Economic valuation of protection and production forests in pekalongan regency

R. Harini*, R.Yuniantari, and R D Ariani

Department of Environmental Geography, Faculty of Geography, Universitas Gadjah Mada
*rikaharini@ugm.ac.id

Abstract. Regional autonomy authorizes local governments to optimize sources of income, one of which is through natural resources. Pekalongan Regency is a district in Central Java which has the potential of forest resources covering an area of 28,486 Ha including limited protected forests, production forests and limited production forests managed by Perum Perhutani. Forests are renewable natural resources that need to be managed sustainably to enable them to fulfill their (economic, social, environmental sustainability) functions according to sustainable development principles. Considering that at present some people do not have insights into the values of forest resources, especially their intangible benefits, this present study aimed to analyze the total economic value of protection and production forests to inform people about the economic value of forest resources. This study used a descriptive-quantitative method with primary and secondary data sources. The quantitative data processing technique used was the Total Economic Value model supported with the market price method, the travel cost method, and the benefit transfer method. The results of the analysis revealed that the economic value of protection and production forests in Pekalongan Regency is IDR. 232,355,092,970. The indirect use value (41.36%) of the forests indicates that forests have substantial intangible benefits. The total economic value analysis of the forests can be used as a recommendation for local governments and stakeholders in allocating forest resources to keep them in the sustainable development order.

1. Introduction

With its ownership of the third-largest tropical forest in the world, forests in Indonesia have a significant role in both national and global issues, one of which is the climate change issue. A study conducted in the Brazilian Amazon in 2008 predicted that the economic losses from climate change are around US $ 4 billion in 2020 and might reach US $ 14 billion by 2070 [1].

A forest is an ecosystem unit in the form of an expanse of land containing biological natural resources dominated by trees integral to their natural environment, which cannot be separated from one another [2]. Forests can be viewed in terms of their functions for which forests are viewed from their benefits and roles for life. Forests according to their functions are divided into several categories, including protection forests and production forests [3]. A protection forest is a forest the existence of which is protected as a buffer for the life system. Technically, the location of a protection forest can be in a production forest, as long as its existence can maintain the ecological balance of the area. A production forest is a forest whose production can be exploited either for its log and non-log products.

Forests have a role in economic growth and community welfare. Based on FAO data of 2010, the forestry sector contributed to employment for 74,700 Indonesians. According to Folmer and Gabel (2001) forest resources serve three functions: 1) produce ecological system support, 2) produce negative
inputs in the production process (contaminated groundwater by industrial waste) and 3) directly consumed conveniences (air, water, and recreational facilities). In general, it can be interpreted that forests are among renewable resources that provide a lot of benefits for human welfare, both tangible (wood providers, animals, etc.) and intangible (water protection and management, erosion prevention and so on)[4].

Regional autonomy authorizes local governments to optimize sources of income, one of which is through forest natural resources. Continuous use of forest ecosystem has consequences either for the sustainability or the existence of the forest itself in that the increasing exploitation of forest resources will usually end up with environmental degradation and when the natural environment quality decrease exceeds the carrying capacity then the intended economic growth will not occur [5]. At present the community, especially the planners and decision-makers, appreciates the benefits of natural ecosystems in terms of their direct-use value, whereas the total economic value includes use values and non-use values. As a result, the community does not properly appreciate the existence of forest resources and thus they convert forests into other uses that are more economically profitable [6]. In addition to goods and services that can be directly or indirectly consumed, forest resources also generate environmental services that provide benefits in other forms including amenity (beauty, tranquility) that are felt more in the long term [7].

Pekalongan Regency is a district in Central Java which has the potential of forest resources covering an area of 28,486 Ha including limited protection forests, production forests, and limited production forests managed by Perum Perhutani. According to the urban planning of Pekalongan Regency, the protection forests and production forests are scattered in nine sub-districts (Kadangserang, Paninggaran, Lebakbarang, Petungkriyono, Talun, Doro, Karganyar, Kajen, and Kasesi). It is hoped that the existing regional spatial pattern policy implemented by the local government can be used to optimize the benefits of forest resources while maintaining environmental sustainability to realize sustainable development. The science which studies sustainable development is environmental economics. One of the central themes in environmental economics is forest resources valuation. The economic valuation of forest resources is carried out by quantifying goods and services with general measures. Assessing environmental benefits in monetary terms is the focus of resource and environmental economics [8]. Quantifying goods and services from ecosystems is important to ensure social recognition and public approval in managing ecosystems and resources [9]. Valuation of economic values is important especially for policyholders for the following reasons, including 1) to justify and decide on the allocation of public expenditure in relation to infrastructure development and social services, conservation, and restoration related to public convenience, 2) to consider the environmental values of public properties and encourage public participation and supports towards environmental improvement initiatives, 3) to compare benefits of different projects or programs, 4) to prioritize restoration and conservation programs, and 5) to maximize the economic benefits of each unit of money paid [10].

This present forest ecosystems valuation study aimed to highlight the important contributions of forests in Pekalongan Regency and its ecosystem services (use values and non-use values) which are often not taken into account in public decision making despite their large social and economic values. With the quantitative evidence of values provided by nature, this can also be used as an effort to significantly increase investments in forest ecosystems and encourage sustainable management of forest natural resources while taking into account the functional aspects and roles of protection forests and production forests, which will expectedly lead to better social justice and long-term economic growth.

2. Methods
This study was conducted in Pekalongan Regency (protection forest and production forest areas). This study attempted to examine the economic values of production forest and protection forest resources in the hope of obtaining the maximum utility without overriding the sustainability of forest resources in the future.
The data used in this study included primary data, namely data obtained directly (interviews with various sources), and secondary data, namely data obtained from various sources or libraries. The secondary data were obtained from literature studies and reports of research results and institutions or agencies relevant to this study.

2.1. Research Data Analysis

The obtained data were descriptive-quantitatively analyzed by analyzing the data based on their frequencies and presenting them in forms of tables or pictures. This study used a quantitative approach by applying the following methods:

1. **Revealed preference method** to monetary assess the effects of the use of forest resources in the forms of goods and services which have no market value relative to the actual market value of other goods and services.
2. **Stated preference method to obtain** the monetary value of natural and environmental resource services through surveys.
3. **Benefit transfer method** to make a quick estimation of the monetary value for which the benefit transfer using study site value was applied to the policy site.

2.1.1. Protection Forest and Production Forest Economic Value Calculation

The economic value of forest resources can be identified from their benefits and functions. The values in detail can be seen in Table 1.

| Table 1. The Analysis Methods of Forest Resources Economic Value |
|-----------------------------------------------|
| **Values** | **Data** | **Analysis Methods** |
|---|---|---|
| **Total Economic Value** | Direct Use Value | Latex value | Market Price Method |
| | | Log value | Market Price Method |
| | | Water value | Market Price Method |
| | Indirect Use Value | Carbon absorption value | Market Price Method |
| | | Oxygen production value | Market Price Method |
| | | Erosion prevention value | Replacement method |
| | Option Value | Biodiversity value | Benefit Transfer |
| | Existence Value | Soil formation value | Replacement method |
| | | Nutrient recycling value | Replacement method |
| | | Waste decomposition value | Replacement method |
| | Bequest Value | Tree value | Market Price Method |

The calculation technique to assess resource economic value refers to the Total Economic Valuation (TEV) method proposed by Dixon et al. (1988) [11]. Mathematically, the equation of Total Economic Value is as follows:

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

where

\[
TEV = \text{Total Economic Value} \\
UV = \text{Use Value} \\
NUV = \text{Non Use Value} \\
DUV = \text{Direct Use Value} \\
IUV = \text{Indirect Use Value} \\
OV = \text{Option Value} \\
EV = \text{Existence Value} \\
BV = \text{Bequest Value}
\]
3. Results and Discussion
The identification of benefits and functions of forests in Pekalongan Regency was grouped into five categories of value, namely: direct value, indirect value, options value, existence value, and bequest value.

3.1 Direct Use Value
Direct use value is the value that can be directly felt by the community. This study calculated the overall direct use value that is often used by the people of Pekalongan Regency. The potential of forests as a source of foreign exchange is not only extracted from log products, but also non-log forest products such as resin, essential oils, fatty oils, starch, fruits, tannins, coloring agents, latex, etc. [12]. Based on the identification results, the direct use of forest resources in Pekalongan Regency which can be directly felt for its benefits is the sap produced by pine trees and resin trees and the potential of wood in the forest.

3.1.1 Resin and Pine Latex Economic Value
Latex from production forest includes pine and resin latex. Latex is one of the mainstays of income from production forests in Pekalongan Regency. Latex tapping empowers the community as tappers. Sap tapping can significantly contribute to the socio-economic condition of the community around protection forests and production forests.

The calculation of the commodity value of pine and resin latex used market value approach because sapped latex can be directly marketed. In general, pine latex is sold to latex factories, whereas resin latex is sold to the free market. The results of pine and resin latex value analysis can be seen in Table 2.

| No  | Latex Commodity          | Production (Kg) | Price (IDR/Kg) | Economic Value (IDR/Year) |
|-----|--------------------------|-----------------|----------------|---------------------------|
| 1.  | Pine (Pinus merkusii)    | 3,067,130       | 3,560          | 10,918,982,800            |
| 2.  | Resin (Agathis loranthifolia) | 14,753         | 15,000         | 221,295,000              |
| Total|                          |                 |                | 11,140,277,800           |

Source: Data processing, 2019

Table 2 shows that the economic value of pine latex is IDR 10,918,982,800/year, whereas resin latex is IDR 221,295,000/year. This means that the total economic value of latex in Pekalongan Regency’s forests is IDR 11,140,277,800/year.

3.1.2 Log Economic Value
The economic value calculation of log in Protection and Production Forests in Pekalongan Regency was carried out with the direct approach method using the prevailing market price. The estimated volume of logs in the protection and production forest in this regency is 1,515 m³/ha and the forest identification results are shown in Table 3.

| No  | Logging Areas      | Area (Ha) | Volume (m³/ha) |
|-----|--------------------|-----------|----------------|
| 1.  | Logging area A2    | 86.35     | 524            |
| 2.  | Logging area D     | 121.35    | 737            |
| 3.  | Logging area E     | 41.76     | 254            |
| Total|                    | 249.46    | 1,515          |

Source: Data processing, 2019
The economic value of log was obtained by calculating the estimated income from forest products where log as the output of forest exploitation is multiplied by the selling price. In this analysis, the types of wood assessed included pine and resin which are valued by log price. The average log price based on 2019 market price is IDR 550,000/m³ for all types of wood. With the forest area of 249.46 Ha, the value of existing wood is IDR 833,250,000/year. For more details, see Table 4.

| No. | Logging Types     | Area (Ha) | Price (IDR/m³) | Volume (m³) | Total Value (IDR/tahun) |
|-----|-------------------|-----------|----------------|-------------|------------------------|
| 1.  | Logging area A2   | 86.35     | 550,000        | 524         | 288,200,000            |
| 2.  | Logging area D    | 121.35    | 550,000        | 737         | 405,350,000            |
| 3.  | Logging area E    | 41.76     | 550,000        | 254         | 139,700,000            |
|     | Total             | 249.46    |                | 1,515       | 833,250,000            |

Source: Data processing, 2019

The obtained value of wood serves as information of the values contained in protection and production forests and consideration in the management of protection forest and production forest resources. This is in line with the policy that prevents protection forests and production forests from offhandedly felled.

3.1.3 Groundwater Economic Value

The forest areas in Pekalongan Regency with secondary dryland forest cover may serve as water resource provider. The rational water discharge method can be used to determine the potential of water resources in the forest with the following calculation.

Water discharge = 0.0028 x C x I x A x year (3)
Runoff coefficient (C) = 0.1
Rainfall intensity (I) = 0.301 mm/hour
Area (A) = 28,486 Ha

Then the water discharge produced by protection forests and production forests in Pekalongan Regency is as follows

= 0.0028 x 0.1 x 0.301 x 28,486 x 365 x 24 x 3600
= 75,711,631.32 m³

With household water tariff of IDR 196/m³

The annual economic value of water contained in the forests is as follows

= 75,711,631.32 m³ x IDR 196
= Rp 14,839,479,738

| No. | Types of Values | Total/Year (IDR) |
|-----|-----------------|------------------|
| 1.  | Latex Value     | 11,140,277,800   |
| 2.  | Log Value       | 833,250,000      |
| 3.  | Water Value     | 14,839,479,738   |
|     | Total           | 26,813,007,538   |

Source: Data processing, 2019

Based on the analysis of the direct uses of forest resources in Pekalongan Regency, a value of IDR 26,813,007.538/year was obtained based on 3 types of forest products, namely latex, log, and
groundwater. The identification results of the direct use values of protection and production forest resources can be seen in Table 5, while the percentages can be seen in Figure 1.

As shown in figure 1, the most utilized forest product is groundwater with an economic value of IDR 14,829,479,738/year. The value of groundwater in Pekalongan Regency’s forests is greater than that of Tele Forest in Samosir Regency which is IDR 14,076,622,600/year, even though in terms of area Tele Forest is wider (67,406 Ha) [13]. The existence of groundwater is high because the forest is not only affected by the extent of the area but also by rainfall intensity. The direct use value of IDR 26,813,007,538/year is still relatively small. The small direct use value of forest resources indicates that only a small portion of the community has direct interactions either with the production forests and the protection forests. This can be positive because it may indicate that there are only limited interactions (taking or utilization) that directly occur between the community and the forests, while excessive interactions may result in negative impacts on forest areas including forest exploitation and forest degradation. This is also in line with the functions of the production forest and protection forest themselves.

![Figure 1. The Direct Use Values of Forest Resources](image)

### 3.2 Indirect Use Values

Among the roles of forests is their ecological functions. Some ecological functions of forests include the ability to absorb pollution caused by contamination of carbon dioxide (CO₂) gas in the air. Aside from being carbon absorbers, forests also play a vital role in oxygen production and erosion prevention. This particular function is included in the indirect value of forest because the economic benefits are not directly felt by the community.

#### 3.2.1 Carbon Absorption Economic Value

Forest is an ecosystem that has a vital contribution as CO₂ absorber or carbon sink (Junaedi, 2008), and forests in Pekalongan Regency is no exception. To calculate the amount of available carbon stock, an adapted method was used by Dahlan (2008) according to which CO₂ absorption in trees is 15.19 kg/tree/year [14]. With the assumption that pine trees erect with a spacing of 3 x 3 m, there would be around 300 trees per hectare. This means that with a total forest area of 28,486 ha, forests in Pekalongan Regency have around 8,545,800 trees. The calculation result suggests that Pekalongan Regency’s forest has CO₂ absorption capacity of 130,266,402 kg/year or 130,266.402 tons/year. Hairiah and Rahayu (2007) state that long-lived plants or trees that live in forests serve as carbon stockpiles with far greater capacity than seasonal crops do [15]. Higher diversity and density of plants in a forest enable them to return organic carbon into the soil and carbon stored in the plant biomass is greater than what is stored in other ecosystems with lower diversity and density of plants. If the price of 1 ton of CO₂ is 14 US dollars and the rate is IDR 14,000/dollar, then the economic value of carbon absorption owned by the forests in Pekalongan Regency is IDR 25,532,214,792/year.
The function of forests as carbon sink and carbon trading issues have positive impacts on the very existence of forests. This is in line with Alam et al.’s statement (2007) that forests have important environmental services for carbon sequestration which can reduce global warming [16].

3.2.2 \( O_2 \) Production Economic Value
The \( O_2 \) production capacity calculation is done by using the number of trees multiplied by 1.2 kg/day [17]. The potential quantity of trees in Pekalongan Regency’s forests is 8,545,800 and therefore the total production of \( O_2 \) is 3,743,060,400 kg/year or 3,119,217,000 m\(^3\)/year (the volumetric mass density of air is 1.2 kg/m\(^3\)) or 3,119,217 liters/year. If the price of \( O_2 \) per liter is IDR 25,000, the economic value of \( O_2 \) production in Pekalongan Regency’s forests is IDR 77,980,425,000/year.

3.2.3 Erosion Prevention Economic Value
Among factors that cause soil damage is the changes in land cover that can cause erosion. The erosion according to Arsyad (2010) can cause loss of nutrients and drought as well as deterioration of the physical properties of the soil which in turn affects plant growth and production and causes soil productivity to decrease [18]. This can be minimized by maximizing forest cover which serves as a deterrent to erosion (erosion control). The benefits from the existence of forest cover can be taken into consideration for erosion prevention/erosion control. Natural control (vegetation) is an erosion control that can generate quite high profits and minimize erosion risks [19]. By using replacement parameters from nutrients lost due to erosion, the value of erosion control benefits can be calculated in rupiah. The economic value of forests as erosion prevention is calculated based on research conducted by Morgan and Arens (1989) in Yakin (2004) with the assumption that the impacts of dryland erosion in Java Island is the same [20]. The calculation results show that the costs associated with dryland non-agricultural income-generating activities (off-site costs) reach 5 US dollars per year per hectare [21]. With US dollar rate of IDR 14,000/dollar, the off-site costs is IDR 14,000 x 5 US dollars = IDR 70,000. More details about the economic value of erosion prevention can be seen in Table 6.

| No. | Forest Functions            | Area (Ha) | Off-site costs (IDR) | Economic Value (IDR/year) |
|-----|-----------------------------|-----------|----------------------|----------------------------|
| 1.  | Limited Protection Forests  | 1,679.29  | 70,000               | 117,550,300                |
| 2.  | Production Forests          | 1,213.55  |                      | 84,948,500                 |
| 3.  | Limited Production Forests  | 25,593.16 |                      | 1,791,521,200              |
| Total|                             |           |                      | 1,994,020,000              |

Source: Data processing, 2019

Thus the economic value of erosion prevention from forest resources in Pekalongan Regency is IDR 1,994,020,000/year for the forest area of 28,486 Ha. Based on the parameters of carbon absorption, oxygen production, and erosion prevention values, forests in Pekalongan Regency have an economic value of IDR 105,506,659,792 per year for indirect uses.

3.3 Option Value
The option value of forest resources in Pekalongan Regency (including protection forests and production forests) in this study was calculated based on the value of the existing biodiversity that can be approached from the importance of the existence of forests. Based on their natural conditions, forests in Pekalongan Regency can be considered as secondary forests, meaning that there is human intervention in the forest management. The biodiversity value of secondary forest is US $ 9.45/ha/year [22]. Assuming an annual price increase of 20 percent, the biodiversity value will be US $ 22.68 per hectare per year. This value is greater than the biodiversity value of existing mangrove forests in Indonesia, which is only worth US $ 15 per hectare per year [23]. Quantification of biodiversity values is obtained by multiplying biodiversity per hectare per year with the total forest area. The economic calculation is as follows:
Biodiversity value = Area x biodiversity price
= 28,486 ha x US $ 22.68 x IDR 14,000
= IDR 9,044,874,720 per annum

3.4 Existence Value
The existence value of forests in Pekalongan Regency was calculated based on a replacement cost approach to determine the costs that must be borne by the community to replace assets that have been damaged or shrinking in number. Replacement costs are used as an approach to the benefit value to avoid damage that may occur or will occur in the future. The results of the Natural Resources Management (NRM) research on forest ecological values in Indonesia can be seen in Table 7.

| Types of Values          | US$ per Hectare per Year | Replacement Costs (IDR) |
|--------------------------|--------------------------|--------------------------|
| Soil and water conservation | 37.97                    | 15,142,587,880            |
| Carbon absorption        | 5.00                     | 1,994,020,000             |
| Flood protection         | 48.64                    | 19,397,826,560            |
| Water transportation     | 5.30                     | 2,113,661,200             |
| **Jumlah**               |                          | **38,648,095,640**        |

*Source: Minister of Environment Regulation Number 15 of 2012*

The result of forest ecology restoration costs calculation in Pekalongan Regency with an area of 28,486 ha is IDR 38,648,095,640/year. More detail results can be seen in Table 8

| Types of Values          | Area (Ha) | US $ per Hectare per Year | Replacement Costs (IDR) |
|--------------------------|-----------|---------------------------|--------------------------|
| Soil and water conservation | 28,486   | 37.97                     | 15,142,587,880            |
| Carbon absorption        | 28,486    | 5.00                      | 1,994,020,000             |
| Flood protection         |           | 48.64                     | 19,397,826,560            |
| Water transportation     |           | 5.30                      | 2,113,661,200             |
| **Jumlah**               |           |                           | **38,648,095,640**        |

*Source: Data processing, 2019*

3.5 Bequest Value
The bequest value of Pekalongan Regency’s forests was calculated based on natural seeds because bequest value is the value that can be set to natural resources to keep them intact for the generations to come. The natural seeds/seedlings assessed in this present study included resin (Agathis lorranthifolia) and pine (Pinus Merkusii). It is estimated that the potential quantity of seeds/seedlings is 200 per hectare [24]. To calculate the economic value of natural seedlings, a direct approach (market value) method was used. The potential quantity of natural seeds is 200 x 28,486 = 5,697,200 per year. The costs paid for wages and fertilizer is IDR 1,500 per seed. Therefore the cost incurred for 5,697,200 seeds/seedlings is IDR 8,545,800,000. If the average price of seedling is IDR 10,000, then the bequest value of natural seeds is IDR 10,000 x 5,697,200 – IDR 8,545,800,000 = IDR 48,426,200,000 per year.

3.6 Forest Resources Economic Value
Based on the results of economic value calculation for each type of benefit in Pekalongan Regency’s forests per year, the total economic value of the forests is IDR 232,355,092,970. The total economic values of forest resources in Pekalongan Regency can be seen in Table 9

| No | Types of Benefits | Economic Values  | Percentages |
|----|-------------------|------------------|-------------|
| 1. | Direct Use Value  |                  |             |
|    | Latex Value       | 11,140,277,800   | 4.79        |

*Table 9. Total Economic Value of Pekalongan Regency’s Forests*
2. Log Value 833,250,000 0.36
3 Water Value 14,839,479,738 6.39
26,813,007,538 11.54

Indirect Use Value
1. Carbon Absorption Value 25,532,214,792 10.99
2. Oxygen Absorption Value 77,980,425,000 33.56
3. Erosion Prevention Value 1,994,020,000 0.86
105,506,659,792 45.41

Option Value
1. Biodiversity Value 9,044,874,720 3.89
2 9,044,874,720 3.89

Existence Value
1. Forest Ecology Restoration Value 38,648,095,640 16.63
38,648,095,640 16.63

Bequest Value
1. Tree Value 48,426,200,000 20.84
2 48,426,200,000 20.84

TOTAL 232,355,092,970 100

Source: Data processing, 2019

Table 9 shows that the direct use values include latex value, log value, and water value. Added together, the total direct-use value is IDR 26,813,007,538, whereas the indirect-use value is IDR 105,506,659,792. These results demonstrate that the direct-use value is high when calculated using the economic valuation method. By summing the direct-use value and the indirect-use value, the total economic value of forest uses is IDR 132,319,667,330. Table 7 also shows a options value of IDR 12,961,130,000, an existence value of IDR 38,648,095,640, and a bequest value of IDR 48,426,200,000. By adding up the options value, the existence value, and the bequest value, the economic value of non-forest uses is IDR 100,035,425,640. The total economic value was obtained from summing the forest uses value and non-forest uses values the result of which is IDR 232,355,092,970.

Valuation of forest benefits and services (natural capital valuation) can increase knowledge and ability to set priorities for programs, policies and actions so that new job opportunities in sustainable sectors can be created, green industry activities can be identified, and opportunities for innovative new economic expansion based on the local natural capacity can be designed. Indirectly assessing forest ecosystems that are based on natural resource management can potentially produce a variety of additional economic income opportunities, which have beneficial impacts on economic growth and poverty eradication. This also supports the achieving of SDGs where target 13 of the 17 proposed targets depends directly or indirectly on natural resource conditions.

4. Conclusion
Based on research results and discussion, forest resources in Pekalongan Regency provide economic as well as ecological benefits. This can be seen from the results of calculations showing that the economic value of uses is Rp. 132,319,667,330, whereas the economic value of non-uses (ecology) is IDR 100,035,425,640 with a total economic value of Rp. 232,355,092,970. These values illustrate the benefits resulting from the existence of protection forests and production forests. The results of calculations indicate that the economic value of uses is greater than that of non-uses (ecology). This also shows that the existence of forest resources has important benefits both at present and in the future because they produce benefits that can be felt directly by the beneficiaries. The greater economic value of uses than that of non-uses (ecology) can be used by the government as the basis in determining policies on forest resources to balance the production benefits and the environmental benefits so that environmental degradation does not occur due to the exploitation of the environment.
References

[1] Ranto R 2018 Konversi Hutan Harus Pertimbangkan Dampak ke Perekonomian Inews https://www.inews.id/finance/makro/konversi-hutan-harus-pertimbangkan-dampak-ke-perekonomian/374225 Inews.id 01 December 2018.

[2] Undang-Undang Nomor 41 Tahun 1999 Tentang Kehutanan, Jakarta: Sekretaris Negara Republik Indonesia.

[3] Peraturan Pemerintah Republik Indonesia No. 34 Tahun 2002 Tentang Tata Hutan dan Penyusunan Rencana Pengelolaan Hutan, Pemanfaatan Hutan dan Penggunaan Kawasan Hutan.

[4] Folmer H dan Gabel L H 2001 Principles of Environmental and Resource Economic USA Edward Elgar Publishing, Inc.

[5] Djaadiningrat S T 1997 Pengantar Ekonomi Lingkungan Jakarta Penerbit PT Pustaka LP3ES.

[6] Dahuri R 2003 Keanekearagaman Hayati Laut Aset Pembangunan Berkelanjutan Indonesia Jakarta PT Gramedia Pustaka Utama.

[7] Fauzi Akhmad 2004 Ekonomi Sumberdaya Alam dan Lingkungan: Teori dan Aplikasi Jakarta Penerbit PT Gramedia Pustaka Utama.

[8] Venkatachalam L 2006 Economic Valuation of Watershed Services of Commons: Marginal Opportunity Cost Approach within the Environmental Accounting Framework India Institute for Social and Economic Change.

[9] Wilson M A and S Carpenter 1999 Economic Valuation of Freshwater Ecosystem Services in The United States 1971-1997 Ecol Appl 9 772-783

[10] Vercueli J 2000 Application of Contingent Valuation Method in Developing Countries Italy

[11] Pomeroy R S 1992 Economic Valuation: Available Methods dalam Chua T E dan L F Scura. Integrative Framework and Methods for Coastal Area Management Association of Southeast Asian Nation/United States Coastal Resources Management Project.

[12] Peraturan Menteri Kehutanan Nomor 35 Tahun 2007 Tentang Hasil Hutan Bukan Kayu Jakarta Departemen Kehutanan.

[13] Simbolon DYP, Afiguddin Y, dan Latifah S 2015 Valuasi Ekonomi Hutan Tele di Kabupaten Samosir Peronema Forestry Science Journal 4 86-94

[14] Dahlan E N 2008 Jumlah Emissi Gas CO2 dan Pemilihan Jenis Tanaman Berdaya Soro

[15] Hairiah K dan S Rahayu 2007 Pengukuran Karbon Tersimpan di Berbagai Macam Penggunaan Lahan Bogor World Agroforestry Centre.

[16] Alam S, Supratman dan M Alif 2009 Buku Ajar Ekonomi Sumberdaya Hutan Laboratorium Kebijakan dan Kewirausahaan Kehutanan, Fakultas Kehutanan Makasar Universitas Hasanuddin

[17] Kusminingrum N 2008 Potensi Tanaman Dalam Menyerap CO2 dan CO Untuk Mengurangi Dampak Pemanasan Global Jurnal Pemukiman 3 96

[18] Arsyad S 1983 Pengawetan Tanah dan Air Fakultas Pertanian Departemen Ilmu Tanah Bogor IPB

[19] Nursa’ban M 2006 Pengendalian Erosi Tanah Sebagai Upaya Melestarikan Kemampuan Fungsi Lingkungan Jurnal Geomedia 4 93

[20] Yakin Addinul 2007 “Dimensi Sosial Ekonomi dan Lingkungan Pemanfaatan Sumberdaya dan Lingkungan Pada Taman Wisata Alam Gili Matra Kabupaten Lombok Barat” Jurnal Agroteksos 17 134-14

[21] World Bank 1990 Indonesia: Poverty Assessment and Strategy Report Washington Country Department III East Asia and Pacific Region

[22] Peraturan Menteri Negara Lingkungan Hidup Republik Indonesia Nomor 15 Tahun 2012 Tentang Panduan Valuasi Ekonomi Ekosistem Hutan

[23] Harini R, Ariani R D, Fistiningrum W dan Ariestantya D 2019 Economic Valuation of Mangrove Management in Kulon Progo Regency IOP Conf Series: Earth and Environmental Science 256
[24] Roslinda E 2002 Nilai ekonomi Hutan Pendidikan Gunung Walat dan Kontribusinya Terhadap Masyarakat Sekitar Thesis Bogor Program Pascasarjana Institut Pertanian Bogor.

Acknowledgments
The authors would like to thank the Research Directorate of Universitas Gadjah Mada for funding the final assignment project through Hibah Rekognisi Tugas Akhir (RTA) (Final Assignment Recognition Grant) 2019. The authors also thanked Pekalongan Regency Government and especially the forest managers in Pekalongan Regency.