

## Public Perceptions on the Importance of Ecosystem Services From Vulnerable Forest: A Case Study of Ampang Forest Reserve, Selangor, Malaysia

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### Abstract

Forest reserve degazettement affects the sustainability of forests by altering their ecological functions, hence threatening human livelihoods. This study examines a recently degazetted forest, using a survey of 120 local respondents living near the Ampang Forest Reserve (AFR) in Selangor, Malaysia. A simple random sampling technique was implemented to reduce sampling bias, and descriptive and correlation statistics were used in the analysis. The study aimed a) to examine the public perceived importance of forest ecosystem services from the AFR, b) to determine public awareness of a range of environmental threat levels towards the AFR's ecosystem services, and c) to assess public agreement on conservation measures that could increase protection and ensure the sustainability of ecosystem services from the remaining area of the AFR. The results revealed that all ecosystem services were perceived as important, and the public was mostly aware of environmental threats. At the same time, conservation measures should be implemented to protect and ensure the sustainability of ecosystem services from the AFR. This study provides insights into public perceptions of the importance of forest ecosystem services derived from vulnerable forest reserves. This indicates the relevance and need for better protection in high-risk forest areas, as local livelihood depends on its significant ecological roles.

*Keywords:* forest degazettement, environmental threats, conservation measures, sustainable forest management, livelihood

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### Introduction

More than half of Malaysian land is covered with forest, but roughly 8.12 million ha of these areas have been affected by deforestation between 2001 and 2019 (WWF Malaysia, 2022). Drastic forest loss has covered 62.8% of the land area since 1990 and 58.2% of the land area by 2020 (World Bank, 2023). In Peninsular Malaysia, as of 2021, the forested area comprised 5.73 million ha, of which 4.85 million ha is allocated as permanent reserved forest (PRF), whereby the PRF is divided into 1.93 million ha of protection forest and 2.92 million ha of production forest, respectively (Forestry Department Peninsular Malaysia, 2023). Although the PRF's production forest is set aside for sustainable timber production, a significant amount of PRF's protection forest is often lost due to the consequential effect of degazettement and accompanying environmental threats.

Similar to other developing countries, the main causes of the degazettement that leads to the significant loss of forest areas in Malaysia are industrial logging, forested land conversion to industrial and agricultural activities, infrastructure and urban development projects such as the building of roads and highways, and commercial agricultural expansion (Forrest et al., 2015). Forest protection tends to weaken as large-scale developments, such as commercial

activities, are prioritized to gain economic benefits. The need for economic growth has often altered land use from forested areas to building infrastructure (Pecl et al., 2017), leading to the shrinking of protected areas (Qin et al., 2019). This situation has prompted discussions on inclusivity in sustainable forest management. As a sustainable livelihood is built upon the symbiotic relationship between humans and nature (UNESCO, 2022), social perception and awareness have become essential to embarking on the sustainability journey. It can be conveyed through insights of public input, as public understanding of natural ecosystems enhances public involvement in decision-making and conservation policy (Hunter & Brehm, 2003).

Principle 10 of the Rio Declaration in 1992 highlighted the need for the inclusion of public participation as a vital aspect of sustainable development and the formation of laws and policies that should consider public perception (De Meo et al., 2011). It stated the need for public participation in resolving environmental issues and ensuring sufficient access to relevant environment-related information to produce sound environmental governance (United Nations, 1992). Adequate and efficient public participation requires an understanding of the public's perceptions and level of awareness associated with forest management and

protection. It is crucial to understand public perception to ensure that a well-intended policy is implemented effectively (Slovic, 1987). It is important, as it often astutely highlights public awareness and addresses concerns about conserving natural ecosystems. In the literature across geographies and multidisciplinary contexts, perception is measured based on self-report measures, including magnitude estimation (e.g., Turpin et al., 2015), magnitude production (e.g., Schlittenlacher & Ellermeier, 2021), method of adjustment (e.g., Chen et al., 2019), forced-choice (e.g., Gendron et al., 2014), and Likert scale reporting (e.g., Ranacher et al., 2017). While various measurements of perception exist in the literature, a common theme when using public perceptions is to outline the judgments people make (Slovic, 1987).

In Malaysia, the Malaysia National Biodiversity Policy 1998 highlighted public awareness and education as crucial principles in sustainable biodiversity management. Public involvement in the planning and management of protected areas has been part of the action plan for strengthening and integrating conservation programs (n.d., 1998). Details of public involvement have also been explored scientifically, in which previous studies found that public perceptions involving forest ecosystem services focus on the extent and differences in its values, as well as on the recognition of its benefits (Ratnasingam et al., 2014; Ranacher et al., 2017; Lin et al., 2021). However, more information is needed regarding the perceived importance of ecosystem services after the degazettement of a particular forest reserve. Thus, this study aimed to examine the perceived importance of ecosystem services, specifically from the perspective of the remaining areas of a forest reserve. This study is based on public perception data focusing on a recently degazetted forest reserve, Ampang Forest Reserve (AFR), in Selangor, Malaysia. The objectives of this study are: a) to examine the public perceived importance of ecosystem services from the AFR, b) to determine public awareness of the level of environmental threats to the AFR's ecosystem services, and c) to assess public agreement on conservation measures that could increase protection and ensure the sustainability of ecosystem services in the remaining forest area at the AFR.

Insights from public perception can assist in forming a better environmental policy (Pan et al., 2020). The ultimate goal of engaging with the public is to provide better planning guidelines and maximize conservation efforts for sustainable urban forests (Binyanya et al., 2022). Understanding the public's awareness and perceptions of forests is the key contributor to the successful development of forest policies and plans that will likely be accepted by the public (FAO et al., 2000).

The contribution of our study is the use of public input, based on their perception of a recently degazetted forest reserve, to explain the perceived importance of forest ecosystem services, its threat levels, and agreement of conservation measures. This study shows how public input can inform the significance of forest ecosystem services from the remaining area of the AFR that fits with the reality of livelihoods. Hence, the results suggest a need for proactive efforts to safeguard the remaining area of the AFR and ensure the sustainability of ecosystem services crucial to local livelihoods.

**The case study of Ampang Forest Reserve (AFR)** AFR covers 2,292 ha of land located at N3°9'53", E101°46'43" in Malaysia and serves as a source of ecosystem services. It is prominently known as an essential water catchment area for Ampang and the surrounding Klang Valley area, hence categorized as an environmentally sensitive area rank 1 (Mayberry, 2017; Adnan & Mamat, 2020). The construction of a 24.16 km road called the East Klang Valley Expressway, EKVE (Figure 1), has caused the degazettement of 106.65 ha of AFR (Yip, 2014). The Ampang Forest Eco Park (108,300 ha), a lowland dipterocarp forest used as a recreational forest and a part of the AFR, is also impacted. It is also a water catchment forest enforced under the National Forestry Act Selangor Enactment 2005 and the LUAS Enactment 1999 (Selangor Waters Management Authority) (Yip, 2014). The EKVE construction is said to exacerbate water scarcity in Ampang and surrounding areas as it reduces forest cover, which is crucial for water catchments, and would create 19 million litres of loss of potable water a day, enough for about 9,225 households (Santiago, 2014). The EKVE construction is also attributed to floods in the Ampang/Hulu Langat area (Fadli, 2021; Zolkepli, 2021). Floods degrade water quality and become a significant threat to livelihoods due to sedimentation and shallowing of riverbeds (Rosli, 2021).

## Methods

**Questionnaire design** The questionnaire was prepared in two languages, Malay and English, to make it easier for respondents to understand the content and aim of the study. The questionnaire was divided into four sections: Sections 1, 2, 3, and 4. Section 1 required the respondents to provide information that contained their socio-economic characteristics. Section 2 consists of questions and statements regarding the public's perceived importance of ecosystem services from the AFR. Section 3 was designed to understand public awareness of the level of environmental threats to ecosystem services from the AFR. The final section of Section 4 aimed to assess public agreement on conservation measures that could increase the protection and ensure the sustainability of ecosystem services in the remaining area of the AFR. The respondents were asked to indicate their opinions on each question/statement using a 5-point Likert scale. The Likert-scale questionnaire offers some advantages, including enabling quick data collection, constituting highly reliable estimates, and ensuring the validity of the data for the interpretation of results using various means (Nemoto & Beglar, 2014). The respondents were given the option to choose from a list of five pre-coded responses, one of which was considered neutral. To analyze the public perception of AFR ecosystem services, each question or statement in Sections 2, 3, and 4 was measured using a five-point Likert scale. For example, statements in Section 4 range from strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1).

**Data collection** The targeted sampled population in this study was the local population living near Ampang. A total of 120 respondents were interviewed using a questionnaire survey. The questionnaires were distributed only to respondents aged 18 years and above. The sampling

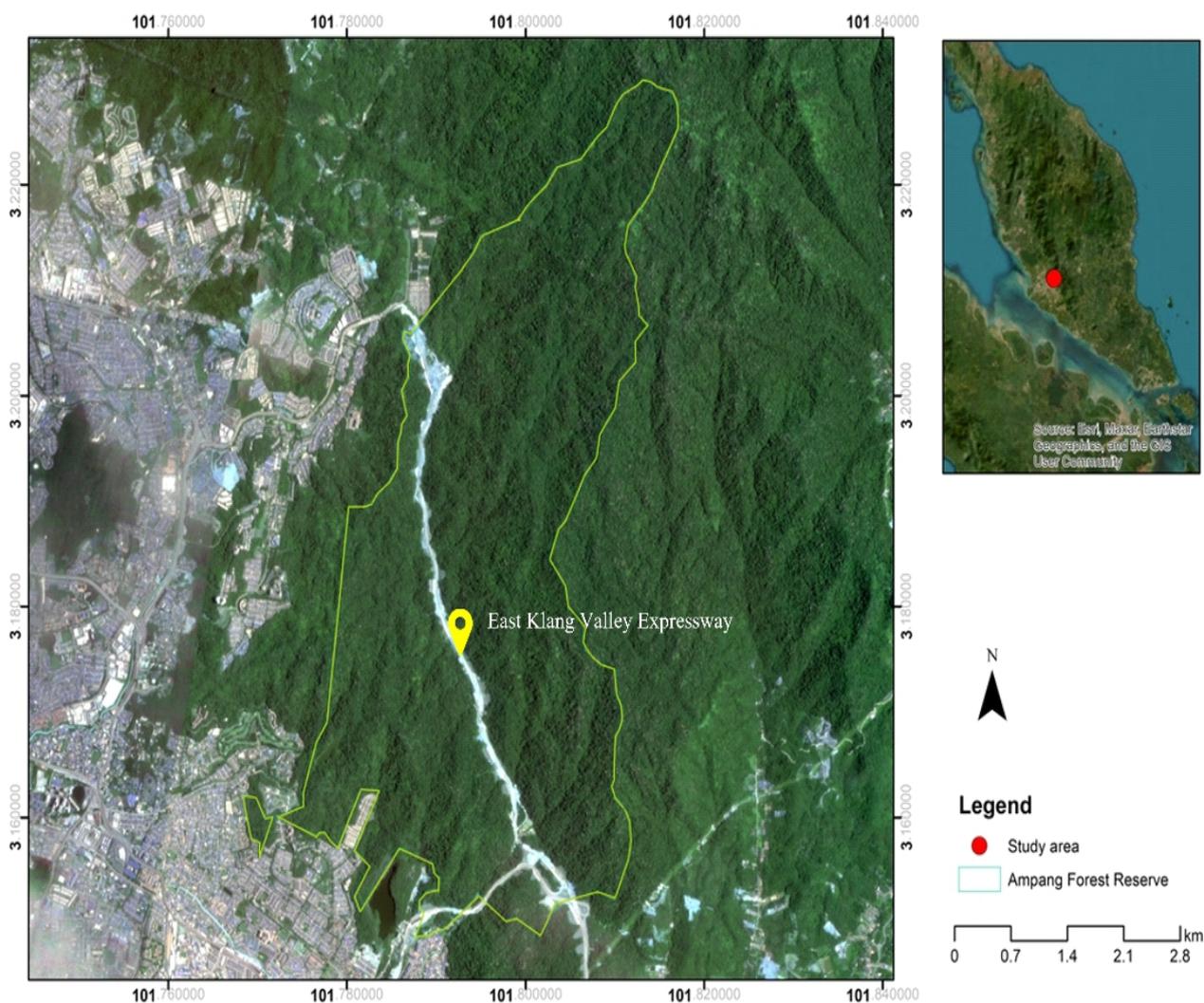


Figure 1 The alignment of the East Klang Valley Expressway (EKVE) which has cut cross Ampang Forest Reserve (AFR).

technique used was a simple random sampling method. It was easy to implement and less costly, as it is a non-stratified sampling technique. This technique allowed this study to obtain data based on input from respondents who lived in the area during the survey. It also ensures that everyone is equally likely to be involved as a sample and avoids sampling bias (Taherdoost, 2016).

**Data analysis** Data analyses were conducted using IBM Statistical Package for the Social Sciences (SPSS) Statistics 29.0. Descriptive analysis was applied to describe and summarize the basic information based on the socioeconomic characteristics of the respondents. The inferential statistic involving the Pearson correlation was conducted to examine the relationship between the tested variables, and the results were used to describe the effects of the tested variables on each other (Goodwin & Leech, 2006). Additionally, the Cronbach's alpha test was employed to determine the reliability of the questionnaire, with a coefficient of greater than 0.70 considered reliable (Tavakol & Dennick, 2011).

## Results and Discussion

**Socioeconomic characteristics of the respondents** A description of the socioeconomic characteristics of the respondents is presented in Table 1. The majority of the respondents in this study were female (78.3%). Most respondents were above 34 years old (45.8%). The marital status indicates half of the respondents are those in the 'others' group (which identifies as in a relationship, engaged, etc.), which is the largest portion in comparison to those who are married (48.3%) or single (1.7%). Regarding education level, 85.8% of the respondents had completed their tertiary education with a bachelor's degree, 10% were at the secondary school level, 2.5% had no formal education, and 1.7% had a professional educational background. Almost half of the respondents were retirees (45%). A significant number of respondents were employed (40.8%). Another four groups of respondents fall into the category with less than 10%, in which 'unemployed' is 5%, 'others' is 4.2%, 'businessman' is 3.3%, and 'student' is 1.7%. More than half of the respondents have an income range equal to or less than RM3,000 (52.5%). The second-highest income group is the

second-largest number of respondents (21.7%), followed by those who earned RM3,000–5,000 month<sup>-1</sup> (18.3%). Of the total respondents, 13.3% earned RM6,000–8,000 month<sup>-1</sup>, and 1.7% earned RM9,000–11,000 month<sup>-1</sup>. The highest-income group (equal to or greater than RM15,000) comprised only 2.5% of the respondents.

**Reliability value** The Cronbach's alpha test was employed to test the reliability of the variables used in assessing the perceived importance of ecosystem services and variable categories (Table 2 and Table 3). The reliability of these variables is based on the interpretation that a number or value closer to 1 indicates a highly reliable variable; otherwise, it shows lower reliability (Mundher et al., 2022). The Cronbach's alpha for all tested variables showed that their reliability is up to 0.98, above the 0.70 threshold level determined by Cronbach's (1951) alpha, thus indicating that the data used in this study are highly reliable.

**Public perceived importance of ecosystem services** The correlation coefficient values for provisioning services that comprised raw materials, water, and genetic resources indicate strong positive correlations with public perceived importance of ecosystem services (Table 4). Water had the highest correlation coefficient value ( $r = 0.921$ ) when tested for correlation between each individual measurement with the overall perceived importance of provisioning service, thus suggesting that it is indeed a main ecosystem service that the public perceives as the essential provisioning service from AFR.

For regulating services, the AFR's function in moderating extreme events, climate regulation, and pollination was also positively correlated with the public perceived importance of ecosystem services (Table 5). The role of AFR in climate regulation had the highest correlation coefficient value ( $r = 0.961$ ), thus suggesting that climate change might be a concern among the public.

The supporting services, which included biomass production, soil formation, and nutrient cycling, have strong positive correlations with public perceived importance of ecosystem services (Table 6). The ecological function of the AFR in the form of soil formation had the strongest positive correlation with the overall perceived importance of supporting services ( $r = 0.928$ ). Its correlation coefficient value was the highest in comparison with the forest function of supporting services and across all types of ecosystem services. This reflects the significance of soil formation in maintaining the health of terrestrial forest ecosystems.

Cultural services were also highly positively correlated with the public's perceived importance of ecosystem services (Table 7). As opposed to AFR being a place solely for recreation and tourism, the function of AFR in providing aesthetic information was also prioritized ( $r = 0.928$ ). This indicates that not only is AFR a space for recreation and tourism, but it is also viewed as a valuable setting for viewing natural landscapes that promote relaxation and nurture good physical and mental health.

As all results are statistically significant at the 0.01 level and considering the reliability values, it implies the great significance of ecosystem services from the AFR to local livelihoods and their overall well-being. Forest ecosystem

services are intercorrelated; hence, damaging any ecosystem service will consequently affect other ecosystem services (Bennett, 2009). The way that the public perceived the importance of these ecosystem services conveyed a similar message, where the perceived importance of one ecosystem service will significantly affect how they value the importance of other ecosystem services at the AFR.

**Public awareness on environmental threats** The public awareness of the level of environmental threats towards

Table 1 Socio-economic characteristics of the respondents (n = 120)

Variable	Items	n	Proportion (%)
Gender	Male	26	21.7
	Female	94	78.3
Age	≤ 18	2	1.7
	19–21	13	10.8
	22–24	42	35.0
	25–27	5	4.2
	28–30	0	0
	31–33	3	2.5
	≥ 34	55	45.8
Marital status	Married	58	48.3
	Single	2	1.7
	Others	60	50.0
Education level	No formal	3	2.5
	Primary	0	0
	Secondary	12	10.0
	Bachelor	103	85.8
	Professional	2	1.7
Occupation	Unemployed	6	5.0
	Student	2	1.7
	Employed	49	40.8
	Businessman	4	3.3
	Retiree	54	45.0
	Others	5	4.2
	Monthly income (RM)	≤ 3,000	63
3,000–5,000		10	18.3
6,000–8,000		16	13.3
9,000–11,000		2	1.7
12,000–14,000		26	21.7
≥ 15,000		3	2.5

Table 2 The reliability of variables used in assessing perceived importance of ecosystem services

Ecosystem services	Reliability statistic (Cronbach's $\alpha$ )	Number of items
Provisioning services	0.93	3
Regulating services	0.94	3
Supporting services	0.97	3
Cultural services	0.89	3

Table 3 The reliability of the tested variables category

Variables category	Reliability statistic (Cronbach's $\alpha$ )	Number of items
Perceived importance of ecosystem services	0.98	12
Awareness on environmental threats	0.95	13
Attitude on conservation measures	0.95	13

Table 4 Pearson correlation between variables explaining public perceived importance of provisioning services (the correlation between each individual measurement with the overall perceived importance of provisioning service)

	Provisioning services (overall)	Raw materials	Water	Genetic resources
Provisioning services (overall)	1.000			
Raw materials	0.910**	1.000		
Water	0.921**	0.776**	1.000	
Genetic resources	0.895**	0.697**	0.746**	1.000

Note: \*\* = very significant,  $p$ -value > 0.01

Table 5 Pearson correlation between variables explaining public perceived importance of regulating services (the correlation between each individual measurement with the overall perceived importance of provisioning service)

	Regulating services (overall)	Control	Regulation	Pollination
Regulating services (overall)	1.000			
Moderation of extreme events	0.924**	1.000		
Climate regulation	0.961**	0.818**	1.000	
Pollination	0.956**	0.803**	0.914**	1.000

Note: \*\* = very significant,  $p$ -value > 0.01

Table 6 Pearson correlation between variables explaining public perceived importance of supporting services (the correlation between each individual measurement with the overall perceived importance of provisioning service)

	Supporting services (overall)	Biomass production	Soil formation	Nutrient cycling
Supporting services (overall)	1.000			
Biomass production	0.958**	1.000		
Soil formation	0.978**	0.905**	1.000	
Nutrient cycling	0.966**	0.872**	0.931**	1.000

Note: \*\* = very significant,  $p$ -value > 0.01

Table 7 Pearson correlation between variables explaining public perceived importance of cultural services (the correlation between each individual measurement with the overall perceived importance of provisioning service)

	Cultural services (overall)	Opportunities for recreation & tourism	Spiritual experience	Aesthetic information
Cultural services (overall)	1.000			
Opportunities for recreation & tourism	0.918**	1.000		
Spiritual experience	0.884**	0.680**	1.000	
Aesthetic information	0.928**	0.843**	0.705**	1.000

Note: \*\* = very significant,  $p$ -value > 0.01

ecosystem services from the AFR was assessed, as shown in Table 8. Most respondents (49.2%) were aware that improper waste disposal is an environmental threat that could cause significant effects on ecosystem services from the AFR. Improper waste disposal can decrease the quality and quantity of ecosystem services, which are hazardous to the environment and public health (Abubakar et al., 2022). Of the total respondents, 48.3% were aware that opening forests for construction was another environmental threat that adversely affected ecosystem services. The distributional proportion of public awareness indicates that this form of environmental threat has medium, high, and very high effects on ecosystem services from the AFR. Although construction is needed for socioeconomic development, proper planning and best practices are necessary to avoid negative impacts on ecosystem services (Tobias, 2013).

Deforestation is also rated as one of the top five environmental threats affecting the sustainability of ecosystem services by the AFR. All respondents viewed deforestation as affecting ecosystem services, but the

majority (45.8%) were aware that it had a very high effect on the sustainability of ecosystem services from the AFR. In Malaysia, deforestation often causes flooding and subsequently creates a loss of livelihood among communities (Tan-Soo et al., 2016). Similarly, land use conversion and urbanization are also perceived as environmental threats to ecosystem services from the AFR. Most respondents (44.2% and 41.7%, respectively) were aware that these environmental threats have a very high effect on ecosystem services. Land use conversion influences ecosystem services and negatively affects human well-being (Hasan et al., 2020), whereas urbanization is associated with ecosystem function loss and climate change impacts (Ferreira et al., 2019). Additionally, all respondents were aware of forest fragmentation due to roads, pipelines, electrical wires, and human encroachment for recreational activities as another environmental threat to ecosystem services in the AFR. Forest fragmentation causes a reduction in food resources, increasing pest problems, and reducing soil fertility (Renó et al., 2016), while forest encroachment

negatively affects species diversity and richness (Zakkak et al., 2014).

In terms of correlation analysis, the results in Table 9 show that the public perceived importance of ecosystem services positively correlated with their awareness of environmental threats. It is evident that the public acknowledges that environmental threats directly influence the sustainability of all ecosystem services from the AFR. Therefore, creating better protection measures for the AFR seems pragmatic, as it could ensure its sustainability and enhance the resilience of ecosystem services for meeting current and future societal needs (Biggs et al., 2012).

**Public agreement on conservation measures that could increase the protection and ensure the sustainability of ecosystem services**

The results in Table 10 show several conservation measures that the public agrees would better protect and secure the sustainability of ecosystem services from the remaining area of the AFR. More than 70% of the respondents agreed that strict legal action should be taken against anyone who pollutes water sources at the AFR. Due to the reality of AFR being a crucial water source for local communities, this finding confirms the public's perceived importance of water, parallel with the result for the provisioning services in Table 4. The majority of respondents

Table 8 Distribution of public awareness on level of environmental threats towards ecosystem services (%)

Environmental threats	Threat level				
	1	2	3	4	5
Deforestation	-	1.7	23.3	29.2	45.8
Urbanisation	-	1.7	21.7	35.0	41.7
Land use conversion	-	4.2	16.7	35.0	44.2
Forest encroachment	-	4.2	28.3	42.5	25.0
Improper waste disposal	-	1.7	22.5	26.7	49.2
Forest fragmentation due to roads, pipelines and electrical wires	-	4.1	29.2	36.7	30.0
Opening of forest for any type of constructions	-	-	20.0	31.7	48.3

Note: Threat level: 5 = very high effect, 4 = high effect, 3 = medium effect, 2 = low effect, 1 = no effect

Table 9 Pearson correlation between variables explaining public perceived importance of ecosystem services and awareness on environmental threats

	Provisioning services	Regulating services	Supporting services	Cultural services	Awareness of environmental threats
Provisioning services	1.000				
Regulating services	0.894**	1.000			
Supporting services	0.829**	0.907**	1.000		
Cultural services	0.835**	0.894**	0.890**	1.000	
Awareness of environmental threats	0.402**	0.398**	0.452**	0.442**	1.000

Note: \*\* = very significant,  $p$ -value > 0.01

Table 10 Distribution of public agreement on conservation measures that could increase the protection and ensure the sustainability of ecosystem services (%)

Conservation measures	Agreement level				
	1	2	3	4	5
Conservation of AFR should be given priority, even if it causes slower infrastructure development and economic growth in Klang Valley			14.2	29.2	14.2
Strict legal action should be taken against anyone that pollute water sources at AFR	-	-	9.2	13.3	77.5
Environmental threats can be reduced if all parties work together to ensure a balanced between development activities with environmental conservation around AFR	-	-	10.0	30.0	60.0
Strict legal enforcement measure should be implemented to control and reduce development activities that affect the sustainability of AFR	-	-	9.2	24.2	66.7
Relevant authorities and the public should cooperate in providing forest stewardship program that conserve and protect AFR	-	-	13.3	23.3	63.3
To protect and conserve AFR, all parties (e.g., state, federal, public, NGOs etc) should oppose further degazettement of AFR	-	-	11.7	22.5	65.8

Note: Agreement level; 5 = strongly agree, 4 = agree, 3 = slightly agree, 2 = disagree, 1 = strongly disagree

(66.7%) also agreed that strict legal enforcement measures should be implemented to control and reduce development activities affecting AFR sustainability. This was followed by 65.8% of the respondents agreeing that all parties (e.g., state, federal, public, non-governmental organizations, etc.) should oppose further forest degazettement to avoid forest opening for any developments. Similarly, most respondents agreed that authorities and the public should cooperate in providing forest stewardship programs that conserve and protect the AFR (63.3%), while working together to ensure a balance between development activities and environmental conservation around the AFR (60%). A modest distributional proportion of the respondents' agreement (i.e., all respondents agree, but the portion of 'strongly agree' did not reach half of the total number of respondents) can be seen in the statement that highlights that the conservation of the AFR should be given priority, even if it causes slower infrastructure development and economic growth in Klang Valley.

These findings show that urban respondents are knowledgeable and more exposed to the conservation of natural ecosystems, perhaps due to their education and income levels (Arcury & Christianson, 1993). Knowledge level significantly influences public perceptions and drives expected behaviors (Yovi et al., 2023). Being knowledgeable facilitates respondents to understand what can be achieved or expected to be beneficial for them (Permatasari et al., 2023).

## Conclusion

This study indicates that the public perceived AFR as an important natural resource despite the decrease in its forest size area. The empirical estimations, based on public input on the perceived importance of ecosystem services, awareness of the level of environmental threats, and agreement on conservation measures, imply that it is crucial to ensure the sustainability of ecosystem services from the AFR. It is clear that the public is aware that the usage or gaining services from the AFR is beneficial, particularly for sustainable livelihood and societal benefit. In addition to awareness, many other factors can potentially change public perceptions. The common denominator is the level of knowledge, which may play an essential role in shaping perceptions. It can be argued that knowledge may influence potential changes in perception, leading people towards measures that ensure the sustainability of ecosystem services from AFR. Given the location of the AFR, it often attracts various possible socioeconomic developments, and there will always be a concern about its protection and sustainability, especially after the case of its recent degazettement. While balancing national development and environmental conservation is challenging, it is vital to consider public participation in environmental governance while promoting economic growth. This study has provided empirical validation for public participation that conforms to Principle 10 of the Rio Declaration, where public perceptions are considered when discussing environmental issues. As such, this study highlights public perceptions of the importance of ecosystem services and finds a positive public response to protecting ecosystem services from AFR. This underlines the importance of ecosystem services from the AFR as it

provides a life support system for the adjacent society, and this system is also built and sustained by all ecosystem services found at the AFR. In conclusion, it may be challenging to guarantee no environmental impact when implementing economic development measures. Nonetheless, it is vital to consider the public's voices to avoid degradation of the environment. This implies that the government should enhance public participation in the approval processes for socioeconomic development projects to produce relevant decisions and policies for public well-being. However, it is important to note that although the observed perception trends in the studied population may relate to environmental conservation, the findings may not be applicable to comparable populations with different livelihoods or in different locations.

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