

Analysing the priority interests of local communities with respect to mangrove forest ecosystem services in Indonesia

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Abstract. Mangrove forests provide a wide range of ecosystem services that directly and indirectly support the livelihoods of coastal communities. Understanding local perceptions and priority interests is critical to generate socially inclusive and ecologically effective conservation strategies. This study analysed the priority interests of local communities regarding mangrove ecosystem services in Indonesia, especially in North Sumatera (Sumut), North Kalimantan (Kaltara), and Southwest Papua (PBD). Data were collected using household surveys of 234 people and field observations. Descriptive statistics was selected to identify variations in priorities in three different regions. Results show that coastal protection was perceived as the most important ecosystem service of mangrove forests, while carbon storage was consistently considered the lowest priority. The main differences emerged in provisioning and supporting services in which Sumut and Kaltara expressed more concern in timber production than PBD. Yet PBD provided more attention in fisheries and nursery grounds, reflecting the different needs and ecological conditions in those regions. These findings underscore the importance of site-specific, participatory, and community-sensitive mangrove management. Conservation programmes should prioritise ecosystem services considered most important by communities, such as coastal protection, and strengthen understanding incentives for undervalued services, such as blue carbon. This will enable mangrove management policies to be more effective and accepted by local communities, contribute to ecological sustainability and coastal economic well-being, and support the effort of Indonesian government to mitigate greenhouse gas emissions through increased carbon sequestration nationwide.

Keywords: mangrove forest, ecosystem services, blue carbon, coastal protection, North Sumatera, North Kalimantan, Southwest Papua.

1. Introduction

Mangrove forest is one of the most valuable coastal ecosystems, providing multiple ecosystem services that support ecological stability and human well-being (Kadaverugu et al., 2021; Bimrah et al., 2022; Ruslan et al., 2022). These include provisioning services (fish, crabs, fuelwood), regulating services (coastal protection, wave attenuation, carbon storage), supporting services (nursery grounds for marine organisms), and cultural services (ecotourism, education)

(Friess, 2016; Himes-Cornell et al., 2018; Sarkar et al., 2024). Despite their importance, mangrove forest continue to experience degradation due to the land conversion (Apriani & Delistiani, 2025), overexploitation (Aransiola et al., 2024; Islam et al., 2024), and limited community involvement in management system (Utami et al., 2024; Gunawan et al., 2025). According to the report from Food and Agriculture Organization (FAO) in 2023, the total mangrove ecosystem in the world is estimated to reach 14,8 million hectares. Of this number, Indonesia Ministry of Environment and Forestry in 2024 estimated 3.44 million hectares (23%) located in Indonesia. However, the previous study showed that mangrove forests in Southeast Asia were lost at an average rate of 0.18% per year between 2000 and 2012 due to the pressure of aquaculture, rice production, and palm oil plantation (Richards & Friess, 2016). In Indonesia, the mangrove forest was reduced greatly in the past decades for human activities, such as in South Sulawesi (Jamaluddin et al., 2022), North Sumatera (Rahmawaty et al., 2023), Central Java (Ardli et al., 2022), and East Kalimantan (Fawzi & Husna, 2021).

Local communities are the primary beneficiaries of mangrove ecosystem services. Nonetheless, their preferences are often underrepresented in conservation decision-making. Consequently, few of them might reject the mangrove conservation projects and social conflicts may arise. Empirical studies indicated that mangrove conservation without social inclusion could not effectively control mangrove degradation due to the anthropogenic pressure (Akram et al., 2023; Del Cid-Alvarado et al., 2024). Additionally, human needs, such as land use change, could negatively impact the ecosystem services (Mekonnen, 2025). To overcome that challenge we should involve local people in mangrove forest management planning and understand them in terms of mangrove ecosystem function. On the contrary, few researchers examined the stakeholders involved in mangrove restoration projects (Suwandhahannadi et al., 2024; Rodríguez-Rodríguez et al., 2025). Most of them focused on the ecological valuation (Kanan et al., 2024; Arifanti et al., 2025) and carbon assessment (Stankovic et al., 2023; Dutta Roy et al., 2024; Ewane et al., 2025) of mangrove forest. None of those studies have not analysed yet how local people prioritise different types of ecosystem services, especially in mangrove forest in Indonesia. Therefore, this research will investigate the priority interest of local communities related to mangrove forest ecosystem services in order to understand their expectations regarding the mangrove forest conservation.

Understanding local preferences of the ecosystem management is crucial because the success of conservation depends on the community support (Fariss et al., 2023). Moreover, misalignment between local needs and conservation policies may lead to the low social participation (Rolfe et al., 2022; Murunga et al., 2024). As a result, local people might utilize the

mangrove forest in unsustainable way. Accordingly, local knowledge plays a central role in ecosystem stewardship. This study aims to fill the research gap by analysing the priority interests of local communities regarding mangrove ecosystem services using empirical data from three different regions in Indonesia, including North Sumatera (Sumut), North Kalimantan (Kaltara), and Southwest Papua (PBD). Survey method would be employed to collect the data and statistical descriptive will be selected to analyze and present the finding of this research. This could assist the government to generate appropriate policy of mangrove forest conservation in order to obtain trust and legitimacy from society. Moreover, community participation in policy-making could answer the local needs and sustainable mangrove forest management would successfully be achieved.

1. Methods

1.1. Study area

The study area is in Indonesia with the total area of 5,180,053 km² (land area of 1,922,570 km² and water area of 3,257,483 km²). Indonesia has mangrove coverage of 3.44 million ha (23% of world mangrove) (Kemenhut, 2024). To investigate the priority interests of local communities with respect to mangrove ecosystem services in Indonesia, we select three study areas in which each represents certain regions of Indonesia (Figure 1). The selection of a research population focused on communities living around mangrove forest was based on the consideration that this group has the most intensive, direct, and continuous interaction with mangrove ecosystem services. Coastal communities are the primary beneficiaries of mangrove ecological functions, such as coastal protection, fisheries resources, blue carbon storage, and socio-cultural values associated with local traditions. Furthermore, they are also the parties most impacted by changes in mangrove conditions, whether due to damage, land conversion, or management policies. Therefore, the perspective of local communities is crucial for understanding the priority needs, perceived benefits, and preferences for mangrove ecosystem services, which can ultimately form the basis for formulating more contextual and equitable mangrove management policies.

First location is in the area of Karang Gading and Langkat Timur Laut Wildlife Reserve, Sumatera Utara Province (Sumut) with total area of 14,752 ha. There are 17 villages around Sumut with a total population of 78,397 people whose lives are very dependent on the existence of mangrove forest. We choose 80 people from 3 villages as sample of respondents in Sumut, namely Kwala Besar village (30 people), Karang Gading village (30 people), and Paluh Kurau, fishpond, dryland farming, and settlement. Based on the study of Utami (2022) that mangrove forests in Sumut are predominantly composed of *Rhizophora apiculata*, *Avicennia alba*, and

Bruguiera parviflora, which play an important role in providing coastal protection. We Select Sumut as one of the study area because of representing the mangrove forest in western region of Indonesia.

Second location is in Bulungan Regency, North Kalimantan Province (Kaltara) with total area of 13,181.92 km². Mangrove forest in Kaltara is approximately 1,372.95 ha. According to the study that mangrove forest in Kaltara consists of several tree species, including *Avicennia officinalis*, *Bruguiera parviflora*, *Bruguiera gymnorhiza*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Ceriops* spp., *Ceriops decandra*, *Nypa fruticans*, *Scyphiphora hydrophyllacea*, and *Acrostichum speciosum* (Kartika et al., 2019). Bulungan is divided into 74 villages with total population of 160,241 people. Due to limited budget, we selected 3 vilages as sample of participants, namely Liagu Village (30 people), Salimbatu Village (20 people), and Sekatak Buji Village (29 people). That village is facing the degraded mangrove forest because many mangrove forest converted into fishpond. Kaltara could represent the mangrove forest the central region of Indonesia.

Third location is in Sorong City, Southwest Papua Province (PBD) with total area of 110,500 ha. Mangrove forest in PBD is approximately 2,154 ha. Mangrove forest in Sorong City is widely dominated by species of *Rhizophora*, *Avicennia*, and *Ceriops* (Athabu et al., 2024). PBD has 41 villages with total population of 302,452 people. PBD has a new status as the capital of Southwest Papua Province so that development is progressing rapidly. That development could threaten the existence of mangrove forest along the coastal of that city. We select two villages as site study, namely Klablim village (40 people), and Klamana village (35 people). Selecting study area in PBD represents mangrove forest in eastern region of Indonesia.

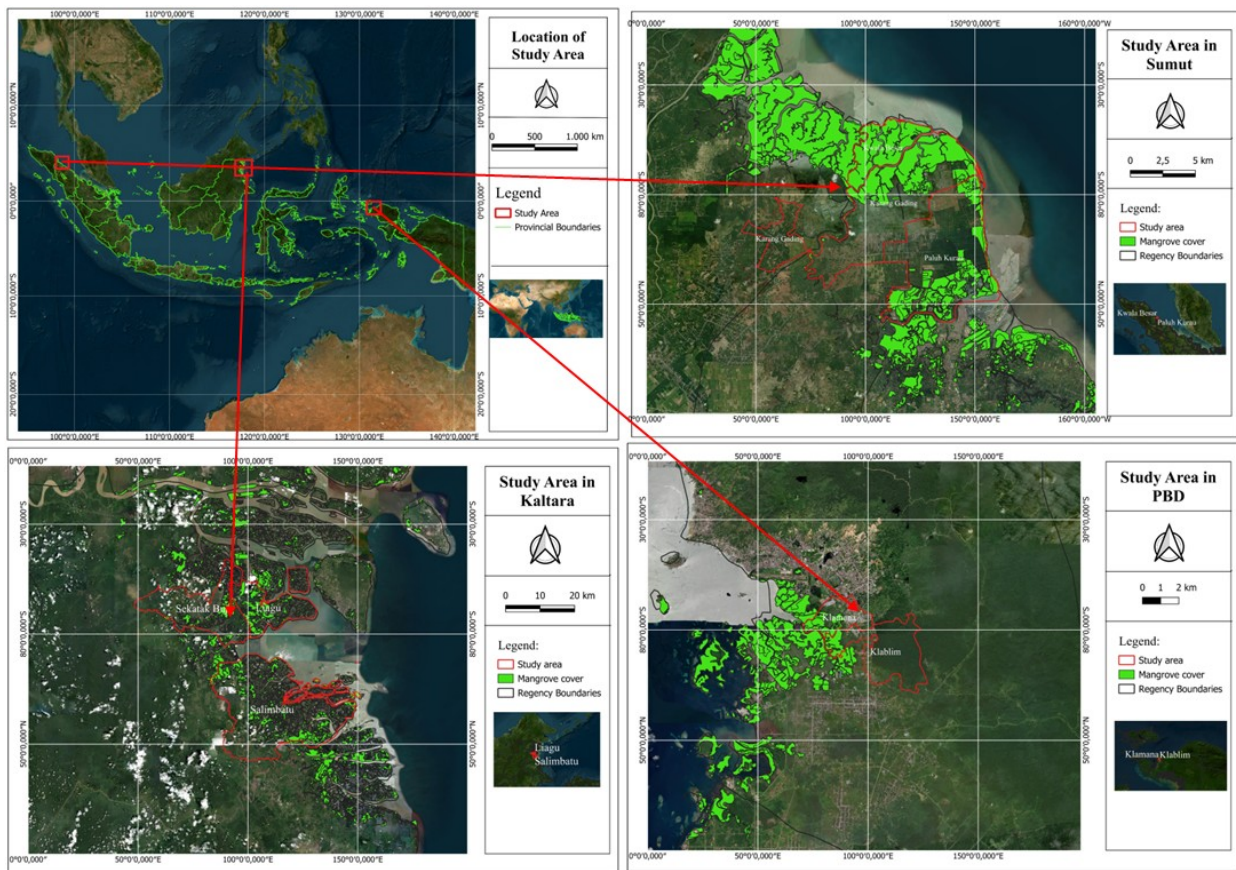


Figure 1. Location of study area

1.2. Data and Analysis

The method of data collection was a field survey using a purposive sampling technique. Data collection was conducted through face-to-face interviews and questionnaires. All respondents were presented with written consent indicating their approval in the survey. All participants were local people whose lives were very dependent on the existence of mangrove forest. To collect information from the respondents, we selected central-location survey and door-to-door survey based on the availability of respondents. Participants were gathered in a forum to socialize the mangrove conservation project and during the event, we requested them to fill the survey. The central-location survey had limitations or bias due to group pressure, such as feeling watched, following others' answers, or fearing different opinions. To deal with these biases, we ensured the participants that they were free to choose the best answer based on their own perspective.

Based on the preliminary survey, participants were reluctant to answer many questions especially regarding their socio-economic backgrounds. Consequently, we only proposed respondents one question to rank six functions of mangrove forest in order of importance that respondents think and feel was important. The survey aimed to assess the priority interests of local communities related to mangrove forest ecosystem services. In this study, we selected six

categories of general mangrove forest ecosystem services based on the previous studies: 1) Fisheries; 2) Timber; 3) Coastal protection; 4) Carbon storage; 5) nursery grounds for marine organisms; and 6) ecotourism (Friess, 2016; Himes-Cornell et al., 2018; Sarkar et al., 2024). Data collection was conducted for two months, from 30th June to 29th August 2025. The survey results were analyzed using SPSS Software and presented in descriptive statistics.

2. Results

The results of this study indicated a consistent pattern in few mangrove forest ecosystem services in Sumut, Kaltara, and the PBD (Figure 2). Coastal protection consistently ranked highest in all regions, indicating that communities generally obtained benefit most from the regulatory and disaster mitigation provided by mangrove forests. Conversely, carbon storage services ranked lowest in all regions. This shows that carbon storage in mangrove forest did not indirectly advantage to local communities so that they overlooked its function.

Provisioning services such as timber and fisheries shown the priority variations across the regions. In Sumut and Kaltara, timber came in second place, but in PBD timber services dropped dramatically to fifth. On the contrary, fisheries were a higher priority in PBD (rank 2), but in Sumut and Kaltara they ranked only third. This variation indicates there was a considerable difference in terms of the dependence of the local economics and the utilization of mangrove forest.

The other ecosystem services such as nursery grounds and ecotourism varied moderately. PBD prioritised nursery grounds (rank 3) higher than Sumut (rank 4) and Kaltara (rank 5), indicating that communities in the PBD perceived much benefits of the ecological function of mangrove forests for the sustainability of their fisheries. Ecotourism was relatively prioritised in Kaltara (rank 4) and PBD (rank 4), but lower in North Sumatra (rank 5).

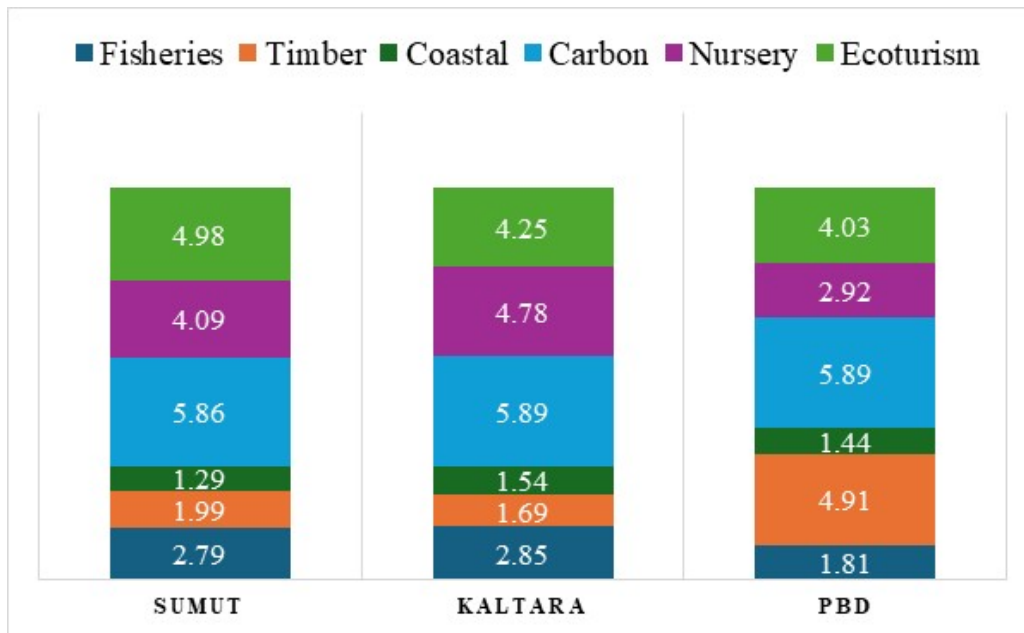


Figure 2. Mean rank of the priority interests of mangrove forest ecosystem services. The lowest number is the most priority, but the largest number is the least priority

Spearman's correlation test shows that Sumut and Kaltara had very similar priority patterns ($\rho = 0.96$). This was reflected in the similarity of almost all ecosystem service rankings, except for slight differences in nursery grounds and ecotourism. In contrast, Sumut and the PBD ($\rho = 0.62$), and Kaltara and PBD ($\rho = 0.51$) illustrated moderate correlations, describing that the PBD had a considerably distinct priority pattern.

Analysis of variation among ecosystem services indicated that two ecological services had the most stable rankings: coastal protection (0 variation) and carbon storage (0 variation). The ecosystem service with the highest variation was timber production, with a difference in ranking between regions of 2–5, followed by nursery grounds (difference of 2). This finding informed that certain provisioning services were widely influenced by the social and cultural characteristics and the availability of local resources.

The results of a simple clustering analysis shown the formation of two regional groups. The first cluster (Sumut and Kaltara) was characterized by: a high priority on timber and fishery production; a direct utilization orientation; and a similar coastal socio-economic condition. The second cluster (PBD) was characterized by: a high priority on fishery production and nursery grounds; community dependence on ecological functions; and a low wood utilization.

3. Discussion

The consistent top ranking for coastal protection services indicated that communities across the region directly experienced many benefits of mangrove forest in reducing abrasion, slowing waves, and protecting coastal settlements. This finding aligned with previous research that the

physical and direct visible benefits were more readily appreciated by local communities (Kadaverugu et al., 2021; Bimrah et al., 2022; Mori et al., 2025). Furthermore, placing coastal protection as the most important ecosystem service for mangrove forests might reflect community concerns about the potential disasters, such as tsunamis and tidal flooding (Jordan & Fröhle, 2022). Indonesia had the second-longest coastline in the world, reaching 81,290 km (ESDM, 2009), and 40% of its population lived in coastal areas (Community, 2025), making Indonesian more vulnerable to coastal disasters, particularly during high tides (Nurhidayah et al., 2022). Therefore, ecosystem-based disaster reduction was gaining popularity as a measure to reduce the threat of coastal disasters (Jordan & Fröhle, 2022). Moreover, these results may reflect a paradigm shift in the society, leading to greater awareness of the possibility of future disasters by adapting to climate change. The Indonesian government has legally responded this situation by establishing policies that prioritize climate change adaptation as mentioned in the Ministerial Regulation of Environment and Forestry Number P.7 of 2018 regarding the Guidelines for Assessment of Vulnerability, Risk, and Impact of Climate Change (KLHK, 2018). In practice, the implementation of this regulation has been supported by the development of analytical tools such as the Sistem Informasi Data Indeks Kerentanan (SIDIK), which enables the mapping of climate vulnerability at the village level using socio-economic and biophysical indicators (Ministry of Environment, 2025). Hence these research findings align with government policy in which local communities were more aware of the function of mangrove forest to shield their home from the negative impact of climate change.

Local people in all study sites placed the carbon storage as the least important ecosystem service of mangrove forests. The main reason is that carbon storage was an intangible benefit, neither directly perceived by the community nor direct economic value (Arifanti et al., 2025). This result was consistent with the study of Nguyen et al. (2022) that the local people were substantially not aware of the ability of mangrove to store carbon. Additionally, the concept of “carbon” may have been relatively technical for some respondents, which could explain why not all participants fully understood the term, even though it was explained during the data collection process. This fact contradicts the policy of Indonesian government to mitigate the global climate change through controlling greenhouse gas emission as stated in the Presidential Regulation Number 98 of 2021 concerning the Implementation of the Economic Value of Carbon to Achieve Nationally Determined Contribution Targets and Control Greenhouse Gas Emissions in National Development (Perpres, 2021). The implementation of that policy was to establish a mitigation strategy in the sector of Forest and Other Land Use Net Sink 2030 (Folu Net-Sink) with the aim of enabling the forestry and land sector to absorb more carbon,

particularly in mangrove forests. This project based on the scientific research that mangrove forest could greatly absorb more carbon than other ecosystems (Alongi, 2014). Therefore, targeted outreach and educational programs are needed to improve local communities' understanding of the ecological function of mangrove forests as significant carbon sinks. Enhancing community awareness of these climate regulation services may increase public appreciation of mangrove carbon ecosystem services. Furthermore, the development of well-designed incentive schemes, such as carbon-based payments, could encourage community participation by providing direct economic benefits linked to mangrove conservation and carbon sequestration. The similar condition has been conducted to protect the terrestrial forests in the water catchment areas (Supriyanto et al., 2024) so that the incentive schemes received by the community were appropriate and met their expectations.

Research analysis revealed a striking difference between Sumut and Kaltara compared to PBD in terms of timber utilization. Sumut and Kaltara demonstrated a higher dependence on mangrove wood because they utilized it to support household and local market needs. This was in line with the previous study that mangrove trees were utilized for the construction of houses (Palacios & Cantera, 2017). Whereas local people in PBD expressed the lowest value for the timber. The primary reason might be the availability of other wood alternatives in PBD.

PBD prioritised the fisheries and nursery grounds higher than other two regions. This may reflect the relatively better and less degraded condition of the mangrove ecosystem, leading communities to rely more heavily on ecological services that support sustainable fisheries. Prioritising nursery ground services indicated that communities directly link mangrove presence to successful fish catches. This aligned with previous research that mangroves could effectively support fishery productivity (Osland et al., 2022; Arfan et al., 2025).

Ecotourism was not the top priority despite its significant potential for local economic development. Kaltara and PBD shown higher priority due to the proximity of mangrove forests to the urban areas. This was similar to the previous studies that the distance shaped the intention of ecotourism from local people (Supriyanto & Puay-Yok, 2017; He et al., 2025). Conversely, in Sumut, the priority of ecotourism was lower because the mangrove forest was quite far from urban areas, making difficult access to the site. As a result, the ecotourism potential remains untapped or undervalued by the community.

Analysing the priority interest for mangrove forest ecosystem services at three different sites in Indonesia revealed a significant variation. These findings can provide an important input for the government in developing site-specific mangrove management policies accordance with the regional needs. The policy should prioritise coastal protection because this ecosystem

service was the most urgent component of climate change adaptation. Moreover, all regions placed the coastal protection as the top priority interest. The low level of public interest in blue carbon ecosystem services should become the government priority. To achieve this, governments should educate and promote the importance of mangroves forest in absorbing greenhouse gas emission. This is a part of the commitment of Indonesian government to the global community to reduce greenhouse gas emissions by increasing national carbon sequestration (Perpres, 2021). To support the commitment of government, payment for ecosystem services based on community participation could be implemented, particularly for mangrove carbon services.

This study has several limitations that should be considered. The relatively limited number of respondents and the selection of only three different study locations mean that the findings cannot fully represent the diverse perspectives of coastal communities at the national level. Variations in socioeconomic and cultural conditions, as well as the dynamics of mangrove utilization in other regions of Indonesia, may result in different priorities for ecosystem services. Nevertheless, the results of this study provide a strong empirical evidence of the reality of community perceptions on the ground, particularly in Sumut, Kaltara, and PBD. As a result, this research could serve as a baseline for further study with a broader scope.

We recommend to the further study to select a broader coverage area and a larger number of respondents to capture the diversity of coastal community perceptions nationally. Comparative studies across provinces or ecoregions could provide a deeper understanding of the social, economic, and ecological factors influencing the preference of mangrove ecosystem services. Additionally, the use of mixed methods such as choice modeling, participatory mapping, or environmental economic analysis could enrich the interpretation of ecosystem service values and provide a stronger scientific basis for community-based policy planning. Further research is also needed to examine changes in community perceptions over time, particularly in the context of the expansion of blue carbon programs and increasing pressure on coastal utilization.

4. Conclusion

This study shows that communities in all three regions ranked coastal protection as the most important mangrove ecosystem service, while carbon storage was consistently ranked as the lowest priority. Key differences emerged in provisioning and supporting services with Sumut and Kaltara prioritising timber production. Whereas the PBD prioritised fisheries and nursery ground for marine ecosystem, reflecting the different needs and ecological conditions across

regions. These findings underscore the importance of site-specific, participatory, and community-sensitive mangrove management. Conservation and rehabilitation programs should prioritise services considered most important by communities, such as coastal protection, and strengthen understanding and incentives for less valued ecosystem services, such as blue carbon. This will enable more effective mangrove management policies, enhance community acceptance, contribute to ecological sustainability and coastal economic well-being, and support the effort of Indonesian government to reduce greenhouse gas emissions through increased carbon sequestration nationwide. Further research is needed to examine changes in community perceptions over time, particularly in the context of expanding blue carbon programs and increasing coastal utilization pressures.

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Data availability: Data will be made available on request.

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