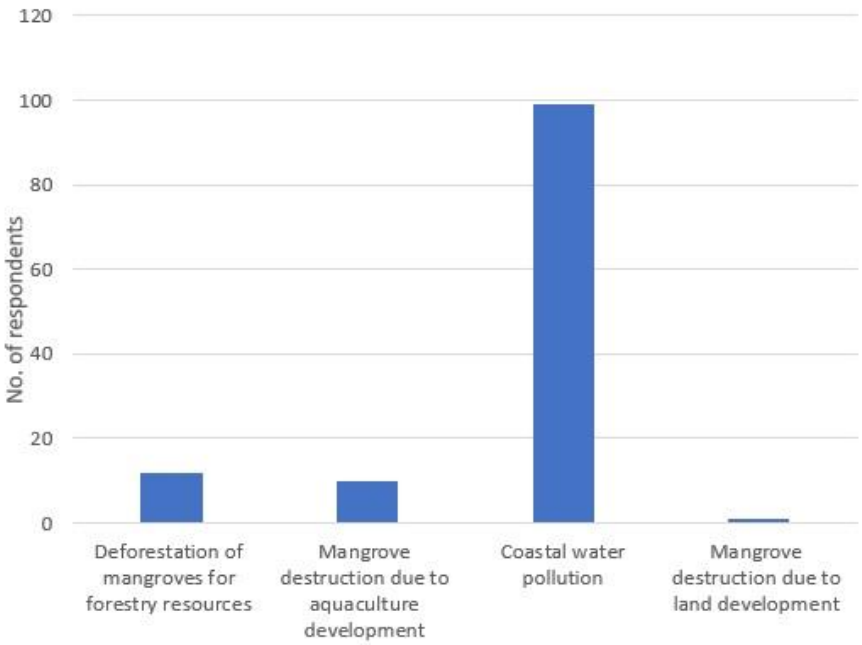

Fig. 2: The most important problem that government must solve in the mangrove sites of the barangays

Testimonies of the respondents in the two barangays confirmed that domestic, industrial, and human wastes are the major sources of coastal water pollution in the mangrove area. Accumulation of waste in the mangrove area can be detrimental not only to the mangroves, but also to the nearshore habitats and their associated species. Domestic wastes, which include plastics are quite lethal as it can suffocate mangroves, preventing the oxygen from reaching their roots system (Bijsterveldt, 2021). On the other hand, Industrial wastes, particularly oil spills may cause damage to mangroves by covering the roots, thus reducing oxygen transport to underground habitats (Kairo, 2005). While reported human waste that has not been adequately treated at a waste treatment facility or household septic systems and is dumped into the water may include pathogenic bacteria and viruses, which may potentially kill the marine organisms inhabiting the mangroves. From the analysis conducted in this study, all the respondents strongly agree that mangroves are important because they provide fishery resources, recreational sites, and home for

diverse marine species. They also recognized the importance of mangroves as coastline protectors, as they believed that mangroves protect them from flood, erosion, and salinization. This conformed with the findings of Holtz (2013), where it showed that the residents of General MacArthur in Eastern Samar province also recognized the importance of mangroves and considered mangroves as one of the best defenses against coastal flooding. However, 50.43% (58 out of 115 respondents) of the respondents strongly disagree to the importance of mangroves as provider of forestry resources. This may be due to fact that they are prohibited by the law to harvest or cut mangroves to produce firewood, charcoal, and timber. Another observation from the study is that 26.96% (31 out of 115 respondents) of the respondents are indifferent and prefer not to answer the question when they are asked if mangroves have benefit for future uses, particularly for pharmaceutical use. Respondents are maybe not aware that mangroves also have potential pharmaceutical benefits. According to Bandaranayake (2002), the ashes and bark of mangroves can be used to treat skin problems and leprosy. It may be used to cure a variety of ailments such as headaches, ulcers, boils, and diarrhea. Furthermore, Abeysinghe (2010) reported that the aqueous and ethanol extracts of some mangrove species contain antimicrobial activities. It is indeed possible to control infectious agents by employing natural products, such as the mangrove extracts that have inhibitory effect on harmful microbes. This research confirmed that mangroves indeed have benefits for future uses, particularly for pharmaceutical use.

Since the residents of Barangay Mampang and Barangay Talon-Talon consider the mangrove ecosystem as very important for them, they were asked about their idea on what could be the factors that will affect the existence of mangroves in their respective barangays. Fig 3 showed the different factors that affect the existence of mangroves in the barangays.

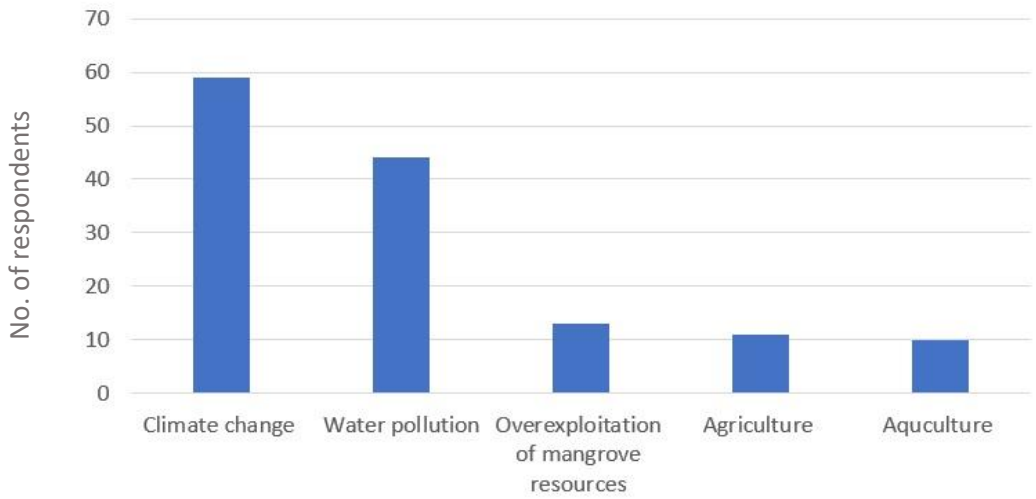

Fig. 3: Factors affecting the existence of mangroves

As shown in the graph, respondents regard climate change and water pollution as the most extreme factors that might affect the existence of mangroves in their barangays. Since 51.30% (59 out of 115) of the respondents vote for climate change, this seems to show that respondents are environmentally aware of the global issue on climate change. Though mangroves are part of the solutions to mitigate the impacts of climate change, changes in climate may potentially have an impact on mangroves in complex ways. These include the melting of polar ice caused by global warming, which in turn may accelerate sea level rise,

affecting the flooding patterns, as well as the structure and area of mangroves (Mckee 2004). In addition, climate change may also modify rainfall patterns, affecting local salinity regimes and the interactions between mangroves and other wetland organisms (Ghalambor 2021). The second issue is water pollution. Water pollution has been an issue in the mangrove sites of Barangay Mampang and Barangay Talon-Talon for years already. As explained in the previous section, water pollution caused by domestic, industrial, and human waste dumped into the coastal waters may suffocate the mangroves and potentially kill the marine organisms inhabiting it. The loss of these mangroves may impact not only the people's livelihood and food supply, but as well as the variety of migratory birds and marine organisms utilizing the mangroves as a shelter and breeding grounds. For the respondents of Barangay Mampang, mangroves serve as their source of income, hence, if mangroves are destroyed, their livelihood will also be affected. However, for the respondents of Barangay Talon-Talon since majority of them do not only rely on mangroves for living, based on their answers, it shows that without mangroves, they believed that they will no longer have protection from natural catastrophic events such as storm surges, cyclones, hurricanes, and typhoons. This goes to show that respondents of Barangay Talon-Talon are more particular with the indirect use value of mangroves rather than its direct use value.

3.3 Option Value of Mangroves

The last part of the survey assessed the respondent's awareness and support for the future mangrove conservation and protection program. A hypothetical market scenario was presented to each respondent, highlighting the current healthy state of the mangroves, the factors that might affect the existence of mangroves, and the possible circumstances that might happen if these mangroves are lost and destructed due to different anthropogenic threats. Respondents were warned that if no action is taken, deterioration of mangrove forest is expected in the next few years. To prevent this from happening, respondents must take actions by protecting and conserving the mangrove forest ecosystem. And, in order to protect and conserve the mangrove forest ecosystem, a supposed trust fund will be created and manage by the mangrove beneficiaries of the barangays, government agencies, local government units, and non-government organization. Respondents were directly asked if they are willing to vote for legislation that will create the trust fund if the passage requires all mangrove beneficiaries to contribute at least USD 8.91 – USD 17.82/household/y. Based on the analysis conducted in this study, 27.14% (19 out of 70 respondents) of the respondents in Barangay Mampang are not willing-to-pay because they believed that the Government must pay for the mangrove conservation and protection program, and payment for the said program must be given voluntarily by each household. On the other hand, 80% (36 out of 45 respondents) of the respondents in Barangay Talon-Talon are not willing-to-pay any amount at all because they are not willing-to-pay for any environmental issues, and they don't have enough income to contribute. However, for those respondents who are willing to contribute to the mangrove conservation and protection program, their average willing-to-pay is USD 8.20/household/y or USD 0.68/household/mo. This value is a bit smaller compared to the mean willingness-to-pay value of the people in Kamuning, Palawan and Banacon, Bohol, which amounts to USD 0.78/mo/individual (Carandang et al. 2013). Table 7 showed the option value of mangroves obtained from the willingness-to-pay of the respondents for the Mangrove conservation and protection program.

Table 7: Willingness-to-pay for the mangrove conservation and protection program in Barangay Mampang and Barangay Talon-Talon, Zamboanga City

Category of economic value	Total Willingness-to-pay	
	USD/y	USD/ha/y
Option value	942.99	1.87

Respondents share their contribution because of several reasons, which include their concern for the future generation, they want to help the local community, they want to share for their own sake and for their family, they want to preserve the culture and belief and most of all they want to help protect the environment. If the average willingness-to-pay is multiplied by the number of households in Barangay Mampang and Barangay Talon-Talon, the willingness-to-pay obtained for the Option value of mangroves amounts to USD 942.99/y or USD 1.87/ha/y. Those respondents who expressed their interest to contribute to the mangrove conservation and protection program in cash were asked on their preferred mechanism to collect the fee for the program. 43.48% (50 out of 115 respondents) of the respondents in Barangay Mampang and Barangay Talon-Talon preferred to give their donation directly to the trust fund instead of recovering the fee through their income tax and requiring them to pay for an environmental fee. Prior to asking the respondents about their preferred mechanism for the collection of fees, they were also asked about the basis in charging the fee. Results showed that 40.87% (47 out of 115 respondents) of the respondents agreed that "income" must be the basis of charging the fee rather than depending the amount of fee to be paid on the number of mangrove resources used and the number of members in each household. On the other hand, assessment of the willingness-to-work of the respondents showed that 17.14% (12 out of 70 respondents) of the respondents in Barangay Mampang and 62.22% (28 out of 45 respondents) of the respondents in Barangay Talon-Talon are not willing-to-work or volunteer for the mangrove conservation and protection program. Respondents reason out that they are not willing-to-work or volunteer for the said program because they are busy on their individual jobs. This may be due to their busy working schedules during weekdays. Housewives also decline to participate in the program because they are busy on doing household chores and taking care of their children. On the contrary, for those respondents who expressed their interest to participate in the future mangrove conservation and protection program in kind, they are willing-to-work or contribute labor for an average of 6 days per month. The labor value was monetized at the market wage rate (USD 5.64 for 8 working hours in Zamboanga City). Thus, the average value that each household was willing to contribute is USD 185.91/y. Which was noticeably higher than the direct monetary contribution. Table 8 showed the option value of mangroves obtained from the willingness-to-work of the respondents for the mangrove conservation and protection program.

Table 8: Willingness-to-work for the mangrove conservation and protection program in Barangay Mampang and Barangay Talon-Talon, Zamboanga City

Category of economic value	Total Willingness-to-work	
	USD/y	USD/ha/y
Option value	21,351.32	42.45

Table 8 showed that Option Value obtained from the respondents' willingness-to-work equates to USD 21,351.32/y or USD 42.45/ha/y in monetary terms at the local wage rate. Result of this study is higher

compared to the result of Susilo et al. (2017) where they found out that households in Makaham Delta, Indonesia have a willingness to contribute labor amount of USD 351.78 annually. The huge difference in the option value of the two locations is mainly due to the fact that residents of Barangay Mampang and Barangay Talon-Talon are willing to contribute more time and labor in the mangrove conservation and protection program rather than giving cash donations. Table 9 showed the results of the logistical regression analysis conducted for the socio economic and demographic data collected in Barangay Mampang, and Barangay Talon-Talon.

Table 9: Different variables used for the logistic regression and the resulting coefficients for the data collected in Barangay Mampang and Barangay Talon-Talon

Independent variables	Willingness-to-pay		Willingness-to-work	
(n=115)	Coefficient	p-value	Coefficient	p-value
Inc	-0.66544	0.332262	0.450758	0.499381
Sex	-0.39508	0.339602	-0.14232	0.731805
Educ	-0.73537	0.081541	-0.37887	0.368178
NOD	-1.01687	0.041868	-1.06148	0.049881
Age	0.834094	0.048223	0.700462	0.107847

Based on the results of the logistical regression for the willingness-to-pay, two independent variables out of five independent variables came out to be statistically significant, specifically the number of dependents (NOD) (p-value = 0.041868) and the age (p-value = 0.048223). While for the willingness-to-work, results of the logistical regression showed that only one (1) independent variable, such as the number of dependents (p-value = 0.049881) came out to be statistically significant, with p-value less than 0.05. The number of dependents (Coef. = -1.01687 for WTP, and Coef = -1.06148 for WTW) negatively affects the willingness-to-pay and willingness-to-work for the mangrove conservation and protection program. This implies that as the number of dependents in each household increases, the probability of willingness-to-pay and willingness-to-work decreases. Findings from the socio economic and demographic data assessment showed that 54.78% (63 out of 115 respondents) of the respondents still have dependents below 18 years old. Based on the testimonies of the respondents, their income and time is only limited, and is essential to support and accommodate the financial needs of their dependents. Moreover, 13.91% (16 out of 115 respondents) of the respondents also declined to contribute labor in the program because they are busy doing household chores and taking care of their children. This conformed with the study of Hasan Basri et al. (2020) indicating that respondents who earned high income, and have smaller household were willing to donate more money to the mangrove conservation fund compared to those with limited income. On the contrary, the age (Coef = 0.834094) of the respondent positively affects the respondent's willingness-to-pay. Based on the survey conducted, older respondents, especially those from Barangay Mampang, are more willing-to-pay than younger respondents. This implies that older respondents are more aware of the factors and consequences of the degradation of mangroves in the community, which can translate into a positive willingness-to-pay for the mangrove conservation and protection program. Studies (Susilo et al. 2017; Nguyen et al. 2020) indicated that if a respondent is aware of the importance of mangroves or showing interest in environmental conservation activities, the probability of agreeing to pay would be higher, because locals are more willing-to-pay for the conservation program if they

acknowledge the benefits provided by mangroves to them. The contribution of the people both in cash and kind is needed to fund and support the needs of the program. Hence, the mangrove conservation and protection program are more likely to succeed if more people agree to voluntarily take part in the program. In general, the willingness and unwillingness of the respondents to pay and contribute labor/work indeed have implications on the conservation project, because as with any other management and conservation projects, the success of the mangrove conservation and protection program relies on the cooperation and participation of the local people, forestry officials, and different interest groups involved (Singh, 1996; Ford et al. 2021). With the shared contribution of the respondents through cash and kind, their top preferred scenarios for the conservation program are the following: mangrove area expansion, increase number of mangrove species, and training courses on mangrove conservation, management, and rehabilitation. Some respondents also suggest that they would be interested to join in mangrove planting and coastal clean-up activities in their respective barangays. The interest of the respondents to conduct mangrove planting activities conformed with the study conducted by Carandang et al. (2013), because similar from the respondents of Barangay Mampang and Barangay Talon-Talon, Zamboanga City, the people of Banacon, Bohol was also interested in rendering labor and time for mangrove planting activities. For the record, planting of mangrove propagules and clean-up activities in Barangay Mampang and Barangay Talon-Talon were actively participated by the communities, people's organization, and other stakeholders. These activities are conducted to protect the mangroves and conserve the biodiversity to ensure food security and help mitigate the impact of climate change (OCENR 2021).

Total economic value of mangroves

Based on the conducted economic valuation study, Mangrove forests have great potential in terms of providing goods and services. As evident from the amount of the total economic value (TEV) of the mangrove forest ecosystem in this research, it revealed that the mangroves in Barangay Mampang and Barangay Talon-Talon have a total economic value of USD 1,559,918.88/y or USD 3,113.35/ha/y. Listed in table 10 are the economic value obtained for each benefit value of mangroves.

Table 10. The total economic value of mangroves

Category of economic value	Total value	
	USD/y	USD/ha/y
Direct use value	661,703.47	1,316.81
Indirect use value	881,524.30	1,752.53
Option value	22,296.11	44.33
Total economic value	1,559,918.88	3,101.23

Comparing the economic value of mangroves based on category, indirect use value (e.g., fish value obtained from the potential of mangroves as a nursery, feeding, and breeding ground, carbon sequestration value, and coastal protection value) has a greater value than other benefits, representing about 56.51% of the total economic value. This finding conformed to the study of Malik et al. (2015) indicating that the highest contribution of the total economic value of mangroves was derived from the indirect use value. The total economic value of mangroves in this study is considerably high compared to the total economic value of mangroves in Banacon, Bohol and Kamuning, Palawan (Carandang et al. 2013). In general, the

variances in total economic value observed in this study and other research depend on the quantity of identified and evaluated mangrove benefits, as well as the current state and extent of the mangrove area being focused. Table 11 showed the comparison of the total economic value by other studies.

Table 11: Comparison of the total economic value by other studies

Title of the study	Category of Economic Value evaluated	Total Mangrove area (ha)	Total economic value (USD/year)	Source
Economic Vauation for sustainable mangrove ecosystems management in Bohol and Palawan, Philippines	-Fishery values -Biodiversity values -Recreational values	470 ha – Banacon, Bohol 836 ha – Kamuning,Palawan	400,037.57 (Banacon, Bohol) 469,777.38 (Kamuning, Palawan)	Carandang et al. 2013
Economic Valuation of Mangrove Services in Vanuatu	-Subsistence fishery -Commercial fishery -Recreational fishery -Wood extraction	136.5 ha – Crab Bay 31.2 ha – Eratap bay	48,000,000	Pascal, 2014
Economic Valuation of Mangroves for Comparison with Commercial Aquaculture in South Sulawesi, Indonesia	-Fishery resources -Forestry resources -Coastal protection	1,719 ha	4,368,582	Malik et al. 2015

Economic Valuation of Mangrove Ecosystem in Youtefa bay, Jayapura, Indonesia	**-Fishery resources -Firewood products -Coastal protection value -Seawater Intrusion Prevention -Carbon sequestration -Willingness-to-pay (WTP) in order to preserve sustainability and to repair or rehabilitate the mangrove ecosystem.**	**233.12 ha**	**3,715,115.02**	**Rumahorbo et al. 2019**
Economic Valuation of Mangrove Forest Ecosystem in Zamboanga City in Philippines	-Fishery resources -Fish value obtained from the potential of mangroves as nursery, feeding, and breeding grounds -Carbon sequestration value -Coastal protection value -Willingness-to-pay for mangrove conservation program -Willingness to work for mangrove	503 ha	1,559,918.88	Alvarez, 2022

	conservation program

Since this study failed to include the forestry value of mangroves due to the prohibition of the law to cut or harvest mangroves, the huge variance in the amount of the total economic value might be due to the lack of identified and quantified mangrove benefits. Thus, this study concludes that in conducting an economic valuation study, the result of the total economic value is influenced by different factors, such as the quantity and the type of values being measured, the current state or condition of the mangrove area, and the extent of the mangrove area being focused on the study. The total economic value of the chosen mangrove sites in Zamboanga City is projected to increase if additional economic benefits of mangrove ecosystem, such as its value as recreational sites, pharmaceutical potential, and biodiversity value are recognized and measured. Comparing the total economic value of mangroves for the studies conducted in the Philippines, the economic valuation study in Zamboanga City evaluated the Direct use value (e.g. fishery value), Indirect use value (e.g. fish value obtained from the potential of mangroves as a nursery, feeding, and breeding grounds, carbon sequestration value, and coastal protection value) and Option value of mangroves (e.g. willingness-to-pay and willingness-to-work for the mangrove conservation and protection program), while in Banacon, Bohol and Kamuning, Palawan, the indirect use values were not included in the scope of the study of Carandang et al. (2013), this may be the cause of the huge variance in the total economic value obtained in Bohol and Palawan, which is relatively smaller as compared to the value obtained in Zamboanga City. Another factor is the current state and extent of the mangrove area being focused in the study, since the mangrove forest of Barangay Mampang and Barangay Talon-Talon, Zamboanga City is chosen as part of this study's research locale, which currently have a total area of 503 has, the total economic value of mangroves in this area is quite smaller (USD 1,559,918.88) as compared to the total economic value of mangroves in South Sulawesi, Indonesia (ranging from USD 4,368,582/y – USD 10,596,552/y) having a total of 1719 has. For this case, though the mangroves in Zamboanga City Philippines and South Sulawesi Indonesia are both in healthy and good condition, the variance in the amount of the TEV depends on the extent of the mangrove area. This is because mangrove area in South Sulawesi, Indonesia is two times bigger compared to the mangrove area in Zamboanga City, Philippines. Hence, mangroves in South Sulawesi, Indonesia, generate higher economic value. However, in contrary, even though Pascal (2014) and Rumahorbo et al. (2019) focused on smaller mangrove areas, the mangrove forests in their study tends to have higher total economic value as compared to the mangroves in Zamboanga City, Philippines. This is because Pascal (2014) and Rumahorbo et al. (2019) evaluated economic benefits and services of mangroves that this study wasn't able to include as part of the assessment. Pascal (2014) included the subsistence, commercial, and recreational fishery value, wood extraction value, mangrove tourism value, bioremediation value, and the sediment trap value. While Rumahorbo et al. (2019) included the forestry products value as part of the calculation of the total economic value of mangroves. Since this study failed to include the forestry value of mangroves due to the prohibition of the law to cut or harvest mangroves, the huge variance in the amount of the total economic value might be due to the lack of identified and quantified mangrove benefits. Thus, this study concludes that in conducting an economic valuation study, the result of the total economic value is influenced by different factors, such as the quantity and the type of values being measured, the current state or condition of the mangrove area, and the extent of the mangrove area being focused on the study. The total economic value of the chosen mangrove sites in Zamboanga City is projected to increase if

additional economic benefits of mangrove ecosystem, such as its value as recreational sites, pharmaceutical potential, and biodiversity value are recognized and measured.

CONCLUSIONS

Mangroves play a crucial role in our ecosystem because they provide a variety of useful goods and services that people use and profit from. Based on the findings of the study, mangroves are essential to the survival of the coastal communities in Barangay Mampang and Barangay Talon-Talon. This is especially true for those respondents who reported having limited income, because aside from seaweed farming, they harvest fishery resources from mangroves to make a living, and even for their personal use. This indicates that the benefits of mangroves go beyond providing income; they also provide a reliable source of food for coastal communities, as shown by the direct use value amounting to USD 659,541.64/y. The survey also found that the respondents were completely aware of the law's prohibition against the clear-cutting of any kind of mangrove trees for coastal protection. This suggests that environmental planning organizations and agencies did a wonderful job of informing the community about the potential consequences of breaking the legislation, urging them to rigorously comply by it and work with the authorities to conserve the mangrove forests. On the other hand, aside from the essential goods provided by mangroves, the study also confirmed that mangroves can provide services useful for humans as observed from its tangled above-ground roots that serves as breeding ground for marine life, its ability to sequester carbon dioxide in the atmosphere, and its tall trees, leaves and branches that aid to minimize wave energy and protect the coasts from flooding and storm surges. These indirect use services of mangroves amount to USD 881,524.30 /y. From the findings of the study, it was found that the option value got the lowest value (USD 22,296.11/y) partly because the majority of the mangrove beneficiaries don't have enough income and time to contribute to the mangrove conservation and protection program due to busy work schedules and low salary rate. Aside from the busy work schedules and low salary rate, the high number of dependents and age are some of the factors that influence the willingness-to-work and willingness-to-pay of each respondent. Thus, the study concludes that the increasing number of dependents in each household, decreases the probability of willingness-to-pay and willingness-to-work due to the limited income needed to sustain the needs of their dependents, and the time needed to perform other job-related tasks and personal agenda. On the positive note, it was confirmed that older respondents are more willing-to-pay compared to younger respondents, clearly implying that older respondents are more willing-to-pay because they are environmentally aware of the possible consequences of the mangrove degradation if no action and cooperation is done among members of the community. Summing up the Direct use value, Indirect use value, and Option value of mangroves, a total economic value of USD 1,559,918.88/y was obtained. As with any other economic valuation studies, the total economic value of any natural resource is dependent on the economic benefits being recognized and measured in the study, the current condition of mangroves, and the extent of the mangrove area being focused in the study. The mangrove forests of Barangay Mampang and Barangay Talon-Talon, Zamboanga City is an evident which supports the idea that mangroves have high value both in environmental and economic perspective. To improve the social welfare of the mangrove beneficiaries, particularly the coastal communities who depend on the mangrove ecosystem for living, it is important to improve the conservation initiatives. As the purpose of the study aims to promote sustainable and environmentally friendly economic development, it is hope that the study can be used as a tool to raise awareness on the effective use of mangrove resources and assist the decision makers in determining priorities that would benefit the greater good of the people, the environment, and the economy.

AUTHOR CONTRIBUTIONS

J.B. Otadoy has contributed to supervising the research, interpreting the results, checking grammatical errors, and preparing the manuscript. L.G. Alvarez conducted the search for related literatures, prepared the survey questionnaire, administered the survey, performed the statistical analysis, interpreted the results, and prepared the research manuscript.

ACKNOWLEDGEMENT

Authors would like to express their heartfelt gratitude to the professors of the Department of Biology – University of San Carlos for all the guidance and help they extend to improve the study, and to the Department of Science and Technology – Accelerated Science and Technology Human Resource Development (DOST-ASTHRP) for their invaluable support.

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