Valuation of Coastal Ecosystem Services: A Case of Tangerang Regency, Indonesia

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Abstract. The north coast of Tangerang Regency, which borders directly with the Java sea, has great potential to be developed and made several coastal areas like the center of economic growth. Coastal Tangerang Regency also has several ecosystem components such as mangrove ecosystems and sand beaches ecosystem, which are currently degradation. Development planning with an ecosystem service approach is essential to understand as an effort to overcome trade-offs between development and the environment. This study aims to assess the Tangerang Regency coastal ecosystem services. The method used is the total economic value approach. Ecosystem services that will be analyzed are mangrove ecosystem services, and sand beach ecosystem services that are on the coast of Tangerang Regency. The data used is secondary data in the last five years (2014-2019). The results showed that the total value of coastal ecosystem services in the Tangerang Regency was IDR 32.610.028.060 per year or the US $ 2,29 million. This value can be considered to protect coastal ecosystems and increase the welfare of coastal communities that depend on ecosystem services. Environmental, economic, and social aspects need to be considered together to create a comprehensive development planning unit.

1. Introduction

Coastal ecosystems are a unit of natural community on the coast that provides essential support for human life. Provision of food, raw materials, medicines, abrasion regulation, biodiversity, recreation, and aesthetics are examples of services provided by coastal ecosystems. The benefits that individuals obtain from ecosystems are called ecosystem services [1]. [2] also defined ecosystem services as direct and indirect contributions to human welfare. There are four main categories of ecosystem services that contribute to community welfare according to [2], they are provisioning services, regulating services, habitat services, cultural & leisure services. These services provide benefits from local scales such as recreation [3], to global scales such as climate regulation [4]. The amount of contribution from ecosystem services can be reflected in the value of ecosystem services.

Coastal ecosystems are part of the natural system that is currently becoming an area with over-utilization, and it encourages land changes, which then become a dominant factor for the declining value of coastal ecosystem services [5]. The decline in the number of coastal ecosystem services due to land changes shows that development planning does not consider coastal ecosystem services. The concept of ecosystem service flows and natural capital reserves is a method used to highlight, measure, and assess the level of interdependence between humans and nature [6], so the concept of ecosystem...
services should be taken into consideration in the development decision-making process. One example of an area that is experiencing ecosystem degradation is the north coast of the Tangerang Regency (Indonesia). Coastal ecosystems in Tangerang Regency, which include mangrove ecosystems and sand beach ecosystems, have been changes in recent times.

From the length of the beach around 51.20 km, the largest mangrove community is only found in the Village of Pagedangan Ilir, District of Kronjo, with an area of about 3.87 ha. The rest, mangrove ecosystems are spread in small community units [7]. The total area of mangrove community units in the entire Tangerang Regency is around 182.14 ha, which is distributed around the coast, river borders, and dams. In 1996-2005, Tangerang Regency experienced an average reduction of mangrove areas by 28.76 ha per year. According to the Tangerang Regency Environmental and Forestry Office, there was a 54% decline in mangrove forests over 16 years. The decrease is in line with changes in the coastline of Tangerang Regency affected by abrasion, on average, 15.9-44.5 m per year (1995-2015) [8].

Tangerang Regency is the buffer zone of Jakarta Capital City, which is affected by extensive urbanization [11]. Also, the east coast is adjacent to the Soekarno-Hatta Airport, and the west is adjacent to the Lontar power plant and the provincial government center of Banten. The Tangerang Regency Government has also designed development in locations in coastal sub-districts, including the construction of toll roads and seaports [12]. Also, the majority of riparian land ownership is owned by several large companies. These development plans will inevitably impact the natural assets of coastal areas and change the functioning of their ecosystem services, as well as the socio-economic conditions of the community. Therefore, policymakers need to consider the values of coastal ecosystem services to minimize the negative impacts of development.

The primary purpose of this paper is to calculate the value of coastal ecosystem services in the Tangerang Regency. This paper provides the economic value of integrated coastal ecosystems, consisting of various ecosystem components such as mangroves and sand beaches. There has been no previous research on integrated coastal ecosystem services in Tangerang Regency. This research is expected to be a material consideration of policies and triggers for further research to realize the development of coastal ecosystems based on ecosystem services that have a positive impact on the environment, economy, and society.

2. Coastal ecosystem services

Twenty-two years ago, the publication of ecosystem services showed by [13], and the value of global ecosystem services [6] received considerable attention in science both theoretically and applicatively, including in the establishment of the journal Ecosystem Services. The journal was later ranked 2nd in a publication in 1997-2017 [14]. In Indonesia, the government collects ecosystem services through ecoregions, but the value of ecosystem services has not been measured in monetary terms. However, this is a positive step to collect ecosystem service data that can be used as a reference for policy and further research.

Coastal ecosystems, according to [15], are wetlands, mangroves, coral reefs, seagrass beds, dunes, estuaries, and deltas. The scope of the coastal area that is in the direction of land covers the administrative area of the sub-district and towards the sea as far as 12 miles (measured from the coastline) [15]. Coastal ecosystems have functions that provide benefits to the community called ecosystem services. Coastal ecosystem services, according to [1], are the benefits that people derive from coastal ecosystems. Ecosystem services and benefits that humans obtain depend very much on the structure of the ecosystem. Therefore, decision-makers must understand the ecological function to determine the potential of ecosystems that can produce services and benefits. The flow structure of the ecosystem to provide ecosystem services and benefits is illustrated in Figure 1 [2].
Figure 1. The flow of ecosystem structures to produce ecosystem services and benefits [2]. Every ecological structure or process has its function. The function provides ecosystem services that deliver benefits that have value. Examples of nutrient cycles (environmental cycles) are needed for water purification (ecological functions) to provide clean water (ecosystem services). Freshwater can be used for a variety of needs, for example, drinking water (benefits). Drinking water has a value that directly or indirectly influences human well-being. Welfare can be affected and change policy.

3. Economic valuation

Ecosystem services provide benefits that contribute to human well-being, as described above. To measure how much the contribution of ecosystem services to welfare in monetary value, it is necessary to assess ecosystem services with economic valuations. Valuation is an essential and valuable tool for sound policymaking, and therefore it must be seen as one of the inputs in decision making [16]. The use of ecosystem services as a framework for valuation provides a significant opportunity to include broader environmental impact analyzes for future policy assessments[16]. The economic approach that is generally used to assess ecosystem services is the concept of total economic value (TEV).

The TEV concept is a concept commonly used in calculating the economic value of the environment. There are several TEV components, such as (i) direct use value, (ii) indirect use-value, and (iii) option value. Non-use value is divided into (iv) bequest value, (v) altruistic value and (vi) existence value. The TEV value is obtained from the sum of the use-values (UV) and non-use values (NUV).

\[ TEV = UV + NUV = (DUV + IUV + OV) + (BV + AV + EV) \]  

The definitions of each component are as follows [2], [16], [17]:

- Direct use value (DUV): Value of direct use of natural resources by humans, both consumptive and non-consumptive.
- Indirect use value (IUV): Value derived from regulatory services provided by species and ecosystems.
- Option value (OV): The value of maintaining ecosystems and their components and habitats to allow future use even though their use is not yet clearly known. Value options can also be considered as a form of insurance.
• Bequest value (BV): Value where individuals are aware of the fact that ecosystem resources will be passed on to future generations.
• Altruistic values (AV): Values of the availability of ecosystem resources for others in the current generation (intrageneration)
• Existence value (EV): Values related to satisfaction obtained by individuals from only the knowledge that species and ecosystems continue to exist (intergenerational equality)

4. Method
This research uses a quantitative approach using secondary data. Secondary data were obtained from journals related to ecosystem services in the Tangerang Regency coastal area from 2010 through 2019. The scope of the journal used in data collection is a journal about the components of the coastal ecosystem. Ecosystem services are identified based on secondary data. The data is then analyzed to recalculate its contribution in shaping the value of coastal ecosystems by considering several other relevant studies. The amount of coastal ecosystem services is calculated using the total economic value approach, according to formula (1), which is the sum of the use and non-use values.

5. Result
Coastal ecosystem services in Tangerang Regency based on journals related to economic value obtained two ecosystems based on research [18], [19], [20], they are mangrove ecosystems and sand beach ecosystems with a composition of direct use value of 45.45%, use-value indirectly at 45.45% and the amount of choice at 9.01%. There is no research on non-use values such as bequest value, altruist value, and existence value in the coastal Regency of Tangerang. Further research is needed for a comprehensive assessment. Based on the sum of the use-values, a total economic value (TEV) is IDR 32,610,028,060 per year. The classification of ecosystem services and their economic value can be seen in table 1.

| No | Ecosystem services     | Type of value | Value (IDR per year) | Source  | Ecosystem provider |
|----|------------------------|---------------|----------------------|---------|-------------------|
| 1  | Tree stand             | Direct use    | 143,412,768          | [18]    | Mangrove⁴         |
| 2  | Mangrove seed providers| Indirect use  | 408,000,000          |         |                   |
| 3  | Baitfish providers     | Indirect use  | 15,947,922,000       |         |                   |
| 4  | Biodiversity           | Option        | 90,456,075           |         |                   |
| 5  | Spawning ground        | Indirect use  | 2,050,115,000        |         |                   |
| 6  | Breakwater             | Indirect use  | 207,500,000          |         |                   |
| 7  | Carbon storage         | Indirect use  | 1,206,081,000        |         |                   |
| 8  | Education              | Direct use    | 43,500,000           |         |                   |
| 9  | Recreation             | Direct use    | 390,000,000          |         |                   |
| 10 | Mangrove fisheries     | Direct use    | 11,236,091,217       | [19]    |                   |
| 11 | Beach recreation       | Direct use    | 886,950,000          | [20]    | Sand beach         |
|    | Total economic value (TEV) |             | 32,610,028,060      | Coastal |                   |

using a mangrove area of 415.89 ha [18]

5.1 Mangrove ecosystem services
The value of mangrove ecosystem services based on analysis [18] and [19] is IDR 31,723,078.060. The assumption used in the area of mangrove land according to [18], which is 415.89 ha, obtained the value of mangrove ecosystem services per hectare per year at IDR 76,277.569. The cost is then used as a base value for the analysis of mangrove ecosystem services with an area of time series in 1996-2012,
according to the Banten Provincial Forestry and Plantation Service and the Tangerang Regency Environmental Service (2012) in [21] and in 2019 according to [7]. The table of the economic value of mangrove ecosystem services based on a land area in 1996-2019 can be seen in table 2.

Table 2. The economic value of mangrove ecosystem services based on the land area in 1996-2019. The economic importance of mangroves continues to decline every year, accompanied by a decrease in the mangrove area.

| Year | Mangrove area (ha) | Economic value (IDR) |
|------|-------------------|---------------------|
| 1996 | 487.5             | 37,185,314,757      |
| 1997 | 469.59            | 35,819,183,501      |
| 1998 | 464.27            | 35,413,386,836      |
| 1999 | 422.12            | 32,198,287,314      |
| 2000 | 400.54            | 30,552,217,380      |
| 2001 | 398.31            | 30,382,118,402      |
| 2002 | 388.6             | 29,641,463,210      |
| 2003 | 254.98            | 19,449,254,476      |
| 2004 | 230.44            | 17,577,402,939      |
| 2005 | 228.7             | 17,444,679,969      |
| 2012 | 222.9             | 17,002,270,071      |
| 2019 | 182.4             | 13,913,028,537      |

Based on the table above, the economic value of mangrove ecosystem services has decreased annually by an average of IDR 2,115,662,384. Based on regression analysis with the dependent variable is the economic value (Y) and the independent variable (X) is the area of land, then the equation \( Y = 0.384 + 76277568.73X \) is obtained. The equation shows that an increase in the land area of 1 hectare will increase the economic value of IDR 76,277,568.73. The downward trend in the value of mangrove ecosystem services can be seen in figure 2.

Figure 2. The trend of decreasing the value of mangrove ecosystem services (million IDR). The decline in the economic value of mangroves, on average, IDR 2,115,662,384 per year.
5.2 Sand beach ecosystem services
Sand beach ecosystem services in the study [20] are Tanjung Pasir beach recreation areas. His analysis showed that the carrying capacity of the area to accommodate tourists was 162 people per day. Tanjung Pasir ticket prices are IDR 15,000 per tourist. Thus, the value of the recreation ecosystem services of the Tanjung Pasir beach in Tangerang Regency is Rp 2,430,000 / day or Rp 886,950,000 / year. This value is the minimum value of ecosystem services for recreation. Value can be higher, taking into account travel costs.

6. Discussion
Based on the economic value of coastal ecosystem services in Table 1, it was found that the benefits that received a large portion of the economic value contributors to coastal ecosystem services were indirect use values of IDR 19,819,618,000. Then followed by direct use-values and their respective choice values of IDR 12,699,953,985 and IDR 90,456,075. Indirect-use value is the highest value in coastal ecosystem services. This value supports the theory [22] that the market does not fully capture ecosystem value or quantified financial services and other manufacturing capital. Consequently, the amount of ecosystem services is given little value in consideration of policy decisions.

The economic value of mangrove ecosystem services has decreased on average by IDR 2,115,662,384 per year. In Mahakam, there has also been a loss of mangrove ecosystem services amounting to Rp 209,688,551,071 per year due to mangrove forests being converted into ponds covering an area of 75,311 hectares [23]. The loss of mangrove ecosystem services globally is US$ 7.2 trillion per year [6]. There is not enough data to analyze the decline in sand beach ecosystem services. Still, based on research [20], it was found that the number of actual visitors in 2014 had exceeded the carrying capacity, so a visitor restriction policy was needed so that the sand beach ecosystem was not degraded. The value of the sand beach ecosystem did not decrease.

Figure 2 shows a picture that changes that occur in coastal ecosystems will change the value of ecosystem services in the region. Several countries experienced a decline in coastal ecosystem services, including the southwestern coast of Bangladesh experienced a decrease in coastal ecosystem services by US$ 2.23 billion in 1980-2016 due to changes in land use (agriculture, forestry, aquaculture, rivers, housing, and others) [24]. The Eti-Osa coastal region in the state of Nigeria also lost ecosystem services of US $ 101,59 million per year during the 1984-2013 period [25]. The change was caused by land reclamation activities for urban and industrial use. In research [6] on changes in global ecosystem services in 1997-2007, coastal ecosystems experienced a decline in ecosystem services by the US $ 10,9 trillion in 1997-2007. This research also supports the theory that coastal ecosystem services are currently experiencing a downturn.

Coastal ecosystems are very vulnerable to environmental changes. These changes can disrupt the functioning of ecosystems and their services provided to the community. These changes affect not only the environment but also economic and social society [26]. The shift of fishing villages into accessible tourism in Mancora (Peru) triggered demand for land in vulnerable coastal areas and triggered conflicts between local authorities [27]. Fishing activities on Bintan Island (Indonesia) provide significant value in the socio-economic framework of the surrounding coastal communities, due to recreational fishing activities in seagrass habitats [28]. Policies that consider the value of ecosystem services can be regarded as sustainable development.

This study has limitations in the amount of research on ecosystem services. Only two ecosystems have been published. It shows that mangrove ecosystems dominate the research interest in the research location on the coast of Tangerang Regency. Whereas, based on observations, there are several other ecosystems, such as estuaries and marine fisheries. Research on the valuation of ecosystem services is also still very little, especially those integrated into a single coastal ecosystem.
7. Summary

Coastal ecosystem services assessed from mangrove and sand beach ecosystems show a value of IDR 32,610,028,060 per year or the US $ 2,29 million. The majority of these values come from indirect use values, followed by direct use values and choice values. So far, research on non-use values has not been conducted on the coast of Tangerang Regency. Further research is needed on integrated coastal ecosystem assessment. The economic value of mangrove ecosystem services decreases every year on average by IDR 2,115,662,384, while the economic value of the sand beach that is used as tourism is IDR 886,950,000 per year. The economic valuation of this ecosystem service needs attention to realize coastal development that can improve the welfare of the community. The value of ecosystem services includes environmental, economic, and social elements, which can be used as a reference for creating a comprehensive development planning unit.

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