UMT PRESS

Journal of Sustainability Science and Management
Journal Homepage: https://jssm.umt.edu.my
eISSN: 2672-7226
DOI: http://doi.org/10.46754/jssm.2026.04.008

THE ECONOMIC VALUE OF SEMANGKA BAY WATERS SERVICE PROVIDER AT TANGGAMUS REGENCY IN THE UTILISATION OF ITS FISHERY RESOURCES

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ARTICLE INFO

Article History:
Received: 31 May 2025
Revised: 3 September 2025
Accepted: 7 November 2025
Published: 15 April 2026

Keywords:
Economic value of resource, ecosystem service, Semangka Bay, small fishermen.

ABSTRACT

The coastal and marine ecosystems in Semangka Bay, located in Tanggamus Regency, Lampung Province, including coral reefs, seagrass beds, and mangroves, support a diverse array of fishery resources that are vital to local livelihoods. This study aims to estimate the economic value of these fishery resources using the effect on production (EoP) approach. The research employs descriptive statistical methods alongside economic valuation through consumer surplus estimation. The estimated economic value of the consumer surplus from the coastal and marine ecosystems is 3,349,247,084 Indonesian rupiah (IDR) per hectare per year. To determine the total EoP value, we multiply the number of fishers (5,704) by the per-hectare consumer surplus and divide by the study area (2,000 hectares). This calculation yields an annual economic value of IDR 9,127,563,124. These findings offer actionable insights for marine resource management and help regional policymakers establish marine conservation, set regulations, and evaluate the socioeconomic impacts of destructive activities in Semangka Bay.

Introduction

Coastal and marine ecosystems play a central role in delivering essential ecological services that underpin human well-being, encompassing provisioning, regulatory, cultural, and recreational benefits (NOAA, 2015). In the past five years, recent studies have updated economic estimates of these services. Brander *et al*. (2024) reported that annual provisioning values in tropical regions range from US$ 100 to 1,500 per hectare per year, while Hernández-Blanco *et al*. (2021) found that mangrove forests in the Gulf of Nicoya generate an annual value of US$ 470 million, highlighting their substantial contribution to coastal protection and carbon sequestration. Other non-market research employing travel cost and contingent valuation techniques has successfully quantified recreational values and sustainability perceptions for coastal ecosystems (Patria *et al*., 2021; Yulianto *et al*., 2021). Moreover, regional investigations have demonstrated that the cultural and regulatory values of these ecosystems carry considerable economic implications, especially under climate change pressures and habitat degradation (Kodiran *et al*., 2020). Consequently, a comprehensive understanding of the economic worth of coastal and marine ecosystems is a prerequisite for evidence-based policy design.

Small-scale fisheries constitute the primary livelihood source for many coastal households in Southeast Asia. Sutisna *et al*. (2020), documented that over 70% of households depend on these activities for their main income, and Stacey *et al*. (2021) showed that modest productivity gains can raise household welfare by up to 30%, particularly in island and remote coastal communities. This economic contribution extends beyond direct earnings to embed deep socio-cultural values linked to traditional fishing practices (Liu, 2019). However, destructive fishing methods have begun to undermine ecosystem functions, degrading the ecological, social, and economic services that sustain these communities (Adrianto, 2013; Romadhon, 2014). Therefore, accurate, scientifically grounded economic assessments are essential to inform conservation policies that balance resource use with ecosystem preservation.

A variety of economic valuation approaches have been applied to coastal areas with characteristics comparable to Semangka Bay, including the market price method, travel cost method, and contingent valuation method. Costanza (2020) demonstrated that market price analyses can capture the production value of fish using actual market data, while Mohamed (2021) emphasised the strength of the travel cost method for estimating recreational values based on visitors' travel expenses. In parallel, Mai *et al*. (2024) reinforced the utility of contingent valuation to capture existential and sustainability-related values of coastal ecosystems. These studies provide a robust methodological foundation for applying the effect on production (EoP) framework to coral reefs, mangroves, and seagrass beds in Semangka Bay. Tanggamus Regency in Lampung Province, Indonesia, is home to one of the largest coastal areas in the region, where Semangka Bay, one of the two major bays in Lampung Province, is located. This coastal area spans 200 km in length and serves as the primary channel for the flow of two significant rivers, Way Sekampung and Way Semangka (Damar *et al*., 2016).

Semangka Bay is located adjacent to Cukuh Balak in the Kota Agung and Wonosobo sub-districts. At the southeastern mouth of the bay lies Tabuan Island, the largest small island in Lampung Province, covering an area of 3,294 hectares. At the northern tip of the bay is Kota Agung, the capital of Tanggamus Regency. The primary economic activities in this coastal region include fisheries (fish catch), aquaculture (shrimp farms), fish landing ports, and oil transfer terminals from larger tankers to small ships (Damsir *et al*., 2023). According to Pratiwi (2010), the coastal and marine ecosystems in Semangka Bay are composed of coral reefs, mangroves, and seagrass beds. These ecosystems provide both direct and indirect benefits to human life. Given the bay's importance for provisioning services, regulatory functions, and as a habitat for economically valuable fish species, the EoP approach can generate realistic economic estimates that serve as a scientific basis for establishing marine conservation zones and promoting sustainable management in the region. Accordingly, this study was undertaken to estimate the economic value of marine and coastal ecosystems as providers of fishery resources in Semangka Bay of Tanggamus Regency using the EoP) approach.

Material and Method of Research

Study Location and Timeframe

The research was conducted in the Semangka Bay area of Tanggamus Regency, Lampung Province. This site was selected due to its significance as the centre of Lampung Province's largest fishing-based economic activity. Tanggamus Regency covers a land area of 2,855.46 km² and an additional sea area of 1,799.50 km², totalling 4,654.96 km². The regency is home to 536,613 residents, resulting in a population density of 178 people per square kilometre. Geographically, Tanggamus is located between 104°18' – 105°12' E longitude and 5°05' – 5°56' S latitude. One of the two major bays in Lampung Province, Semangka Bay, lies within the regency. It features a 200-km coastline and serves as the outlet for two large rivers: The Way Sekampung and the Way Semaka. Additionally, the climate in Tanggamus is influenced by both coastal tropical air masses and mountainous terrain, resulting in a relatively cool average temperature of 28°C (BPS Tanggamus, 2023). The regency is also rich in marine and fisheries resources, which are vital assets for promoting regional economic growth, primarily through the sustainable utilisation of coastal and marine zones.

The fisheries sector is a key industry in Tanggamus Regency and deserves focused attention for development into a sustainable blue economy. This importance arises from the fact that fisheries (especially capture fisheries) provide a vital livelihood for communities living along the Tanggamus coastline. Geographically, the Semangka Bay area of Tanggamus is part of Indonesia's Capture Fisheries Area (Wilayah Pengelolaan Perikanan Republik Indonesia, WPPRI) 572, which is abundant in large pelagic fish, small pelagic fish, and demersal species. According to data from the Ministry of Marine Affairs and Fisheries in 2023, there are 6,766 individuals engaged in capture fisheries and 2,804 individuals involved in aquaculture in Tanggamus Regency. The 2023 Agricultural Census indicates that capture fishery operators are primarily concentrated in the districts of Pugung (34.94%), Wonosobo (10.66%), and Sumberejo (10.46%). Meanwhile, aquaculture operators are mainly found in Cukuh Balak (27.74%), Pematang Sawa (24.01%), Kota Agung (16.02%), Kelumbayan (11.20%), and Limau (10.33%) (KKP, 2024). Data collection was carried out over a one-month period in November 2023, and the research location is illustrated in Figure 1.

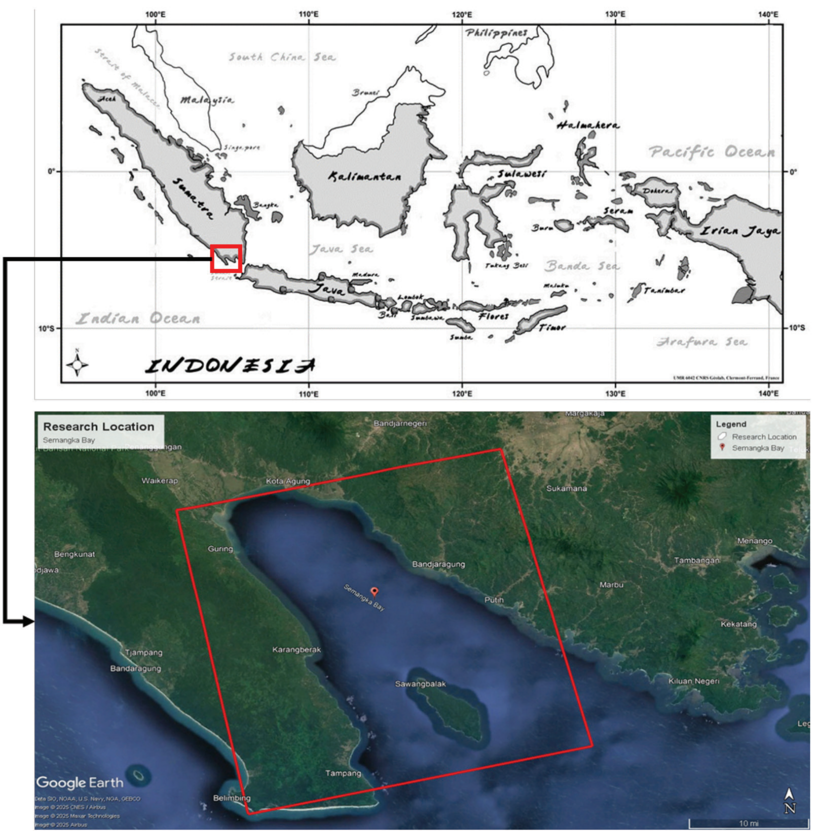

Figure 1: Map of the research location

Data Types and Sources

The data required for this research comprised both primary and secondary sources. Primary data were collected through interviews with respondents using a structured questionnaire administered to selected individuals. Secondary data were acquired from various sources, including previous research reports and studies conducted in the same area, scientific publications, regional regulations, and information from government agencies, private sector entities, non-governmental organisations, and academic institutions relevant to the study. The details of the primary and secondary data are presented in Table 1.

Determination of Sample Size

The Cochran formula is used to calculate the minimum sample size needed to achieve a specified level of precision, confidence, and estimated proportion in a population. It is particularly effective for large populations. Introduced by Cochran in 1963, this formula helps determine the necessary sample size when dealing with large-scale populations.

$$n_0 = \frac{Z^2 * p * q}{e^2} \quad (1)$$

The formula is valid where n_0 represents the sample size, Z^2 indicates the area of the acceptance region in a normal distribution (1 - α), e is the desired level of precision, p is the estimated proportion of an attribute present in the population, and q is equal to 1 – p.

If the population is small, the sample size can be slightly reduced. This is because a given sample size provides more information proportionately for a small population than for a larger one. The sample size (n_0) can be adjusted as follows:

$$n = \frac{n_0}{\left[1 + \left\{\frac{n_0 - 1}{N}\right\}\right]} \quad (2)$$

where n represents the sample size and N denotes the population size. This adjustment can significantly reduce the required sample size for small populations and is also referred to as the population correction.

Data Analysis

Utilisation Activities of Marine Fishery Resources in Semangka Bay

The analysis of marine fisheries resource utilisation in Semangka Bay was conducted using a descriptive statistical approach to interpret and explain the research data. The analytical process involved several stages, including raw data collection, transcription, data reduction, interpretation, and conclusion. This analysis follows the framework established

Table 1: Description of the primary and secondary data

No.		Type of Data	Source
1	Primary Data:		
	-	Benefited results (captured fish/fish yield)	Interview
	-	Price of fish yield	Interview
	-	Fishermen’s income	Interview
	-	Socioeconomic typology of respondents	Interview
	-	Catch fishery economic effort	Interview
	-	Perceptions from fishermen and the community	Interview
2	Secondary Data:		
	-	Semangka Bay length area	Literature studies and Statistic Bureau (BPS) of Lampung Province
	-	Number of fishermen	Central Statistics Bureau (BPS) of Tanggamus Regency in 2024

by Kaliyadan and Kulkarni (2019), who explained that descriptive statistics are used to summarise data through simple quantitative measures such as percentages or means, as well as visual summaries like histograms and box plots. Descriptive statistics can analyse either a single variable (univariate) or multiple variables (bivariate/multivariate). In cases involving multiple variables, the relationships between them can be summarised using tools like scatter plots. Additionally, Hadiansyah *et al*. (2023) clarify that descriptive statistics generally fall into two main categories: sorting/grouping and illustration/visual display, along with summary statistics.

Economic Valuation of Marine Fisheries Service Provider

The economic valuation of the coastal and marine ecosystem service provider in the Semangka Bay area of Tanggamus Regency was conducted using a direct use approach focused on capture fisheries activities. This was achieved through the productivity method, also known as the EoP method. To estimate the economic value derived from the EoP analysis, research data were processed using a demand analysis approach. This approach involves calculating the economic value by estimating consumer surplus (CS) and assessing the utility value obtained from the use of the coastal and marine ecosystems in the study area. According to Adrianto (2006) and Arkham *et al*. (2023), economic valuation employing a production-change approach can also be conducted using a demand-based approach. Once a demand function has been estimated, analysts can utilise the demand model to estimate changes in consumer and producer surplus associated with variations in the quantity of resources demanded. Demand-based valuation is commonly applied to cases of direct-use values, such as fish in coral-reef ecosystems, firewood in mangrove ecosystems, and similar examples. The economic calculation of the service provider of captured fishery/fish yield consisted of several steps as follows:

(1) The estimation for the demand function to assess the direct benefit of the coastal and marine ecosystem in the Semangka Bay area is calculated by using the following equation:

$$Q = \beta_0 X_1^{\beta 1} X_2^{\beta 2} \ldots X_n^{\beta n} \tag{3}$$

where Q = fish production (kg/year); X_1 = average price of fish (Indonesian rupiah [IDR]/kg); X_2 = income (IDR/year); X_3 = attempted catch/trip (times); X_4 = age (years); X_5 = number of family members; X_6 = education (years); and, X_7 = operational costs (IDR/year). The relationship between fish price (X_1) is assumed to be negative for resource demand. The higher the fish price, the lower the level of demand for this resource.

(2) The demand function is transformed into a linear price equation using the following formula:

$$\begin{aligned} LnQ &= \beta_0 + \beta_1 LnX_1 + \beta_0 LnX_1 + \cdots \beta_n L_n X_n \\ LnQ &= ((\beta_0 + \beta_2(LnX_2) + \beta_n(LnX_n)) + \beta_1 L_n X_1 \\ LnQ &= \beta' + \beta_1 LnX_1 \end{aligned} \tag{4}$$

(3) The demand function is transformed into the initial equation form (step 1) as follows:

$$Q = \exp(\beta')X^{\beta 1} \text{or} \ldots Q = \beta X^{\beta 1} \tag{5}$$

(4) The demand function is transformed into a price function by employing the following equation:

$$X_1^{\beta_1} = \frac{Q}{\beta} \text{ or } X_1 = \frac{Q^{\frac{1}{\beta_1}}}{\beta^{\frac{1}{\beta_1}}} \tag{6}$$

(5) The total willingness to pay for resources (economic value of resources) is estimated using the following equation:

$$U = \int_0^a f(Q)dQ \tag{7}$$

where U = utility value of the resource; a = limit of the average amount of consumed resource; and, *f(Q)* = demand function.

(6) The consumer surplus value is estimated with the following equation:

$$CS = U - Pt$$
$$Pt = X_1 \times \bar{Q} \quad (8)$$

where CS = consumer surplus (IDR/individual/year); Pt = total price paid; Q = average amount of the consumed resources; and, X_1 = unit price of the consumed resources.

(7) The economic value (U), price paid (Pt), and consumer surplus (CS) per unit of resource are estimated with the following equation:

Example: Captured fish/fish yield (kg)

$$U/kg = \frac{u}{\bar{Q}} \; ; \; Pt/kg = \frac{Pt}{\bar{Q}} \; ; \; CS\ /kg = \frac{CS}{\bar{Q}} \quad (9)$$

(8) The total economic value (NET) is estimated with the following equation:

$$NET = \frac{CSxN}{L} \quad (10)$$

where NET = total economic value from the utilisation of resources (IDR/hectare/year); N = number of resource users (fishermen); L = area of resources (ecosystem).

Results and Discussion

Fish Yield/Catch Fishery Economy Activity in Semangka Bay Area

Fishing activities serve as the primary source of livelihood for fishermen in the Semangka Bay area of Tanggamus Regency, Lampung province, and are considered a small-scale industry (often referred to as small-scale fisheries). Their fishing grounds are located near the coast, at a distance of no more than 10 miles, with efforts made only once a day (termed as one-day fishing). The types of fishing equipment used by fishermen in this area primarily include hand lines, longlines, drift gillnets, and trolling rods, with outboard motorboats serving as the fishing fleet. The majority of fishermen's yield is sold to collectors or at a fish auction place (Tempat Pelelangan Ikan/TPI), with only a few sales made directly to consumers. This observation aligns with the findings of Romadhon (2014), which also noted that fishing activities (fish catches) provide benefits from coastal and marine ecosystems. This type of one-day fishing employs hand line and other traditional fishing equipment, with the fishing fleet utilising outboard motorboats (Ramadhan *et al*., 2016). The identification of capture fishery activities in the study location, based on interviews and direct observations conducted in the research field, is presented in Table 2.

The average fish yield earned by fishermen in the Semangka Bay area of Tanggamus Regency varies according to the fishing season. During the high or peak season, the average catch in one round trip reaches 80–100 kg/trip, while in the low season, it only amounts to 25–30 kg/trip. The selling price of fish also fluctuates with the season, ranging from IDR 15,000 to IDR 55,000, depending on the species and seasonality. Consequently, the average income of fishermen from fish sales lies between IDR 500,000 and IDR 1,000,000 per trip. Fishermen in the study area fish nearly throughout the year, with occasional non-fishing days for boat or engine maintenance when catches are sufficient. These results are more favourable compared to the findings of Romadhon (2014), which stated that the average income of coastal fishermen from selling fish for one trip in their efforts to exploit coastal and marine ecosystems varied from IDR 365,000 to IDR 700,000 per round trip at sea. This level of income is also supported by the availability of good fisheries resources in Semangka Bay, enabling fishermen along the Semangka coast and in Tanggamus Regency to harvest commercially valuable fish species. The types of fish caught by fishermen in the study area are presented in Table 3.

Economic Valuation of Fisheries Service Provider at Semangka Bay

The economic valuation of the marine fisheries provisioning services in the Semangka Bay area of Tanggamus Regency was conducted using the EoP analysis. This approach estimates the

Table 2: Catch fishery activity in Semangka Bay, Tanggamus Regency, Lampung Province

No.	Catch Fishery Activity		Description
1.	Number of fishermen benefiting from the area	:	5,704 people (Source: BPS of Tanggamus Regency)
2.	Semangka Bay length area	:	2,000ha (Source: Panji *et al*., 2016)
3.	Dominant type sof fishing gear	:	Fishing line Fishing pole Longline fishing line Drift gillnets
4.	Type of fleet/fishing boat:		
	- Engine	:	Outboard motor (15 – 60 PK)
	- Size of ship/boat	:	Minimum (6m x 0.7m x 0.5m) Maximum (9m x 1.5m x 0.8m)
5.	Fishing season:	:	
	- High	:	September – November
	- Moderate	:	December – June
	- Low	:	July – August
6.	Distribution of fish yield	:	Fish collectors, Fish auction place (TPI) and direct selling to consumers.

Source: Interview results from 55 study respondents

Table 3: Types and prices of fish caught by fishermen in Semangka Bay of Tanggamus Regency

No.	Type of Fish	Fish Price per Fish Season (IDR/kg)		
		High	Moderate	Low
1.	Mackarel tuna	15,000	20,000	30,000
2.	Marlin	35,000	45,000	55,000
3.	Mackarel	30,000	40,000	45,000
4.	Squid	35,000	45,000	50,000
5.	Largehead hairtail	25,000	30,000	40,000
6.	Swanggi	15,000	25,000	30,000

economic value derived from the productivity of coastal ecosystems in supporting fishery resources. Data were obtained through interviews with 55 selected fishermen operating in the Semangka Bay area. The valuation involved estimating the fishermen's demand function for coral reef provisioning services by regressing fish production (Q) against several explanatory variables: The average price of fish (X_1), income (X_2), catch per fishing trip (X_3), age (X_4), household size (number of family members) (X_5), education level (X_6), and operational costs (X_7). These variables were used to construct a demand curve and calculate the consumer surplus (*CS*), which in turn was used to estimate the economic value of the resource utilisation area. Following Arkham *et al*. (2023), the economic valuation assumed a linear relationship between the dependent variable (Q) and the independent variables (X). The average values and standard deviations of fishing variables for the coral reef ecosystem at the research location are presented in Table 4.

Table 4: The average score and standard deviation of the caught fish/fish yield variable at Semangka Bay in Tanggamus Regency

Variables	Description	Average Value	Standard Deviation
Q	Amount of captured fish (kg)	51,175	27,727.61
X_1	Average price (IDR/kg)	29,166	5,347.01
X_2	Income (IDR/year)	79,614,545	82,362,845.40
X_3	Operational trips	316	28.88
X_4	Age (year)	43	10.47
X_5	Number of family members (person)	3	1.87
X_6	Education (year)	8	4.02
X_7	Operational costs (IDR/year)	68,672,836	80,823,488.64

Based on the statistical analysis presented in Table 4, the average age of the respondents is 43 years, with an average education level of 8 years of compulsory education, indicating completion of elementary education. These findings suggest that the majority of fishing activities are carried out by individuals in their productive yeasr, with many having started their fishing ventures around the age of 17. This reflects a significant human resource potential for optimising the utilisation of fishery resources in Semangka Bay. As explained by Mantra (2004), economically productive age groups are classified into three categories: (a) individuals under 14 years of age, who are considered non-productive; (b) those aged 15-64 years. who are the productive age group; and, (c) individuals over 65 years, who are categorised as unproductive.

The annual average production value from fishermen in the Semangka Bay area is 51,175 kg/year, with an average of 316 fishing trips annually. The average production per fishing trip is 163.3 kg. Additionally, the average price received from the sale of fish is IDR 29,166/kg, resulting in an annual income of IDR 79,614,545/year or IDR 6,634,545/month. These figures indicate that the fishery resources in Semangka Bay hold significant economic value. The economic value of capture fisheries services in this area is estimated using the Consumer Surplus (CS) approach, which calculates the total area under the demand curve. This approach, as confirmed by Suryawati *et al*. (2018), is commonly used to assess the economic value of fisheries resources in coastal and marine ecosystems.

The results of the EoP analysis for capture fisheries activities yielded a regression outcome representing fishing activities within the coral reef ecosystem of Semangka Bay, Tanggamus Regency, from which the following demand function was derived:

$$LnQ = 19.70510889 - 1.419838204X_1 - 0.376442518X_2 + 1.277053106X_3 - 1.007968242X_4 + 0.108375466X_5 - 0.125878731X_6 + 0.499264017X_7$$

The result of the regression analysis displays the significance level of the relationship between fish production and several independent variables, as reflected by an adjusted R-squared value of 0.62. This suggests that 62% of the variation in fish production can be explained by the independent variables used in the model, which include fish price, fishermen's income, number of fishing trips, age, family size, education level, and operational costs. The estimated demand function shows a negative relationship between fish production and four variables: Average fish price, fishermen's income, age, and education level. This implies that an increase in any of these variables is associated with a decrease in fish production. Conversely, positive relationships are observed between fish production and the number of fishing trips, family size, and operational costs, indicating that increases in these variables lead to higher fish production. These findings align with Warningsih (2016), who stated that a negative sign in a demand model reflects an inverse relationship, while a positive sign suggests a direct relationship between the variables and the demand function (Arkham *et al*., 2020). Results from the regression analysis in this research were subsequently used to construct a demand curve and estimate the consumer surplus value from the capture fishery service provider in the coastal and marine ecosystems of the Semangka Bay area. The demand curve representing the capture fisheries service is shown in Figure 2.

According to the demand curve above, an estimation is made to determine the economic value of the service provider from the captured fishery production in the coastal and marine ecosystem of the Semangka Bay area, Tanggamus Regency, Lampung Province, by calculating the amount of surplus consumer value (*CS*). The willingness to pay of each fisherman using the coastal area (*U*) is IDR 4,692,900,558 per year, while the price paid by consumers or the consumers' limit price (PQ) is IDR 26,256 per kg. Based on the analytical approach of EoP, the estimated economic value of consumer surplus (*CS*) for the coastal and marine ecosystem is IDR 3,349,247,084 per hectare per year. To determine the total economic value of the EoP for coastal and marine resources in Teluk Semangka, Tanggamus Regency, we calculate it by multiplying the total number of fishers (5,704) by the per-hectare consumer surplus (IDR 3,349,247,084 per hectare per year) and then dividing by the study area (2,000 hectares). This calculation results in a total economic value of IDR 9,127,563,124.

The results of the economic valuation from service providers on capture fisheries in the coastal and marine ecosystems of the Semangka Bay area, Tanggamus Regency, Lampung Province, hold significant value for the fishermen in the Semangka Bay area. This economic value indicates that the existence of the coastal and marine ecosystems in Semangka Bay is crucial for the local community as a source of food security. This condition also highlights the dependency of fishermen on the coastal and marine ecosystems in Semangka Bay to support their welfare. Therefore, if there is pressure or a threat of damage to these ecosystems, it will adversely affect the ecological, habitat, and economic functions that support the fishermen's welfare. In line with this research, Lestaluhu and Jasahua (2014) and Arkham *et al*. (2020)

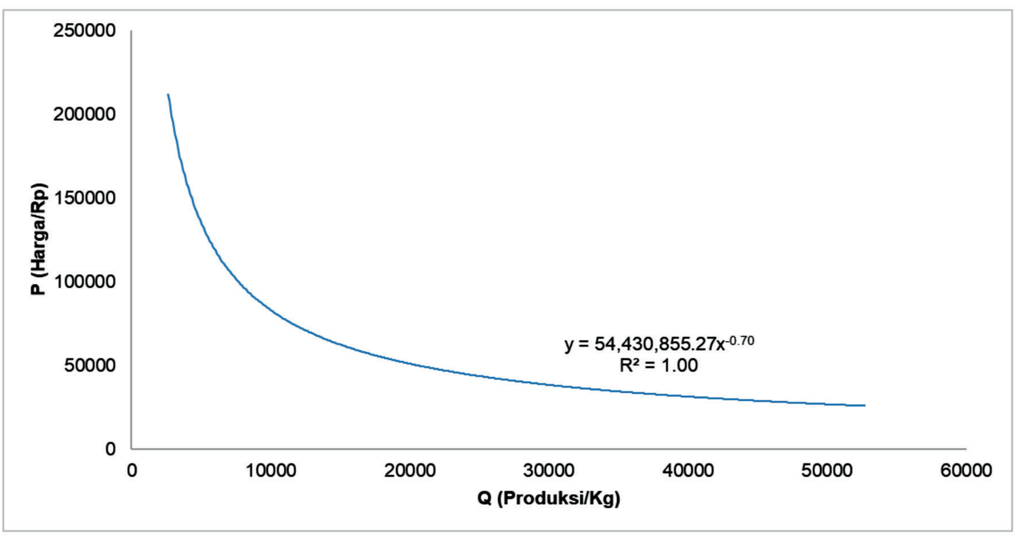

Figure 2: The demand curve for captured fish providing services to the coastal and marine ecosystems in Semangka Bay in Tanggamus Regency

reported that one functional role of coastal and marine ecosystems is to support fisheries productivity as a provider or source of food or protein, thereby improving the welfare of the surrounding community.

Discussions

Fishery activity of the fishermen in the Semangka Bay area is classified as a small-scale fishery business, with a fishing ground extending no more than 10 miles off the coast. This form of business is typically conducted in one day of fishing, using simple fishing gear such as hand lines, longlines, drift gillnets, and trolling lines. According to Carvajal-Arenas (2022), small-scale fishery production like this plays an important role in local food security and the livelihoods of coastal communities, although this small business often faces challenges such as limited market access and technological limitations. For this reason, policy interventions are needed to support better access to technological advances and a larger market so that the captured fish can provide higher economic value for local fishermen.

The distribution of fishery harvests from the fishermen in this area is primarily conducted through fish collectors, sales at the fish auction centre (TPI), or direct selling to consumers. The pattern of this distribution cycle indicates a high dependence on local supply chains, which can either present an opportunity or, conversely, pose a challenge for the fishermen. A study by Wahyudin *et al*. (2016) highlights the importance of increasing supply chain efficiency to reduce post-harvest losses and enhance fishermen's income. By strengthening the distribution system, such as providing cold storage infrastructure and expanding access to the regional market (Huda *et al*., 2018; Chalkiadakis *et al*., 2022), fish harvests in Semangka Bay can yield greater economic benefits for local communities.

Recent regional assessments show that these seasonal yield patterns are consistent with those reported in other parts of Sumatra and the broader Southeast Asian fisheries. For instance, a 2023 study of coastal communities in Central Java reported peakseason catches of 70–90 kg/trip and lowseason averages of 20–35 kg/trip (Novianto *et al*., 2023). Similarly, research from the Mekong Delta indicated comparable fluctuations, with peak-season yields averaging 85 kg/trip (Nuon *et al*., 2025). These parallels suggest that the observed seasonal dynamics in Semangka Bay are primarily driven by shared biophysical factors, such as monsoonal currents and spawning migrations, rather than site-specific practices.

The income range of IDR 500,000–1,000,000 per trip translates to a monthly household income of roughly IDR 3–6 million, which aligns closely with findings from other Indonesian coastal economies. A survey of fishing villages in West Nusa Tenggara (Stacey *et al*., 2021) documented that 70% of household income derives from fisheries, underscoring the sector's pivotal role in livelihood security. In Semangka Bay, the high reliance on fish sales makes households vulnerable to price volatility and seasonal shortfalls, a pattern echoed across the archipelago.

Climaterelated stressors, particularly rising sea surface temperatures and shifting precipitation patterns, have been linked to reduced fish abundance in the IndoPacific region (FAO, 2022). Preliminary observations in Semangka Bay suggest a modest decline in catch per unit effort during recent El Niño years, consistent with regional trends. Moreover, limited access to formal markets forces many fishers to sell directly to local intermediaries, often at lower prices than those recorded in organised fish landing sites (Adhuri *et al*., 2016). Enhancing coldchain infrastructure and facilitating certification for sustainable catches could improve price realisation and buffer against climateinduced production variability.

The result of this research shows that coastal and marine ecosystems in Semangka Bay of Tanggamus Regency play a strategic role in providing a productive service related to capture fishery resources. The EoP approach used in this research reveals a consumer surplus

(*CS*) value of IDR 3,349,247,084 per hectare per year. This economic value describes the potential direct benefits for fishermen from their sea fish harvest, highlighting the importance of the Semangka Bay area as an economic base for local communities. A similar opinion is found in research by Barbier (2016), which emphasises the importance of an economic approach in managing coastal ecosystems; measurements like these help to understand the relationship between ecosystem function and the direct benefits received by society. In addition, Costanza *et al*. (2021) underlines that an economic approach based on the extent of territorial area clarifies the importance of preserving coastal ecosystems in improving the welfare of local communities. In this context, the coastal ecosystem in Semangka Bay functions as an economic asset that must be managed sustainably.

A significant value from the consumer surplus also reflects the high dependency of fishermen on the productivity of coastal ecosystems. As noted in studies by Martínez-Vázquez *et al*. (2021) and Wahyudin *et al*. (2018), a high economic value such as this coastal ecosystem is often accompanied by management challenges, including overexploitation and environmental degradation. Therefore, it is important to adopt an ecosystem-based governance approach that can maintain the sustainability of resources and ensure their benefits continue for future generations.

Furthermore, the presence of fishermen who benefit from the Semangka Bay area underscores the importance of strengthening their capacity to manage fisheries resources sustainably. This aligns with the findings of P. de Alencar *et al*. (2020), which emphasise that capacity building within local communities is a key factor in successful coastal ecosystem management. These strengthening efforts should include skill improvement, better access to environmentally friendly technology (Wahyudin, 2023), and active participation in decision-making processes related to resource management.

Conclusions

The conclusion of the research results explains that the coastal and marine ecosystem in the Semangka Bay area of Tanggamus Regency, Lampung Province, provides services in the form of productivity from marine fish harvests. Based on the analysis using the effect on production (EoP) approach, an estimated economic value of consumer surplus (CS) for the coastal and marine ecosystem can be determined, amounting to IDR 3,349,247,084 per hectare per year. To determine the total economic value of the EoP for coastal and marine resources in Teluk Semangka, Tanggamus Regency, we calculate it by multiplying the total number of fishers (5,704) by the per-hectare consumer surplus (IDR 3,349,247,084 per hectare per year) and then dividing by the study area (2,000 hectares). This calculation results in a total economic value of IDR 9,127,563,124. The analysis of the economic value provided by services from the coastal and marine ecosystem in the Semangka Bay area of Tanggamus Regency, Lampung Province, related to capture fishery activities, can be used as a consideration in area management regarding the value of resource assets. Any development policies that involve destructive economic utilisation (impacting damage to coastal and marine ecosystem habitats) in the study location are expected to be taken into consideration by both regional and central government when formulating policies. This will ensure that the development of economic activities around Semangka Bay in Tanggamus Regency, Lampung Province, does not diminish the economic value or the benefits derived from the existence of the coastal and marine ecosystem for local communities and fishermen.

Acknowledgements

The authors would like to express their sincere gratitude to the Government of Tanggamus Regency, particularly the Regional Development and Research Agency (BAPERIDA), the Department of Marine and Fisheries, and the Department of Environment, for their generous support, collaboration, and facilitation throughout the implementation of this research. The valuable data, insights, and assistance provided by these institutions were instrumental to the successful completion of the study. It is earnestly hoped that the findings of this research will contribute to evidence-based policy-making and the sustainable management of marine and environmental resources in the region.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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