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Article

The economic value of Indonesia's tropical rainforest park (TH2TI) in South Kalimantan

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Abstract. Urban forest is a form of environmentally oriented development. One form of urban forest in South Kalimantan is the Indonesia's Tropical Rain Forest Park (TH2TI). This study aims to calculate the total economic value and future value of TH2TI. The total economic value calculated in this study consists of direct use value (recreation, wood, carbon and oxygen), indirect use value (water absorption), and option value (existence and heritage). The method used in this research was quantitative research method to calculate the value of wood, carbon, oxygen, and water absorption and qualitative research method to calculate the value of recreation, existence, and heritage. Results indicated that the economic value of recreation was the highest amounted to IDR 1,568,514,750.00 and the total economic value of TH2TI amounted to IDR 3,085,373,964.75. In the next 5 years, the economic value of TH2TI could reach IDR 3,664,456,405.74. The knowledge of the economic values of TH2TI is expected to make people aware to the importance of the environment for life.

Keywords: TH2TI, Economics, Forest, WTP, Quantitative

INTRODUCTION

Indonesian forests have abundant and diverse natural resources. Therefore, the large scale development lately should be of more concern because every development will cause land clearing, most of which do not pay attention to the environment. Good development is environmentally oriented development (sustainable development). One type of sustainable development is urban forest development.

In the Regulation of the Government of Indonesia No. 63 of 2002, urban forest is defined as a compact and dense expanse of tree-growing land in an urban area either on State land or private land that designated as urban forest by the authorized official and the area of the urban forest in a compact expanse is at least 0.25 Ha. South Kalimantan Tropical Rainforest Miniature is one of the urban forests located in Banjarmasin City. It geographical location at 3º28'46.6" - 3º28'52.9" S and 114º49'10.1" to 114º50'24.8" makes TH2TI have a tropical climate and high rainfall. To facilitate the administration of crop management, the 90 ha TH2TI area is divided into 4 main blocks and 25 sub-blocks (Pemprov Kalsel, 2019).

TH2TI was established in 2017. The tree species planted there are fast growing species, therefore the current vegetation structure is dominated by pole and tree stage. In the future, the TH2TI is expected could function as a urban open space to preserve tree diversity, absorb carbon emissions and create a microclimate, provide multipurpose benefits of forests in the life of society and the nation that ensure the sustainability of life.

Forests have various functions, both direct and indirect, for human welfare. These benefits will be realised if the sustainability of forest functions can be maintained optimally (Muthmainnah & Tahnur, 2018).

These forest benefits can be calculated using the economic value asseseement method. Economic value in principle aims to provide value for the resources used in accordance with the real value from the community's point of view (Yusri, 2012). According to Albarqoni (2013), economic value can be calculated using the principle of total economic value (NET) or Total Economic Value (TEV) by summing up all the benefits that can be obtained from a forest or area. This research aims to calculate the total economic value of TH2TI as well as its future value.

MATERIAL AND METHODS

This research was conducted in January 2022 at the South Kalimantan Miniature Tropical Rainforest located in Banjarbaru City, the capital of South Kalimantan Province, Indonesia. Materials and tools needed during the research are TH2TI location map, GPS, meter tape, clinometer, raffia rope, stakes, camera, tally sheet, questionnaire, stationery, and laptop. The objects studied were TH2TI South Kalimantan and the visitors of the research object. Research parameters and data sources of the secondary data are described in Table 1.

Table 1. Data sources and parameters based on research objectives

Research Parameters	Data Source
1. TH2TI land use data	1. Secondary Data/Satellite Imagery
2. Direct Use Value	2. Direct Use Value
a) Recreation	a) Primary Data/Questionnaire (*Travel Cost Method*)
b) Timber value and market price of each type of timber	b) Primary Data/Direct Measurement & Secondary Data
c) Carbon value and market price of carbon	c) Primary Data/Direct Measurement & Secondary Data
d) Oxygen provision and market price of oxygen	d) Secondary Data / Research Literature
3. Indirect Use Value	3. Indirect Use Value
a) Water infiltration value	a) Secondary Data / Research Literature
4. Existence Value	4. Primary Data/Questionnaire (*Willingness to Pay*)
5. Heritage Value	5. Primary Data/Questionnaire (*Willingness to Pay*)
6. Total Economic Value and Estimated Future Value	6. Calculation with formula

Stands growing in the study site was inventoried at each TH2TI land cover density classification. Density classification results were obtained based on analysis using ArcGIS. Stand inventories were made in the 20 m x 20 m plots for the tree level, in the 10 m x 10 m sub-pluts for the pole level. The Tree parameters measured were the girth of tree trunk at 1.3 m above ground using a meter tape, and the height of branch-free truck using a clinometer. Data form the measurement of tree girth were converted to diameter for the purpose of calculating carbon storage (Betani et al., 2016).

Questionnaires were distributed colle data on the economic value of recreation using the travel cost method (TCM), heritage value and existence value using Contingent Valuation Method (CVM) analysis, namely the Willingness to Pay (WTP) method. Sampling (respondents) was dertemined incidentally (accidental sampling), namely taking respondents as samples based on chance, anyone who happens to meet the researcher can be chosen as a sample on condition that the person is suitable as a data source (Pratama, 2019). The main criteria for taking respondents are TH2TI visitors over the age of 15 who are considered able to communicate well and are willing to be interviewed. Respondents in this study were 30 people. According to Mahmud (2011), the minimum number of samples to be taken for statistical data analysis is 30 samples.

a. Calculation of direct use value

Direct use value is the value that can be directly benefited. The direct use values measured in this study include recreation value, and timber value.

1) Recreation economic value

The economic value of recreation is estimated using the travel cost method (Anjani & Harini, 2016).

$$BPTi = BTr + BD + BK + L \quad (1)$$

(IDR/person/visit), BTr = Transportation cost from place of origin to tourist attractions (Rupiah/person/visit), BD = Documentation cost (IDR/person/visit), BK = Consumption cost (IDR/person/visit), and L = Other costs (Rupiah/person/visit).

2) Timber economic value

The economic value of wood is obtained using the market price approach method, namely by multiplying the price of wood (Rp/m^3) by the amount of potential wood in TH2TI (m^3) (Mulyadin & Surati, 2018).

$$Nk = Hk \text{ X } Pk \quad (2)$$

where Nk = Economic value of wood (Rp), Hk = Wood price (Rp/m^3), and Pk = Wood potential (m^3).

3) The economic value of carbon

The carbon stock analysis used in this study is an allometric equation obtained from the results of the inventory and calculation of tree biomass, which will then be converted to obtain carbon stocks in TH2TI. The calculation of biomass in this study uses the equation from Ketterings et al. (2001) with the formula:

$$W = 0{,}11 \text{ x } \rho \text{ x } D^{2,62} \quad (3)$$

where W = Biomass (kg), ρ = Specific gravity (g/cm^3), and D = Diameter at breast height or 1.3 cm (cm).

After obtaining the value of biomass in the research location, the value can be used to calculate carbon above the surface in the research location. The calculation of carbon in this study uses the equation from IPCC (2006) with the formula:

$$C = \text{Biomass x \%C Organic} \quad (4)$$

where C = Carbon content of biomass (kg) and %C Organic = Percentage value of carbon content. the percentage value of carbon content used in this study is based on the average percentage of carbon content in secondary forests, which is 47% or 0.47.

Carbon price according to Mulyadin & Surati (2018) states that the price of 1 ton of carbon is US$5. According to Firdaus (2013), the economic value of carbon can be calculated using the equation below:

$$NEK = CO \text{ x } PC \text{ x } LA \quad (5)$$

where NEK = Total economic value of carbon (Rp/ton), CO = Carbon content in wood/ha, PC = Carbon price (IDR) with a carbon price of US$5 (IDR72,047.17), and LA = Study area (ha).

4) The economic value of oxygen

According to Mulyadin & Surati (2018), the assumed ability of trees to produce oxygen per day is 1.2 kg. Calculation of the potential value of oxygen production, namely:

$$NO_2 = PO_2 \text{ x } L \text{ x } HO_2 \quad (6)$$

where NO_2 = Economic value of oxygen (Rp/year), PO_2 = Potential of vegetation to produce oxygen (kg), L = Vegetation area (hectares), and HO_2 = Oxygen price (IDR).

b. Calculation of indirect use value

The indirect use value in this study is the value of water infiltration. The value of water infiltration is calculated based on the ability of water absorption by plants, using the assumption that one 10-year-old tree can hold approximately 7 m^3 of water. The economic value of infiltration was obtained using the formula (Muthmainnah & Tahnur, 2018).

$$Hsrp = Tsa \times Ha \quad (7)$$

where Hsrp = Price of water uptake by trees (Rp/m^3), Tsa = Total water uptake by trees (m^3), and Ha = Water price of PDAM Banjarbaru City (Rp/m^3).

c. Calculation of existence and heritage value

The existence and inheritance values were calculated using the WTP contingency method approach. The formula used in calculating the alleged average WTP (Pratama 2019), is:

$$EWTP = \sum_{i=0}^{n} WiPfi \quad (8)$$

where EWTP = Estimated average WTP, Wi = The i-th WTP value, Pfi = Relative frequency, n = Number of respondents, and *i* = The i-th respondent who is willing to pay the SDA value.

The next step is to summarize the data. Data summation is a process where the mean value is converted to the total population in question. After estimating the middle value of WTP, the WTP value can be estimated using the formula (Pratama, 2019):

$$TWTP = \sum_{i=i}^{n} WTPi \left(\frac{ni}{n}\right) = P \quad (9)$$

where TWTP = Total WTP, WTPi = WTP of individual to *i,* ni = Number of i-th sample willing to pay WTP, P = Total population, n = Number of samples, and *i* = The i-th respondent who is willing to pay for natural resources and environmental services.

Total Economic Value (NET) or Total Economic Value (TEV) is obtained by summing up all the calculated values of the urban forest. According to Bahruni et al. (2007) the total economic value is a dynamic value because the value is influenced by changes in forest conditions due to forest management and utilization.

$$TEV = DUV + IUV + EV + HV \quad (10)$$

where TEV = Total Economic Value, DUV = Direct Use Value, IUV = Indirect Use Value, EV = Existence Value, and HV = Heritage Value.

Estimates of future economic value can be calculated using the compounding factor principle. The compounding factor principle is to convert present value to future value by taking into account interest. The compounding factor calculation uses the formula (Sutri, 2020).

$$F = P \times (1 + i)^t \quad (11)$$

where F = Future Value, P = Present Value, i = Interest, and t = Time.

RESULTS

Recreation Economic Value

The total economic value of TH2TI recreation is obtained from the sum of transportation costs, documentation costs, consumption costs, and other costs not included in the previous three costs (Figure 1). Among the four types of costs, consumption is the highest cost, which reaches IDR 30,050, while the lowest cost incurred by visitors when visiting TH2TI is the documentation cost which is IDR 0 or no cost at all.

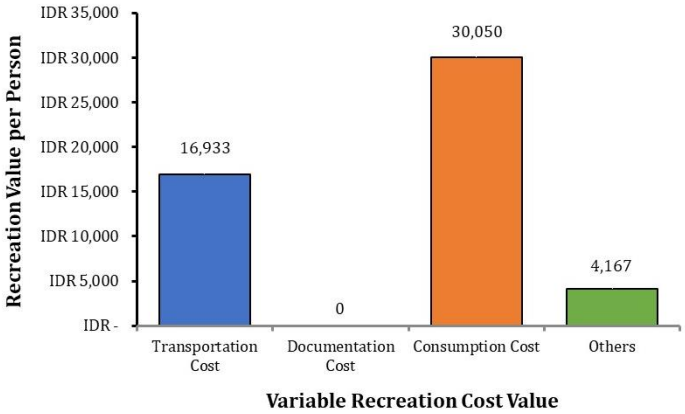

Figure 1. Breakdown of total cost expended by TH2TI visitors per person

Timber Economic Value

The calculation of the economic value of wood in this study was divided based on each forest density in the research location which is divided into 3 density categories: high, medium, and. Each category of the forest density area can is shown in the Figure 2 and the total timber potential is shown in the Figure 3**.** The highest density of forest trees has the lowest area, while the lowest density of forest trees has the largest area. A high-density forest indicates that the forest is covered by many trees some of which produce economically valuable timber. Meanwhile, the low-density forest indicates that the forest areaa have open land or land that is not covered by vegetation.

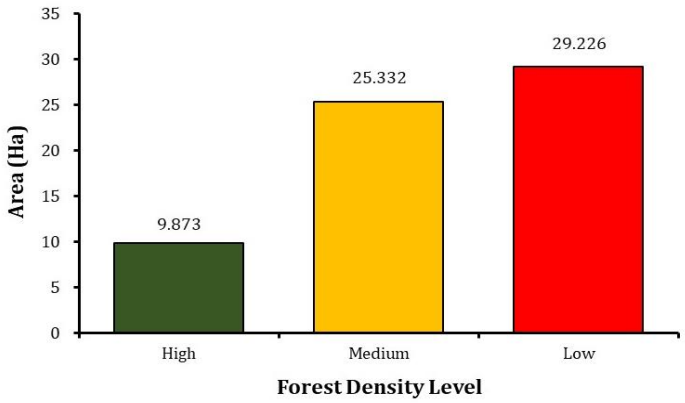

Figure 2. Area of each forest density in TH2TI

The highest timber potential per unit area exists at the high-density forestwhich is 26.413 m^3/ha (Figure 3). This condition is due to the diameter of stands at this high-density forest reach more than 20 cm

and the brach-free trunks reach more than 5 meters in height. Although timber potential per unit area at this density category is the highest, the total economic value of the timber produced is the lowest (Figure 4).

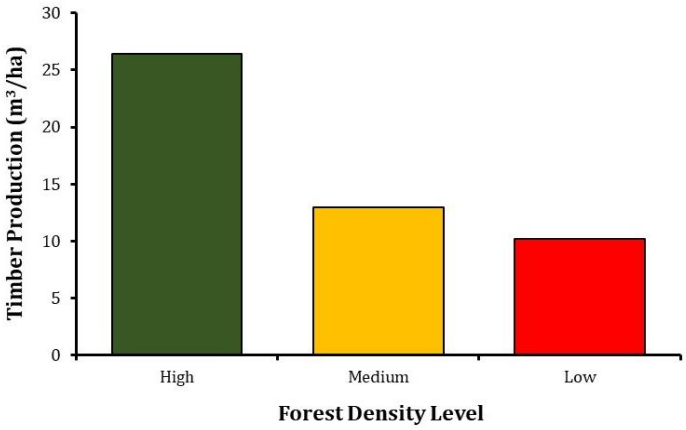

Figure 3. Average of timber production in TH2TI

The economic value of each density category of forest is IDR 125,172,264.52 in the high-density forest, IDR 157,830,436.39 in the medium-density forest, and IDR 143,629,836.09 in the low-density forest is. Based on the data, the highest value of wood in TH2TI is in the medium-density forest and the smallest value is in the high-density forest (Figure 4).

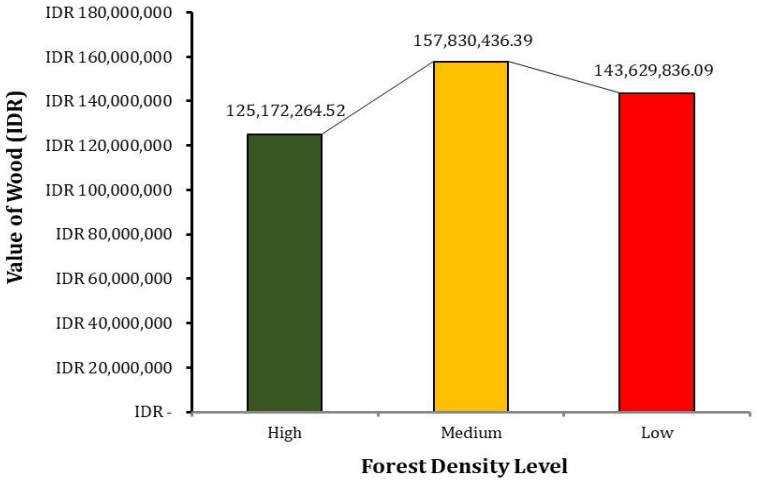

Figure 4. The economic value of wood in TH2TI

Economic Value of Carbon

The economic value of carbon in this research was measured from the biomass of pole and tree level. This live stage level was chosen because at that time the stand was large enough to estimate how much carbon was stored. To determine the biomass value in this research, we must know the specific gravity of each wood. The specific gravity used in this research includes jabon species, with a specific gravity of 0.425 g/cm^3, sengon with a specific gravity of 0.48 g/cm^3, and mahogany with a specific gravity of 0.6675 g/cm^3. In calculating the economic value of carbon in the urban forest, it is necessary to convert the value of carbon produced by multiplying it with the market price of carbon. According to Pirard (2005) andMulyadi & Surati (2018), the price of 1 ton of carbon is US$5. The US dollar exchange rate in the research month was IDR

14,409.43, so that the price of 1 ton of carbon is IDR 72,047.17. Based on the calculation, Figure 5 shows the economic value of carbon (only for the pole and tree live stage) in TH2TI.

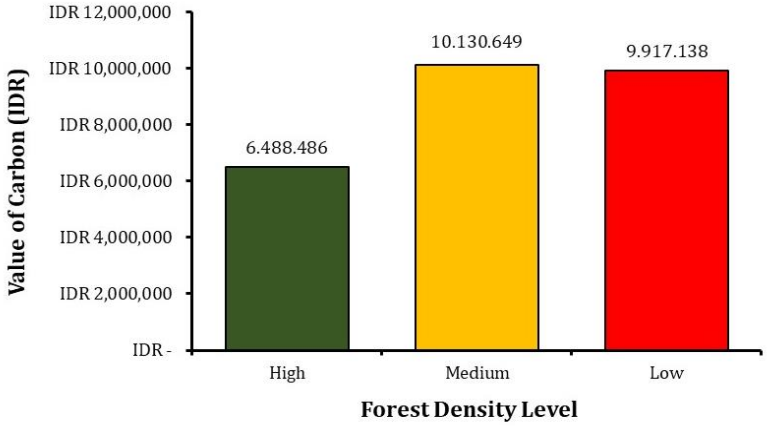

Figure 5. The economic value of carbon TH2TI

In line with the timber potential value, the highest value of carbon in TH2TI is in the medium-density forest which is IDR 10,130,649 and the smallest value of carbon in TH2TI is in the high-density forest which is IDR 6,488,486.

Existence and Heritage Value

Based on the results of the interview, the economic value of the existence and the heritage value of of TH2TI are shown in the Figure 6 andf Figure 7:

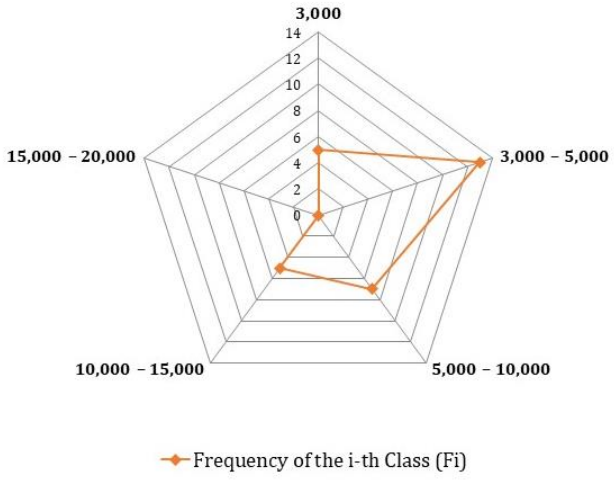

Figure 6. The result of WTP of existence TH2TI

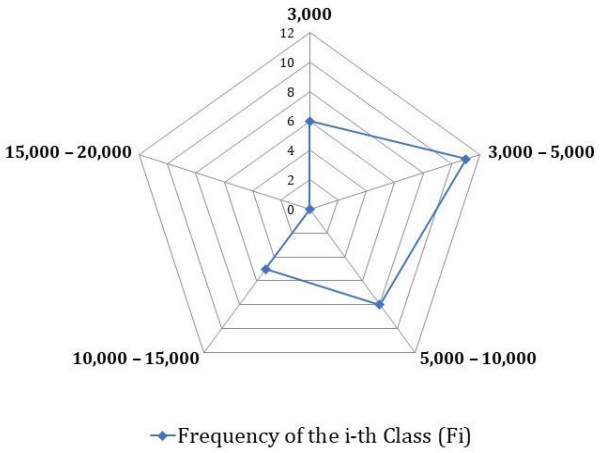

Figure 7. The result of WTP of heritage TH2TI

Total Economic Value

Total economic value was obtained by summing the direct use value, indirect use value, existence value, and heritage value (Table 2). The total Economic value of the TH2TI is IDR 3,085,373,964.75.

Table 2. Total Economic Value of TH2TI

Value Category	Economic Value (IDR)	Percentage (%)
Direct Use Value		
Recreation	1,568,514,750.00	50.837
Wood	426,633,811.78	13.828
Carbon	26,536,273.31	0.860
Oxygen	705,519,450.00	22.867
Indirect Use Value		
Water Infiltration	411,346.33	0.013
Existence	**178,368,083.33**	**5.781**
Heritage	**179,390,250.00**	**5.814**
Total Economic Value	**3,085,373,964.75**	**100.00**

DISCUSSION

TH2TI Direct Economic Use Value

Jala & Nandagiri (2015) stated that one of the economic valuation techniques used to assess environmental services utilized as a tourist attraction is the Travel Cost Method (TCM). The results of the research shows that 573 visitors come every week to TH2TI or about 30,665 visitor in a year. The high number of people visiting the TH2TI is due to the location is quite close to Banjarbaru city and this location is a new destination in Banjarbaru that presents environmental scenery as a tourist attraction.

Figure 1 showed that TH2TI visitors spent more on transportation and consumption, while for other costs only a few people spent it, and no visitors spent on documentation. The visitors do not spend money on documentation costs because they use their smartphones to capture the moment. The highest cost incurred by visitors is consumption costs, with an average of IDR 30,050.00. Since the total of visitors in TH2TI is 30,665 person/year, then the total travel cost spent by a visitor in TH2TI is IDR51,150.00/person/visit. A similar value was also been reported previously by Huda (2022) who stated that the cost of consumption value in a recreation site was IDR 58,450.29. Thus, in total, the economic consumtion value of recreation in this study site reached the amount of IDR 1,568,514,750.00 per year.

The majority of stand types that grow in TH2TI are fast-growing plants such as Jabon (*Neolamarckia cadamba*), Sengon (*Albizia cinensis*), and Mahogany (*Swietenia mahagoni*). The total value of timber production is obtained by multiplying the price of timber by the volume of timber production in m^3 that exist in theapproximately 64.431 ha wooded land area. Based on Regulation of the Ministry of Environmental and Forestry (Permen LHK) Number 64 of 2017, the price of the mixed jungle type group of medium round wood category (KBS) timber of the the Kalimantan region origin is IDR 480,000.00 per m^3. The calculation of the economic value of wood in this study is divided based on each forest density in the research location which is divided into three parts, high, medium, and low forest density.

The economic value of wood (Figure 3) is different from the result of timber production from each density. It can happen because in the calculation of economic value, in addition to timber production, the area of the high-density level is the smallest land area compared to the area of the medium and low-density levels. Based on this reason, the total economic value of timber produced in this study amounted to IDR 426,633,811.78.

The higher the level of forest density, the greater the average carbon stored Lubis et al. (2013) stated that the height of carbon stored is directly proportional to the increase in stem diameter. Rezekiah et al. (2021) also reported that the higher the growth rate, the greater the carbon stored. In this research, the highest carbon economic value was generated by the medium forest density level because the area of this density level is much larger than the high forest density level. The total economic value of carbon generated in this study amounted to IDR 26,536,273.31.

Oxygen can only be produced by living things that have chlorophyll. Therefore, nothing can replace the function of plants in producing oxygen. The value of oxygen provision is calculated by estimating how much a single tree can produce oxygen per day, then multiplied by the study area and the price of oxygen. The estimation of oxygen production value by this stand is based on Kusminingrum (2008) cited in Mulyadin & Surati (2018), assuming the ability of trees to produce oxygen per day is 1.2 kg.

The oxygen production by TH2TI per day is 77.317 kg. The larger the area planted with trees, the oxygen production will increase. The increased of oxygen production also increases the economic value of oxygen in that location. According to data from BPS Cilacap Regency in 2013, the price of oxygen is IDR 25,000 per kg. So from these various data, the economic value of oxygen in TH2TI per year is approximately IDR 705,519,450.00.

TH2TI Indirect Economic Use Value

The indirect use value of forests is often not realized and ignored by managers and communities. However, the existence of indirect benefits from the forest will be immediately felt if the forest function has begun to decline or has been damaged so that the impact is very pronounced. One of the forest functions that is not directly felt but the impact will be widely felt if the forest function has begun to be damaged is the function of the forest as a water infiltrator

The existence of an urban forest is very beneficial to the life around it. Urban forests have high infiltration because they have a strong root system and litter that turns into humus which can enlarge soil pores. In addition, the larger the mass of the tree, the more water it can store, and the size of the tree's biomass depends on the age of the tree. TH2TI was built in 2017 so the age of the trees at the time of the study was 4 years. Kodoatie et al. (2006) assume that a 10-year-old tree can store up to 7 m^3 of water or equivalent to 5 m^3/ha. So, it can be assumed that a 1-year-old tree can hold as much water as 0.5 m^3/ha.

The economic value of water infiltration in this study is based on the amount of costs incurred by residents to pay for tap water (PDAM) and the PDAM water price group of residents taken is the non-commercial household group. The water price taken in this study is the average price of water from 6 categories of non-commercial household groups, which is IDR 5,505.00/m^3 and the average fixed fee paid is IDR 19,500.00.

By multiplying the water absorption assumption and the area of this study, the calculation of the water absorption value is obtained. The calculation of the water absorption value is done with the assumption that in 1 year, TH2TI can store 32,216 m^3 of water, so that in 1 month it can absorb 2,685 m^3 of water. The data is then multiplied by the price of water and calculated with a fixed load and multiplied by 1 year. So that the economic value of water infiltration is IDR 411,346.33.

Existence and Heritage Value

TH2TI is operated as a green space that can be accessed for free by all residents. At the time of the study, TH2TI did not charge for tickets or admission. The economic value of existence and heritage was calculated using the WTP method. Based on the survey results, it was found that at least 71 people were visiting on weekdays and 109 people visiting on holidays so in 1 year an estimated 30,665 people were visiting TH2TI. The selection of WTP value in this study is based on the characteristics of visitors who are mostly teenagers who do not have income.

The existence value is calculated to maintain the condition or existence of a resource so that it does not change both physically and functionally. The heritage value is calculated as a value to preserve the TH2TI ecosystem so that it still exists and can be utilized by future generations. The benefit of calculating this heritage value is that it is hoped that in its management it will still pay attention to the integrity and authenticity of the resource so that the next generation understands and knows how a resource was in previous times.

Based on Figures 5 and 6, it is known that the majority of respondents are willing or able to pay at range IDR 3,000 – IDR 5,000 to maintain the existence of TH2TI and preserve its authenticity. To obtain the average price of the selected WTP by multiplying the average range of each value with the total respondent who chooses the range. For instance, the average of pay range IDR 3,000 – IDR 5,000 is IDR 4,000 and the total of respondents who chose the range is 13 people, so the average price of WTP that range from IDR 3,000 to IDR 5,000 is IDR 52,000. After obtaining all the average prices of each range, the data is multiplied by the total visitors in TH2TI per year so that can be obtained the value of existence and heritage. The value of existence TH2TI is IDR 178,368,185.55 and the value of heritage TH2TI is IDR 179,390,250.00.

The value of existence and heritage in this study is highly dependent on the choice of the majority of respondents and the number of visitors in one year. In addition, visitors feel that with the existence of TH2TI, visitors can feel the various benefits provided, such as providing coolness and views that are rarely obtained in urban areas. It cannot be denied, with the existence of TH2TI urban areas become cooler and more beautiful so that these conditions need to be maintained for human survival. Information regarding visitors' willingness to pay cannot be used as a benchmark that visitors do not care about the environment because this analysis method is only used as an assumption of how much money individuals can spend to preserve the location.

Based on Table 2, the greatest benefit of TH2TI can be felt directly, namely the benefit as a place of recreation with a percentage reaching 50.837% while the lowest is the benefit as a water catchment of 0.013%. Although it has the smallest economic value, the function of the forest as a water catchment is difficult to replace because this function affects other functions such as protecting the soil from landslides. The reason why the value of water infiltration in TH2TI is still not too large is because most of the growth levels of stands in TH2TI at the time of the study were still at the seedling to pole level, with only a few at the tree level. The economic value calculated in this study does not include all values in TH2TI such as the value of providing a place to grow for flora and fauna and other intangible values.

The calculation of potential in TH2TI in the coming years is calculated using the future value equation. The parameters used in calculating future value include the estimation of the year we want to know the value, the economic value at the time of the study, and the average bank interest rate for the last 12 months according to Bank Indonesia data. Based on Table 2, the present value in this study is IDR 3,085,373,964.75 and the average bank interest rate from February 2021 - January 2022 is 3.50%. So that, the future value in the next 5 years will be IDR 3,664,456,405.74.

The direct and indirect use values derived from the benefits of TH2TI prove that natural resources and the environment need to be rewarded better in their utilization and management. It is anticipated that the economic value assessment will help the community recognize the value of an environment whose advantages are not immediately felt but rather over time.

CONCLUSION

The economic value found in TH2TI is categorized into direct use economic value, indirect use economic value, existence economic value, and heritage economic value. The direct use economic value in TH2TI is obtained from the recreational value of IDR 1,568,514,750.00, the economic value of wood of IDR 426,633,811.78, the economic value of carbon of IDR 26,536,273.31, and the economic value of oxygen of IDR 705,519,450.00. Indirect use economic value is obtained from the value of water infiltration in TH2TI, which amounted to Rp411,346.33. The economic value of existence and heritage in TH2TI was obtained from the results of interviews with visitors, which amounted to IDR178,368,083.33 and IDR179,390,250.00. Thus, the total economic value of TH2TI is IDR 3,085,373,964.75 and the future value of 5 years to come is IDR 3,664,456,405.74. The information contained in this research is expected to be utilized as well as possible both for the community in making it easier to understand the importance of the environment for life and for the government to take the right policy in managing TH2TI so that the existence of TH2TI can be sustainable and can continue to benefit in the long term.

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AUTHOR CONTRIBUTIONS

Arfa Rezekiah: research coordinator, data analysis, data interpretation, manuscript writing; Abdi Fithria: contributor research member, research implementer, data analysis, data interpretation, manuscript writing; Yasinta Shiba: contributor research member, research implementer, data analysis, data interpretation, manuscript writing; Wahyuni Ilham: member contributor, research implementer, manuscript writing.

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