http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 12, No 03 2023
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

ECONOMIC VALUATION OF MANGROVE BIOLOGICAL SYSTEM ADMINISTRATIONS IN UJUNG PANGKAH AREA OF GRESIK, EAST JAVA

Friza Rahmawanto Wibowo[1], Gatot Yulianto[2], Benny Osta Nababan[3]
[1]Mahasiswa Magister Program Studi Ekonomi Kelautan Tropika, Institut Pertanian Bogor, Kampus IPB, Bogor, 16680, [2]Dosen Fakultas Prikanan dan Ilmu Kelautan, Intitut Pertanian Bogor, Kampus IPB, Bogor 16680, [3]Dosen Fakultas Ekonomi dan Manajemen, Institut prtanian Bogor, Kampus IPB, Bogor 16680
Medan

ARTICLE INFO

Keywords:
Coastal Development,
Economic Valuation,
Mangrove Service,
Total economic valuation,
Ujung Pangkah Mangrove

ABSTRACT

The mangrove ecosystem is important to the people of the Ujung Pangkah Subdistrict because they use it to catch fish, crabs, and shellfish and as a place to make mangrove wood. As a result, it is critical to ensure the long-term viability ecosystem of mangrove in a number, one of which is by providing economic reports on these ecosystems. The motivation behind this study is to gauge the monetary worth of mangrove biological systems. This study was led in Ujung Pangkah Locale utilizing an overview technique. The economic value of mangrove ecosystem services, which include support, supply, regulatory, and cultural services, is used to analyze the data. The outcomes show that the absolute financial worth of mangrove environment administrations covering an area of 1,445 Ha is Rp. 8.981.001.176.087/year or Rp. 6.215.225.727/Ha/year, which includes a value of Rp for supporting services. 7.967.215.987.975/year, the benefit of offering types of assistance is Rp. IDR 23.801.226.560 annually, 988.562.461.194 annually for regulatory services, and 1.421.500.358 annually for cultural services. Mangrove ecosystems have a high environmental service value and must be conserved in order to maintain their high economic value, as evidenced the highest value of economic is regulatory and supporting service. The results of this study's maps can provide local managers and decision-makers with a picture of what occurred to the target ecosystems' quality, enabling them to implement more effective management strategies for the conservation of these ecosystems.

E-mail:
Frizarahma321@gmail.com

1. INTRODUCTION

Mangroves describe forest that grow at estuary and on the coast, stands that live between the sea and the land. Therefore, a forest on the beach is also called a mangrove forest (Saputro, 2009). As pointed out by Sloan (1993) the roots of mangrove trees also retain heavy metals and shed pesticides that can pollute the ocean. In Adddition, MacFarlane and colleagues. 2002) stated that the Avicennia marina mangrove foundation can be used as an organic marker in conditions polluted by heavy metals such as copper (Cu), lead (Pb), and zinc (Zn) through periodic checks. It is parallel down on the biological systems in this coast. It will lead a negative impact on environmental sustainability if this is handled improperly.

The Ministry of Environment and Forestry (KLHK) reports that in 2017 there are currently 16,530,000 ha of mangroves in worldwide. 1500 species are found in mangrove ecosystems in Malaysia and Indonesia (McNally, et.al. 2011). In fact, there is only a small part of the mangrove ecosystem can be found in several countries, and Indonesia is one of them. According to the Ministry of Environment and Forestry (2017), Indonesia's mangrove ecosystem covers a total of 3,489,140.68 ha or 23% of the mangrove in the world. According to data compiled by the East Java Forestry Service in 2017, the area of East Java's mangrove forests reaches 1,361,146 ha. According to Rudianto (2014), 40% of the total 678,879 ha of mangrove forests in Gresik Regency are damaged. The damage that occurred in Gresik is carried out in eight sub-districts including the Manyar, Kebomas, Bunga and Ujungpangkah, Sidayu and Panceng, and Tambak, Sangkapura parts of Bawean Island. Around the coast, Manyar and Ujung Pangkah Districts are the worst affected.

http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 12, No 03 2023
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

The occurrence of mangrove reduction has an impact on reducing environmental capabilities which then has an impact on its monetary value. The advantages and disadvantages are equal, especially in the Ujung Pangkah mangrove, Gresik Regency. The estimation of absolute monetary value (complete financial worth) can be used to make or decide on Gresik's mangrove management strategy procedures. The fact that mangrove forest ecosystems can be lost or destroyed if there is no economic valuation model used to fund the rehabilitation of damaged mangroves is quite concerning.

2. METHOD

Type and Source of Data

A survey approach is conducted in this study. The review strategy is a technique applied to get the reality of the existing peculiarities that are really related to the social, monetary, and political foundations of an association or district (Nazir, 2003). Sampling was carried out by purposive sampling since the respondents were people who knew the condition of mangroves. The information collection was completed from August 2021 to April 2022. The information used was from essential and additional information sources. Figure 1, it depicts a location map.

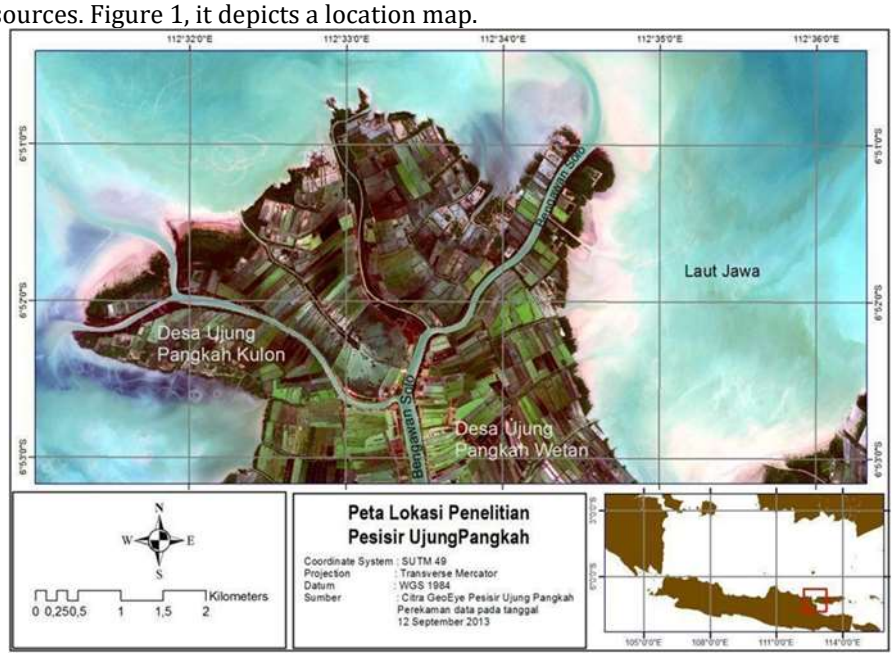

Figure 1. Map of Research Location

The Ministry of Maritime Affairs and Fisheries recorded 499 people through KUSUKA data collection (Marine and Fisheries Business Actor Card/ Kartu Pelaku Usaha Kelautan dan Perikanan) until December 2021. According to the table above, the sample size obtained is 10% of 499, in particular 49.9 then added up to 50. Therefore, there were around 50 respondents who were focused on this review.

An analysis of the economic value of the services provided by the mangrove ecosystem was used to evaluate the data collected for this study. Evaluation of four types of mangrove ecosystem services—supporting services, supply services, regulating services, and cultural services—is used to determine the economic value of mangrove ecosystem services (MEA, 2005).

Data analysis method

Mangrove forest economic valuation analysis

Supporting Services

All other ecosystem services, such as energy processing, soil formation, primary production, and other supporting services, are supported by services called supports (MEA, 2005). The value of the biodiversity of mangrove ecosystems and marine biota spawning grounds was conducted in this study to calculate the value of supporting services. The following is the formula for determining the economic value of supporting services:

$$SS = \sum_{i=1}^{2} \text{SSi}$$

Information :
SS = Supporting services (Rupiah/ year); SS1= spawning grounds (Rupiah/year); SS2 = biodiversity (Rupiah/ year)

Provisioning services

The products such as food, raw materials, medicines, energy, and resources found in ecosystems are examples of service providers (MEA, 2005). In this review, specialist organizations obtained from fishery items such as fish, shellfish, and crab. The Effect on Production (EoP) approach is used to calculate the production value of fish, shellfish and crabs. Mangrove ecosystem services can be calculated using the following formula:

$$PS = \sum_{i=1}^{3} PS\text{i}$$

Information:
PS=provisioning services (Rp/ year); PS1=fish income (Rp/ year); PS2=Shellfish income (Rp/ year); PS3=crab income(Rp/ year)

Regulating services

Administration is the benefit derived from guidelines carried out by biological systems such as environmental guidelines, carbon sequestration, water cleaning, prevention of seawater disturbance, and various other administrative administrations. In this review, the administration is taken from the security value of the coast, security against seawater disturbance, carbon sink, and oxygen generator. The value of coastal abrasion protection and seawater intrusion protection is determined by the replacement cost method. On the other hand, the value of the carbon sink and oxygen generator is determined by the benefit transfer method. The recipe for calculating mangrove environmental administration is as follows:

$$RS = \sum_{i=1}^{4} RS\text{i}$$

Information:
RS= regulating services (Rp/ year); RS1 = resisting abrasion (Rp/ year); RS2= protecting against seawater intrusion (Rp/ year); RS3= carbon absorber (Rp/ year); RS4 = producing oxygen (Rp/ year)

Cultural Services

According to Alam et al. (2009), the value of cultural services is the value obtained through the method of willingness to pay for the existence of natural resources. The willingness of an individual or community to pay for the maintenance of the mangrove ecosystem in Ujung Pangkah shows the cultural value of the mangrove forest in Ujung Pangkah District. The study of cultural services includes the recreational benefits of mangrove tourism. Travel costs paid by visitors are used as the basis for calculating value. According to Adrianto (2006), this approach relies on the understanding that everyone, both those who have visited and those who will visit, will visit a tourist attraction without paying an entrance ticket.

Total Economic Value of mangrove forest

The total economic value is the aggregate of all economic values from mangrove ecosystem resources in the Ujungpangkah sub-district, Gresik Regency.

3. RESULT AND DISCUSSION

Economic Valuation of Ujung Pangkah Mangrove Forest Ecosystem

The total value of the valuation in this study is the value of supporting services, the value of service providers, the value of regulating services, and the value of cultural services. The value of supporting services is obtained from the value of spawning places and biodiversity in mangroves. The value of the service providers obtained from the receipt of fish, shellfish, and crab production. The value of the service providers obtained from estimating abrasion resistance, providing fresh water, absorbing carbon, and producing oxygen. The latter is a cultural service obtained from the calculation of WTP tourist visitors in the Ujung Pangkah sub-district.

Supporting services

The value of marine biota spawning grounds and the diversity of mangrove ecosystems provide supporting services for this study. The biological benefits of the mangrove ecosystem include places to eat, lay eggs, and grow (Fahrudin, 1996). The procedure conducted to calculate administrative support is through the advantage move approach. This method adjusts the valuation of services provided by mangrove ecosystems to district/city and national minimum wages.

The value of marine biota spawning places

The first mangrove ecosystem supporting service value is as a spawning ground. The regression model between the area of the mangrove ecosystem and the fishing effort for crab production produces this value from the formula (Marlianingrum, 2007). The following formula can be used to estimate crab production:

$$h=0.0268EM + 0.0000141E2$$

Information:

H: Crab Production (kg/ year), E : Effort Catching (trip/ year), M: The area of the mangrove ecosystem (ha)

The typical crab-catching effort in the Ujung Pangkah area is 96 times per year, by a mangrove area of 1,445 ha. Crab production in Ujung Pangkah District is 39,992.4 kg per year according to these calculations. The typical price of crabs in the Ujung Pangkah area is Rp 26,000 per kg, with the lowest wage normalization permitted by law in Batam City in 2007 and the Gresik Regime UMK in 2022 of 5.26. Rp 7,895,626,845 per year is the value of mangrove ecosystem services as a spawning ground for marine biota.

The annual value of the mangrove ecosystem as a spawning ground for marine life is Rp 7,895,626,845,813. This value indicates that the mangrove ecosystem in the area has high economic value and has not been badly damaged. The production of fish, crabs, and shrimp will be affected by the state of the mangrove ecosystem. This is in line with the opinion of Mardawati (2004) which states that the production of fish, crabs, and shrimp will also increase as the mangrove ecosystem grows larger. The size of the mangrove ecosystem has a significant impact on the economic value of marine biota spawning grounds. Therefore, it is very important to preserve the mangrove ecosystem to maintain the high economic value of marine biota spawning grounds.

Biodiversity value of mangrove ecosystems

The administrative benefits of supporting the biodiversity value of mangrove biological systems were assessed in terms of the environmental benefits of mangroves for unrefined modern components at a value of US$1500/KM2/year (Ruitenbeek, 1992). The national standardized average minimum wage serves as the basis for biodiversity values. Biodiversity value comes from:

$$NKH = (D/Ha) \times M$$

Information:

NKH=Biodiversity Value (IDR/ year);D= Estimated value of mangrove ecosystem biodiversity (Rp/ Ha/ year); M= the mangrove ecosystem area (ha)

According to Ruitenbeek's research (1992), the environmental biodiversity value of mangroves is US$ 15 per hectare annually. The ratio of the rupiah to the US dollar was 1 US to Rp. in 1992. 2,029.92. Therefore, 15 US dollars was equivalent to 15 Rp. 30,448.80. The value of the rupiah against the US dollar will be IDR 14,848.82 in 2022. This indicates that the mangrove ecosystem in Ujung Pangkah District has a biodiversity value of IDR 7,589,142,162 per year.

In Ujung Pangkah District, the mangrove ecosystem has a biodiversity value of IDR 71,589,142,162 per year. This shows that the mangrove ecosystem in this area is very diverse. It can be expressed as the number of different biota species found in an ecosystem. The high biodiversity of marine biota found in mangrove ecosystems will have an impact on the economic value of supporting services. This is consistent with the consequences of Islam and Haque's research (2004) who reasoned that the mangrove environment in Bangladesh has increased the efficiency of marine biota because it has high biodiversity.

Provisioning services

The provider value in this study was obtained from the results of fishery assets such as fish, shellfish, and crabs. To find out the value of supplier services, the effect on creation (EoP) approach is conducted by observe the salaries of people who use fishing gear, clams, and crabs. In the EoP approach, the socio-economic factors of natural resource users were also taken into account. The existence of the

mangrove ecosystem, according to Yulianto (2017), has an impact on increasing catches, fishing efforts, and economic rents.

1. results of fishing
   The benefit value of the first Service Provider is the production value of Sea Fish that is sought around the mangroves. The average price per kg is Rp 24,075. In this study, it was found that each person has an average marine fish production of 1,619.4 kg/year/person. The average operational cost is Rp 13,437,500/year/person. Fishermen's average income is Rp 38,756,669 / year/person. The consumer surplus value and the economic value of fish beneficiaries are determined using demand as an approach and a number of social economic variables. The details are a consumer surplus of Rp 131,630,029/year/person and an economic value of Rp 13,294,632,954/year.
2. Production of crab
   According to appendix 4, the catch within a year yields 714 kg/person at an average price of Rp 26,000/kg. Fishing carried out by fishermen in a year costs around IDR 11,562,000/person, with a total fishing trip of 96 trips/person. In this production, each person gets an average of Rp 18,550,000/person/year. The consumer surplus value for crab production is Rp. 187,088,317/year/person, so the economic service value of mangroves from crab production is Rp. 10,476,945,727/year.

Capture fisheries are influenced by the presence of mangrove ecosystem. The mangrove framework will increase yield, fishing effort, and add economic value under conditions of static open access (OA), maximum reasonable yield (MSY), and greatest return (MEY) (Yulianto, 2017). The production of shrimp is also influenced by the mangrove ecosystem which has an impact on the income of shrimp fishermen. This is accordance with the research of Barbier and Ivar (1997), which states that the decay or destruction of the mangrove environment will reduce the creation and benefits of crabs. The economic value of crab production costs is strongly influenced by the state of the mangrove ecosystem, a mangrove environment with proper areas and conditions will generate high economic value.

Shellfish Production Income

The average fisherman catch per year is 4,140 kilograms, and the price of clams per kilogram is Rp 5,950. The shell are caught by fishermen an average of 128 times/ year, with an annual operational cost of Rp 6,951,000/person. The annual income of a fisherman is Rp 24,633,000/person. Customer added value from the mangrove environment obtained from clam anglers is Rp 29,647,879/year for each individual, with a monetary value of Rp 3,943,167,893/year.

Service Arrangement (Regulating services)

In this observation, the administration alludes to the value of shoreline safety, seawater intrusion guarantees, carbon sinks, and oxygen generators. The replacement cost approach is the one to take. Use the transfer value from previous research to determine the value of carbon absorbers and oxygen producers, and replace the function of mangroves with concrete building construction to break waves to prevent coastal erosion to calculate the value of regulatory services. The cost of constructing a concrete building, the value of providing clean water, the value of carbon absorbers, and the value of producing oxygen determine the value of the regulatory services obtained.

The service value of making ocean wave-breaking concrete.

Value as a break-water, management of the mangrove ecosystem in Ujung Pangkah District is the first benefit. The benefits of the sea wall are determined by calculating the expected costs of constructing the sea wall protected by the mangrove biological system. The break-water has an economic life of thirty years and costs Rp 5,839,880/meter, as stated by the Ministry of Public Works (2014). The coastline that is guarded by the mangrove environment is 6,160 m long and Indonesia's loan fee in January 2022 is 5.00%. The construction of the breakwater will cost Rp 35,973,660,800, or 7,194,732,160/ year, according to these calculations.

Prevention of sweater intrusion is obtained from the value of the fresh water provider (Rupiah/year)

Preventing the entry of sea water into the land is another function of regulating mangrove ecosystems. Using the fresh water supplied value method, its value as a seawater deterrent is calculated. This approach was chosen because local people need new water for their daily needs through wells and groundwater extraction. There are 10,284 households utilizing the new water provided by the mangrove biological system, with a typical new water requirement of 1,000 m3/year for each household. The calculation results show that the need for fresh water/year is 10,284,000 m3, and the cost of fresh water

is Rp 3,000/m3. The value of new water provided by the mangrove environment is Rp 30,852,000,000 every year.

The condition and extent of the mangrove ecosystem greatly influences its economic value as a barrier to seawater intrusion. The ability of mangrove ecosystems to protect against seawater intrusion can be compromised by poor ecosystem conditions and sizes. This is consistent with research led by Janssen and Padilla (1999) which states that damage to the mangrove environment will not affect the ideal elements of the mangrove biological system such as flood avoidance.

Carbon Absorption (Rupiah/year)

The capacity of mangrove ecosystems to store carbon is another benefit. As pointed out by Windarni et al. (2018), mangrove ecosystems accumulate 198.61 tons of carbon/ hectare/year. The mangrove ecosystem covers 1,445 ha, and in February 2022, the carbon price in Europe will be Rp 1,563,400/tonC. In 2018 the UMK standard for East Lampung was 2.11, and in 2022 the UMK Gresik standard was 2.11. Based on calculations, the value of the ability, the mangrove environment as a carbon store in the Ujung Pangkah area is Rp 946,718,449,034/year. Due to their large area and high carbon market price, mangrove ecosystems are very valuable as carbon sinks. According to Donato et al., mangroves absorb CO2 emissions more effectively than peatlands or rain forests. 2011). A lot of carbon accumulation in a functioning mangrove ecosystem increases its economic value.

Oxygen Producer (Rupiah/year)

Mangrove biological systems have another financial advantage as oxygen generators. According to Siregar, Mangroves have the potential to produce oxygen at a rate of 3.65 m3/ha/year. Mangrove forest covering an area of 1,445 ha in Ujung Pangkah District will produce 5,274 m3 of oxygen annually. The estimated cost of oxygen in Ujung Pangkah Local is Rp 150,000/m3 and the MSE coefficient to Kubu Raya and Grsik's MSE is 4.80. The annual value of the mangrove ecosystem as a producer of oxygen is Rp 3,797,280,000/year.

Cultural Service (Cultural services)

Cultural services which can be in the form of tourism, recreation, or education are one of the mangrove ecosystem services (Lau, 2012). The value of social services is determined by the benefits of the mangrove biological system using a single spending approach during the trip (Fauzi, 2014). Costs for consumption, transportation, entrance tickets and toilets are taken into account when planning a trip to the mangrove ecosystem. The mangrove ecosystem in Ujung Pangkah District costs an average of around Rp 253,839/visit for tourists. The actual travel costs are multiplied by the number of tourists visiting the mangrove ecosystem at any given time to estimate the tourism value. 60,000 tourists will visit the mangrove ecosystem of Ujung Pangkah District in 2022. Based on this multiplication, the annual tourist value of the mangrove ecosystem is Rp 1,421,500,358.

Total Economic Value (TEV)

The total economic value of the mangrove ecosystem in Ujung Pangkah District is the sum of supporting, provider, regulatory and cultural ecosystem services. Table 1 illustrates this value.

Table 1 Total economic value of mangrove ecosystem services in Ujung Pangkah sub-district

No	valuation of mangrove ecosystem services	Value (Rupiah/year)	Percentage (%)
1	**Support Service**		
	The value of marine biota spawning places	7.895.626.845.813	87,91%
	The value of marine biota spawning places	71.589.142.162	0,80%
	Total	**7.967.215.987.975**	**88,71%**
2	**Provider Service**		**0,00%**
	Income of Fish	13.294.632.954	0,15%
	Income of Crab	10.476.945.727	0,12%
	Income of Shell	29.647.879	0,00%
	Total	**23.801.226.560**	**0,27%**
3	**Service Arrangement**		**0,00%**
	Making a breakwaters	7.194.732.160	0,08%
	Ocean intrusion deterrent:		0,00%
	Value of fresh water suppliers	30.852.000.000	0,34%
	Absorbent of C	946.718.449.034	10,54%
	Producer of O2	3.797.280.000	0,04%
	Total	**988.562.461.194**	**11,01%**

4	**Cultural Service**		**0,00%**
	benefits of mangrove tourism	1.421.500.358	0,02%
5	**Total Economic Value**	**8.981.001.176.087**	**100,00%**

Source: research result 2022

Regulatory services and supporting services contribute 88.71 percent and 11.01 percent of the value of mangrove ecosystem services, respectively. In Ujung Pangkah District, mangrove ecosystem services have a total economic value of Rp 8,981,001,176,087/year, or Rp 6,215,225,727/hectare. Rahmawati (2018) found that the value of mangrove ecosystem services in East Aceh District was Rp 173,458,107/hectare per year. As a result, the economic value of mangrove ecosystem management is not too unique because the two districts have almost the same quality and use.

Economic value calculations show that regulatory and support services account for the majority of mangrove services. Although not immediately visible, these environmental services provide significant benefits to society. This was confirmed by the examination of Costanza et al. (2014), who emphasized that mangroves provide environmental services that contribute to human well-being. Mangroves also affect the climate transmission threshold and affect the recognition and profitability of fishery assets. In this way, the monetary value of mangrove benefits must be maintained so that the management and conservation of assets can proceed with individual government assistance.

REFERENCES

Adrianto, L. (2006). Introduction to the Economic Assessment of Coastal and Marine Resources. Bogor: : Center for Coastal and Marine Resources Studies Bogor Agricultural University

Alam, S. Supratman, dan Alif, M. 2009. Textbook of Forest Resource Economics. Forestry Policy and Entrepreneurship Laboratory. Makassar: University of Hassanudin

Barbier, E. B., & Ivar, S. (1997). Valuing Mangrove-fishery: A Case Study of Campeche, Mexico. Amsterdam: Paper prepared for the 8thAnnual Conference of European Association of Environmental and Resource Economics (EAERE).

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., & Turner, R. K. (2014). Changes in the global value of ecosystem services. Global Environmental Change, 26(1), 152–158. https://doi.org/10.1016/j.gloenvcha.2014.04.002.

Donato, D. C., Kauffman, J. B., Murdiyarso, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2011). Mangroves among the most carbon-rich forests in the tropics. Nature Geoscience, 4(5), 293–297. https://doi.org/10.1038/ngeo1123.

Fahrudin, A. (1996). Economic Analysis of Coastal Land Management in Subang Regency, West Javat (Master's thesis). Retrieved from https://repository.ipb.ac.id/handle/123456789/21669.

Fauzi, A. (2014). Economic Valuation and Assessment of Damage to Natural Resources and the Environment. Bogor: IPB Press

Islam, M. S., & Haque, M. (2004). The mangrove-based coastal and nearshore fisheries of Bangladesh: Ecology, exploitation and management. Fish Biology and Fisheries, 14(2), 153–180. https://doi.org/10.1007/s11160-004-3769-8.

KLHK. 2017. Mangrove Ecosystem Economic Valuation Guide. Jakarta: State Ministry of Environment.

Lau, W. W. Y. (2012). Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem services. Ocean andCoastalManagement,83(1),5–14.https://doi.org/10.1016/j.ocecoaman. 2012.03 .011.

MacFarlane GR, Pulkownik A, Burchett MD. 2002. Accumulation and distribution of heavy metals in the grey mangrove, Avicennia marina (Forsk.) Vierh: biological indication potential. Environmental Pollution (123): 139 – 151.

Mardawati U. 2004. Study of the linkages of mangroves and the productivity of pond cultivation in Kamal Village, North Jakarta [thesis]. Bogor (ID): Postgraduate School, Bogor Agricultural University.

McNally CG, Uchida E, Gold AJ. 2011. The effect of a protected area on the tradeoffs between short-run and long-run benefits from mangrove ecosystems. Proceedings of the National Academy of Sciences. 108(34): 13945–13950.

Millennium Ecosystem Assessment (MEA). (2005). Ecosystems and Human Well-Being: Synthesis. Washington, DC: Island Press

Nazir M. 2003. Research methods. Jakarta (ID): Ghalia Indonesia.

Rahmawati. 2018. Sustainable Mangrove Ecosystem Management Policy in East Aceh District, Aceh Province [thesis]. Bogor (ID): Postgraduate School, Bogor Agricultural University.

Rudianto. 2014. Analysis of Integrated Coastal Area Ecosystem Restoration Based on Co-Management: Case Studies in Ujungpangkah District and Bungah District, Gresik Regency. Journal of Life Sciences. Malang Brawijaya University.

Ruitenbeek J. 1992. Mangrove Management: An Economic Analysis of Management Options wiyh A Focus on Bintuni Bay, Irian Jaya. Jakarta (ID): Environmental Management Development in Indonesia Project.

Saputro GB. 2009. Indonesian Mangroves Map. Jakarta (ID): Marine Natural Resources Survey Center, National Survey and Mapping Coordinating Agency (Bakosurtanal).

Sloan N. 1993. The various impacts of oil on marine resources: a review of the worldwide literature relevant to Indonesia. Jakarta (ID): EMDI Environmental Report.

Yulianto, G. (2017).). Policy Design for Integrated Management of Mangrove and Fisheries (Case Study in Indramayu Regency, West Java) (Doctoral dissertation). Retrieved from https://repository.ipb.ac.id/handle/123456789/85347.