The Hidden Value of Green Open Spaces: IDR 10 Trillion Worth of Environmental Services in Sleman District, Indonesia

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Abstract. This scientific article aims to demonstrate that conventional Gross Regional Domestic Product (GRDP) does not accurately reflect the level of welfare in a region, as it fails to account for natural resource depletion and degradation. To address this issue, the concept of green GRDP is introduced, which incorporates the valuation of environmental services, such as those provided by green open spaces. The study focuses on the Sleman District of Yogyakarta, Indonesia, and uses a particular approach to determine the Total Economic Value of the environmental services provided by the green open space. The results show that the estimated value of these services is IDR 10,203,212,977,405, which comprises Direct Use Value and Indirect Use Value. This study highlights the importance of including environmental services in economic assessments, as it provides a more comprehensive understanding of the level of welfare in a region and helps policymakers make informed decisions to promote sustainable development.

Keywords: GRDP · Valuation · Environmental Services · Economic Value · Open Green Space

1 Introduction

The accomplishment of a region's economic performance and development is reflected in gross regional domestic product (GRDP) values. In Indonesia, GRDP reports are now annually prepared by the Regional Development Agency (BAPPEDA) in collaboration with Statistics Indonesia (BPS). Each report contains information on the economic progress of various sectors in different geographies. However, an important determinant remains unaccounted for in GRDP to date, that is, the contributions of natural resources and the environment.

H. Ku et al. (Eds.): ICARSE 2022, ASSEHR 748, pp. 241–247, 2023.
https://doi.org/10.2991/978-2-38476-048-0_27

Developments vigorously implemented to increase regional income have drained or depleted natural resources on a massive scale, resulting in environmental damage or degradation [1]. The consequent loss of natural resources, a capital in development, has never been factored into GRDP calculation. For this reason, the GRDP report shows economic performance alone, whose values tend to increase continuously, without accounting for the shrinking reserves of natural assets extracted in the production process [2].

GRDP records the total monetary value of final goods and services produced by a regional economy within a year [3]. It is equal to the added value that all sectors of economic activities (i.e., business fields) in the same territory generate. GRDP is used as an instrument to measure the achievement level of economic sectors within the development corridor of a region to indicate the state of its welfare [4]. In addition, Indonesia Government Regulation Number 46 of 2017 on Economic Instruments of the Environment refers to GDP and GRDP that incorporate the depreciation of natural resources and environmental damage as environmental GDP and GRDP, which are alternative measures to their traditional counterparts. Green GRDP is also outlined in Law Number 32 of 2009 on Environmental Protection and Management and Number 25 of 2004 on the National Development Planning System.

Conventional GRDP calculations do not include environmental factors. Consequently, some potential implications may have misleading measurement results in extracting and utilising natural resources. Therefore, it is necessary to calculate green GRDP that gives sufficient weight to the environmental consequences of economic growth [5].

Information on green (or environmental) GRDP is juxtaposed with other ecological management studies that measure natural resource depletion and degradation. While these two reduce GRDP, other factors arguably increase its value, such as green open space, which is the focus of this study. The economic valuation of the environmental services provided by green open space in the Sleman District (D. I. Yogyakarta Province, Indonesia) has been conducted to determine its direct and indirect use values, which increase the GRDP.

2 Methodology

Conventional GRDP is inherently limited because it does not account for the environmental aspects of economic growth. Green GRDP answers the need for a more comprehensive indicator as it considers not only depletion and degradation of natural resources that reduce conventional GRDP figures but also environmental services that give an additional value. The environmental services observed in this study are limited to one object/asset, green open space. Empirical data and statistics show that many green open spaces in Sleman are in the forms of urban forests, urban parks and others. They provide a wide variety of environmental services like absorbing carbon, producing oxygen, bringing comfort and many others.

Economic valuation gives a monetary value or price to environmental services (presented in a country's currency). To determine the economic value of green open space, it is necessary to first identify the use value, which can be divided into direct and indirect

Table 1. Components, Data Sources, and Valuation Methods of Environmental Services in the Sleman District

Calculated Values		Types	Locations	Data Sources	Valuation Methods
Total Economic Value	Direct Use Value	Carbon sequestration's value	Forest areas	Land area & stand inventory	Market prices
			Green open space	Land area & stand inventory	Market prices
	Indirect Use Value	Existence value	Green open space	Interviews with selected respondents	Contingent valuation method (CVM)
			Reservoir/retention basin		
		Value of climate-cooling effects	Green open space	Land area & cooling costs	Shadow prices (substitution)
			Forest area	Land area & cooling costs	Shadow prices (substitution)

Source: [10–12].

use values. As seen in Table 1, the Direct Use Value refers to carbon sequestration, and the Indirect Use Value consists of existence and microclimate regulation from the cooling benefits.

To monetise the environmental services, the direct use value was calculated from the carbon sequestration function of forest areas and green open spaces in the Sleman District.

Carbon sequestration indicates the amount of carbon stored in urban forest vegetation. In every plant—a good carbon absorber and storer, carbon is sequestered in biomass. The more plants are grown, the more carbon is stored. Carbon is the main element of greenhouse gases (GHG) which can cause a city to have much warmer temperatures relative to neighbouring rural or less-physically developed areas, or called urban heat island (UHI), and is believed to have contributed to global warming. Market pricing was the approach used to calculate carbon sequestration.

Forest areas can contribute positively to reducing the factors and moderating the impact of global warming [6]. In addition, vegetation is known to provide other benefits like producing oxygen that is beneficial for human lives. According to the Yogyakarta Environment and Forestry Services, there were 1,729.47 hectares of forests in the Sleman District area in 2020. All of these were conservation forests designated for sheltering diverse flora and fauna and providing water for the downstream regions in the province [7].

Green open space shares the same significant role as forest areas in the province. Besides having an aesthetic function, it also has carbon absorption potential that can later be used in carbon emission trading. Based on the Sleman Environmental Services, Yogyakarta had 2,890.88 hectares of green open space in 2022, including green lines, urban parks or forests and reservoirs or retention basins commonly used as tourist attractions or public recreational areas.

The indirect use value estimated in the environmental services valuation encompasses the existence and climate-cooling effect.The existence value was generated from two areas, namely green open space and reservoirs/retention basins, using the contingent valuation method (CVM). CVM is developed on the concept of willingness to pay according to those benefitting directly from the existence of green open space [8]. Interviews with people visiting the district's green open space and reservoirs/retention basins revealed the maximum price they were willing to pay. The results were divided into four classes: IDR0–10,000 (approximately £0–0.60), IDR10,000–25,000 (£0.60–1.50), IDR25,000–50,000 (£1.50–3.00) and IDR50,000–100,000 (£3.00–6.00). For visitors, the existence value can be experienced through recreational activities in any green open spaces distributed across the district. Knowing the economic value of an environment or asset based on its existence provides an overview of the added values and benefits felt directly by the public.

This value monetises the climate-cooling effects of green open space and forest areas in the district. It was estimated using the shadow pricing technique by calculating the cost of procuring an air conditioner (AC) to obtain the same climate-regulating service. For this purpose, the AC was set to run on 5 PK to keep a cool temperature in a 100 m^2 room (1 hectare = 10,000 m^2; 10,000 m^2/100 m^2 = 100 units of AC) [9]. During this study, the market price of a 5 PK AC was about IDR22,000,000 (£1275).

Total economic value (TEV) is the sum of the direct and indirect use values of all assets or objects that provide environmental services. It was calculated using the equation below.

TEV = DUV (Csv) + IUV (Ev + Ccv).

TEV = Csv(Gfa + GOS) + [Ev(GOS + Res) + Ev(Gfa + GOS)].

Notes:

TEV = Total Economic Value.

DUV = Direct Use Value.

IUV = Indirect Use Value.

Csv = Carbon sequestration's value.

Ev = Existence value.

Ccv = Climate-cooling effect's value.

Gfa = Green forest area.

GOS = Green Open Space.

Res = Reservoirs/retention basins.

3 Results and Discussion

The total economic value of the environmental services provided by different types of green open space in Sleman District was calculated using the contingent valuation method and other approaches like market and shadow pricing.

Sleman had 1,729.47 hectares of conservation forest that could capture and store 204,596.30 tonnes of CO2 with potential carbon trading at IDR1,000 (£0.06) per tonne. This means that the total economic value of their carbon sequestration capacity was IDR204,596,301 (£11,821.72). Based on the conversion of land area and carbon sequestration, it was found that Sleman could store up to 118.3 tonnes of CO2/ha. Therefore,

about 2,890.88 hectares of green open space in the district could absorb 341,991,104 tonnes of CO2. This figure was then multiplied by the carbon trade rate of IDR1,000 (£0.06) per tonne, resulting in an economic value of IDR341,991,104 (£19,748.81). Based on the capacity to sequester carbon, the total direct use value of the forest area and green open space in Sleman was IDR546,587,405 (£31,563.53).

In this study, the indirect use value monetises the existence of green open spaces and reservoirs/retention basins and the climate-cooling effect of green open spaces and forest areas.

The existence value was measured with CVM. Visitors of the green open space (60 respondents) were interviewed to identify their willingness to pay. It was found that the largest share of the respondents (42%) put a maximum price of IDR0–10,000 (approximately £0–0.60) on the area's existence. Meanwhile, 38% opted for IDR10,000–25,000 (£0.60–1.50), 15% for IDR25,000–50,000 (£1.50–3.00) and only 5% for IDR50,000–100,000 (£3.00–6.00). Based on these results, the highest price selected by many respondents (relative to other classes) was IDR10,000 (£0.60). Then, it was multiplied by the district's population size (1,082,754 people), producing an existence value of IDR10,827,540,000 (£625,253.04).

Visitors of the reservoirs/retention basins (30 respondents) were also interviewed for the same purpose. It was found that nearly half of them (47%) were willing to pay IDR10,000–25,000 (£0.60–1.50). Meanwhile, 36% opted for IDR0–10,000 (£0–0.60) and 17% for IDR25,000–50,000 (£1.50–3.00). Based on these results, the highest price selected by most respondents was IDR25,000 (£1.50). After multiplying it by the population size, an existence value of IDR27,068,850,000 (£1,563,344.90) was obtained. Therefore, the total existence value of green open spaces and reservoirs/retention basins in Sleman was IDR37,896,390,000 (£2,188,682.86).

The climate-cooling effects were economically evaluated with shadow pricing. The cost of an air conditioner (AC) with 5 PK to keep a cool temperature in a 100 m2 area was used to replace green open spaces and forest areas. Sleman had 2,890.88 hectares of green open space, and with the conversion factor of 100 AC units per hectare, it would need 289,088 AC units as a substitute. Based on the market price, the value of the climate-cooling effect was IDR6,359,936,000,000 (£367,314,219.03). In addition, to mimic the climate-regulating function of the forest area (1,729.47 ha), about 172,947 AC units with the same specifications were needed, and the cost of providing such temperature control was IDR3,804,834,000,000 (£219,745,863.68). Overall, the total climate-cooling effect's value of the green open space and forest area was IDR10,164,770,000,000 (£587,060,082.71).

From the prices put on existence and climate-cooling effect, the indirect use value of different types of green open space in Sleman wasIDR10,202,666,390,000(£589,248,765.57).

Total economic value (TEV) is the sum of direct and indirect use value. Environmental services that have been evaluated economically add value to the GRDP figure. Based on its existence and capacity to regulate microclimate and sequester carbon, the entire green open space in the district had a TEV of IDR10,203,212,977,405 (£589,280,333.39). However, these objects or assets that provide environmental services require more attention, primarily to continuously provide adequate sanitation facilities,

from dustbins to clean toilets. These improvements are expected to increase convenience and maintain the ecological functions of green open spaces or other environmental service providers.

4 Conclusion

Environmental services give added value to green GRDP. Objects or assets providing such services own ecological functions in addition to aesthetic features for visitors to appreciate and relish. From direct and indirect use values, the environmental benefits of green open space in Sleman District are estimated at IDR10,203,212,977,405 (£589,280,333.39). It is of vital importance that the assets be maintained so as not to experience degradation. In addition, improvements like clean toilets and adequate litter bins are necessary to provide better sanitation and increase the green GRDP figure.

Acknowledgement. The authors would like to thank the Institute for Research and Community Services, University of Pembangunan Nasional Veteran Yogyakarta, for their assistance.

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