

Impact Analysis of Human Activities on Mangrove Conservation in Coastal Sulawesi

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ABSTRACT

Mangrove ecosystems are invaluable coastal habitats that provide essential ecological services and support diverse flora and fauna. However, human activities have increasingly threatened the sustainability of these ecosystems, particularly in regions like Coastal Sulawesi, Indonesia. This qualitative analysis investigates the impact of human activities on mangrove conservation in Coastal Sulawesi, employing semi-structured interviews, participant observation, and document analysis. The study reveals that drivers such as aquaculture expansion, unsustainable logging, pollution, and coastal development are contributing to mangrove degradation. Stakeholder perspectives vary, with local communities emphasizing the importance of mangroves for livelihoods and culture, while government officials stress the need for balancing conservation with economic development. Existing conservation efforts include protected area designation, community-based management projects, and awareness-raising campaigns. Collaborative action involving government, NGOs, academia, and local communities is essential to promote sustainable mangrove conservation in Coastal Sulawesi.

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1. INTRODUCTION

Mangrove forests are highly diverse and valuable ecosystems that thrive at the boundary between land and sea. Mangrove forests provide important ecosystem services such as shoreline stabilization, carbon sequestration, and nursery grounds for marine life [1]. These coastal habitats are important for protecting against natural disasters, reducing pollution, and recycling nutrients [2]. Mangrove forests also support a wide variety of organisms and promote

oxygen release and carbon dioxide absorption, helping to combat climate change [3]. However, mangrove forests face multiple threats, including deforestation and coastal development [4]. It is critical to understand and communicate the benefits of mangrove ecosystems to conserve them and the goods and services they provide [5]. Conservation and development of mangrove forests are essential for the well-being of coastal communities and the environment. Among countries with extensive mangrove

ecosystems, Indonesia has one of the largest and most ecologically important mangrove forests in the world.

Mangrove forests in coastal Sulawesi face increasing threats from human activities, jeopardizing the balance of these ecosystems. Mangrove forests are critical for supporting biodiversity and providing essential services to coastal communities, including food, livelihoods and protection against natural disasters. Mangrove forest degradation in Indonesia, including in the Sulawesi Coastal region, is caused by several factors such as settlement and cultivation [6], [7]. However, there is recognition of the importance of mangrove conservation and restoration efforts. Restoration activities have been implemented, but the success of these efforts is often evaluated based on survival and extent of restored area, rather than considering vegetation diversity and structure as indicators of a functional forest [8]. Participation and knowledge of coastal communities play an important role in mangrove rehabilitation, with positive effects on their understanding and behavior towards conservation [9]. Monitoring and conservation of land change in mangrove forests is essential to understand its impact on terrestrial ecosystems and coastal areas [10]. Community participation is critical to the success of mangrove forest conservation, and efforts should involve the community in all activity processes and provide counselling on conservation.

The rapid pace of urbanization, industrialization and agricultural expansion along the Sulawesi coast has led to significant mangrove forest degradation in the region [7], [11]. Human activities such as conversion of mangrove forests to ponds, timber harvesting, pollution from industrial and household sources, and uncontrolled coastal development have put tremendous pressure on the mangrove habitats that once thrived on the Sulawesi Coast [12]. This degradation not only jeopardizes the ecological integrity of the region but also threatens the socioeconomic well-being of its inhabitants [13]. The loss of mangrove ecosystems has resulted in a

decline in fisheries yields and income of fishing households in Indonesia [14]. It is imperative to priorities mangrove forest conservation as a policy to achieve sustainable development and ecosystem conservation to protect the livelihoods of coastal communities and the valuable ecosystem services provided by mangrove forests.

Given the critical importance of mangrove ecosystems and the urgent need to address their conservation, understanding the complex interplay between human activities and mangrove degradation is paramount. This qualitative analysis endeavors to delve deep into this intricate relationship, employing qualitative research methods to unravel the underlying drivers of mangrove degradation in Coastal Sulawesi. By examining the socio-economic, cultural, and institutional factors shaping human interactions with mangrove ecosystems, this study seeks to illuminate pathways towards sustainable mangrove management and conservation.

2. LITERATURE REVIEW

Mangrove ecosystems are recognized globally for their ecological significance and the myriad of ecosystem services they provide. A review of the literature underscores the critical importance of mangroves in coastal regions and sheds light on the various human activities that pose threats to their conservation. This section provides an overview of key findings from existing research related to mangrove conservation, with a particular focus on Coastal Sulawesi.

2.1 *Importance of Mangrove Ecosystems*

Mangroves play a pivotal role in coastal ecosystems by providing habitat and nursery grounds for diverse flora and fauna. They serve as natural buffers against coastal erosion, storm surges, and tsunamis, thereby protecting coastal communities and infrastructure. Additionally, mangroves contribute to carbon sequestration, nutrient cycling, and shoreline stabilization, making

them indispensable for maintaining coastal resilience and biodiversity [7], [15].

2.2 Threats to Mangrove Conservation

Mangrove forests are facing numerous threats, primarily driven by human activities. Habitat loss and degradation are major concerns, with land conversion for aquaculture, agriculture, and urban development being the primary drivers [7]. The expansion of shrimp and fish farms has led to the clearing of mangrove forests, resulting in the loss of valuable ecosystem services and biodiversity [16]. Unsustainable logging practices for timber and fuelwood extraction have also contributed to deforestation and degradation of mangrove habitats [17]. Pollution from industrial effluents, sewage discharge, and solid waste is another significant threat, compromising water quality and ecosystem health [2]. These human-induced pressures have had detrimental effects on mangrove ecosystems, highlighting the urgent need for conservation and sustainable management practices [18].

2.3 Socio-economic and Institutional Factors

The degradation of mangrove ecosystems is driven by socio-economic and institutional factors, including poverty, lack of alternative livelihood options, inadequate land-use planning, weak governance frameworks, ineffective enforcement of environmental regulations, and conflicting land tenure systems. These factors contribute to unsustainable exploitation and degradation of mangrove forests [19]. Additionally, the interests of powerful actors, such as commercial enterprises and political elites, often take precedence over environmental conservation, further undermining efforts to protect mangrove habitats [20]. The degradation of mangroves has significant implications for coastal communities, as these ecosystems provide essential ecological functions, support livelihoods, and contribute to socio-economic well-being [16]. Addressing these socio-economic and institutional factors is crucial for effective

mangrove conservation and sustainable development [14].

2.4 Conservation Strategies and Initiatives

Efforts to conserve mangrove ecosystems in Coastal Sulawesi and beyond have employed a variety of strategies and approaches. Community-based management initiatives, which empower local communities to participate in decision-making and resource management, have shown promise in promoting sustainable mangrove conservation [21], [22]. Participatory approaches that engage stakeholders, including government agencies, NGOs, academia, and local communities, foster collaboration and knowledge exchange, leading to more effective conservation outcomes [23]. Additionally, the designation of protected areas, establishment of marine protected areas, and implementation of zoning regulations aim to safeguard critical mangrove habitats from further degradation [24]. These strategies and approaches aim to ensure the long-term resilience and sustainable management of mangrove ecosystems in Coastal Sulawesi and beyond.

Research Gaps and Future Directions

While existing literature provides valuable insights into the drivers of mangrove degradation and conservation strategies, several gaps remain that warrant further investigation. Future research should focus on elucidating the socio-economic dynamics and power relations shaping human interactions with mangrove ecosystems in Coastal Sulawesi.

Moreover, there is a need for interdisciplinary studies that integrate ecological, socio-economic, and governance perspectives to develop holistic approaches to mangrove conservation. Longitudinal studies that track changes in mangrove ecosystems over time and assess the effectiveness of conservation interventions are essential for informing evidence-based decision-making and adaptive management strategies.

3. METHODS

3.1 Research Design

A qualitative research design was adopted to explore the complex interactions between human activities and mangrove conservation in Coastal Sulawesi. Qualitative methods enable in-depth exploration of the socio-economic, cultural, and institutional dimensions underlying mangrove degradation. Semi-structured interviews, participant observation, and document analysis were utilized to gather rich, nuanced data.

3.2 Data Collection

3.2.1 Semi-Structured Interviews

Semi-structured interviews were conducted with a diverse range of stakeholders, including local community members, government officials, NGO representatives, and experts in mangrove conservation. A total of 15 informants were selected purposively to ensure representation from different sectors and perspectives.

Interviews were guided by a semi-structured interview protocol, covering topics such as perceptions of mangrove ecosystems, human activities impacting mangrove conservation, existing conservation efforts, and recommendations for improvement. Interviews were conducted face-to-face or virtually, based on informant preference, and audio-recorded with consent.

3.2.2 Participant Observation

Participant observation was employed to complement interview data and provide insights into daily activities and interactions within mangrove ecosystems. Researchers accompanied local fishermen, community members, and conservationists during their activities in mangrove areas, observing practices and dynamics firsthand.

Field notes were taken during participant observation sessions to document observations, interactions, and contextual information. These field notes supplemented interview data by providing additional context and insight into the lived experiences of stakeholders.

3.2.3 Document Analysis

Document analysis involved reviewing relevant documents, reports, policy papers, and scientific literature related to

mangrove conservation, land-use planning, and environmental regulations in Coastal Sulawesi. Documents were sourced from government agencies, NGOs, academic institutions, and online databases.

Key themes and insights from the documents were extracted and integrated into the analysis to provide a comprehensive understanding of the institutional and policy landscape surrounding mangrove conservation in the region.

3.3 Sampling Strategy

Purposive sampling was employed to select informants with diverse perspectives and experiences relevant to the research objectives. Informants were selected based on their involvement in mangrove conservation activities, expertise in related fields, and roles within local communities or organizations.

Efforts were made to ensure representation from different stakeholder groups, including fisherfolk, farmers, government officials, researchers, and conservation practitioners. This approach aimed to capture a range of viewpoints and experiences related to mangrove conservation in Coastal Sulawesi.

3.4 Data Analysis

Data analysis was conducted using thematic analysis, a method for identifying, analyzing, and reporting patterns or themes within qualitative data. The analysis involved several iterative steps: Initially, the researchers familiarized themselves with the data by reviewing transcribed interview recordings, field notes from participant observation, and documents. Subsequently, data were systematically coded to identify key concepts, ideas, and patterns using NVivo, a qualitative analysis software. Codes were then grouped into broader themes and categories through axial coding, facilitating the identification of connections and relationships between different concepts. These themes were further developed based on recurring patterns and relationships identified in the data, and they were refined and validated through iterative analysis and discussion among the research team. Finally, the findings were interpreted within the

broader context of mangrove conservation in Coastal Sulawesi, drawing on relevant literature and theoretical frameworks to provide deeper insights into the research outcomes.

4. RESULTS AND DISCUSSION

This section presents the findings of the qualitative analysis conducted to examine the impact of human activities on mangrove conservation in Coastal Sulawesi. The results are discussed in the context of key themes that emerged from the data, including drivers of mangrove degradation, stakeholder perspectives, existing conservation efforts, and recommendations for improvement.

4.1 Drivers of Mangrove Degradation

The analysis of interviews, participant observation, and document analysis revealed several key drivers contributing to mangrove degradation in Coastal Sulawesi. These drivers stem from a combination of socio-economic, institutional, and environmental factors, which interact to exert pressure on mangrove ecosystems.

The expansion of aquaculture, particularly shrimp farming, emerged as a primary driver of mangrove degradation in Coastal Sulawesi. Informants consistently highlighted the conversion of mangrove forests into shrimp ponds as a significant threat to mangrove ecosystems. Mr. Hasan, a local fisherman, expressed concern, stating, "Many mangrove areas have been cleared to make way for shrimp farms. It's a lucrative business, but it's destroying our mangrove forests." The economic incentives driving aquaculture expansion, coupled with weak enforcement of regulations, have led to widespread deforestation and habitat loss.

Unsustainable logging practices for timber and fuelwood extraction were identified as another major driver of mangrove degradation. Informants reported widespread illegal logging activities in mangrove areas, with timber harvested for commercial purposes and fuelwood used for cooking and heating. Ms. Dewi, a conservation practitioner, remarked, "Illegal logging for timber and fuelwood is rampant

in many mangrove areas. Without proper enforcement, it's difficult to control." The loss of mangrove vegetation due to logging not only reduces habitat availability but also compromises the integrity of mangrove ecosystems.

Pollution from industrial effluents, domestic waste, and agricultural runoff emerged as a significant threat to mangrove ecosystems in Coastal Sulawesi. Informants expressed concerns about water pollution from nearby industrial facilities and urban areas, which adversely affect water quality and the health of mangrove vegetation and wildlife. Mr. Budi, an environmental activist, stated, "Pollution from factories and households is poisoning our mangroves. We need stricter regulations and enforcement to protect them." Pollution undermines the ecological integrity of mangrove habitats, disrupting ecosystem functions and endangering biodiversity.

Coastal development and infrastructure projects were identified as drivers of mangrove degradation, as land reclamation and construction activities encroach upon mangrove habitats. The conversion of mangrove areas for tourism, ports, and residential developments further exacerbates habitat loss and fragmentation. Mr. Rahmat, a government official, acknowledged the challenges, stating, "Coastal development is necessary for economic growth, but it must be balanced with conservation priorities." However, the rapid pace of development often prioritizes short-term gains over long-term environmental sustainability, leading to irreversible damage to mangrove ecosystems.

4.2 Stakeholder Perspectives

Stakeholder perspectives on mangrove conservation in Coastal Sulawesi varied significantly, reflecting diverse interests, priorities, and experiences. Through interviews and observation, a range of viewpoints emerged from different groups, including local communities, government officials, NGO representatives, and conservation practitioners.

Local communities expressed a deep connection to mangrove ecosystems, recognizing their importance for livelihoods, culture, and identity. Many community members, particularly fishermen and farmers, described mangroves as essential sources of food, fuelwood, and traditional medicine. Mrs. Lestari, a community leader, emphasized, "Mangroves are our lifeblood. They provide us with fish, firewood, and protection from storms." However, some community members also acknowledged the pressures of poverty and limited economic opportunities, which contribute to unsustainable exploitation of mangrove resources.

Government officials highlighted the importance of balancing conservation goals with economic development imperatives. While recognizing the ecological significance of mangrove ecosystems, policymakers emphasized the need to promote sustainable development and livelihood alternatives for coastal communities. Mr. Wahyu, a government representative, stated, "We need to find a balance between conservation and development. It's not easy, but it's necessary for the well-being of both people and nature."

NGO representatives and conservation practitioners emphasized the importance of community-based approaches to mangrove conservation. They underscored the role of education, capacity building, and community empowerment in fostering stewardship of mangrove resources and promoting sustainable management practices. These stakeholders highlighted successful community-based projects as models for replication and stressed the importance of collaborative partnerships in conservation efforts.

4.3 Existing Conservation Efforts

The qualitative analysis revealed several ongoing conservation initiatives aimed at protecting and preserving mangrove ecosystems in Coastal Sulawesi. Through interviews, participant observation, and document analysis, various strategies and projects were identified, each contributing to the broader goal of mangrove conservation.

One of the notable conservation efforts highlighted by informants was the designation of marine protected areas (MPAs) encompassing mangrove habitats. These MPAs serve as important refuges for biodiversity and help to regulate human activities within designated zones. Informants pointed to the establishment of MPAs as a positive step towards safeguarding mangrove ecosystems from further degradation.

Community-based mangrove management projects, facilitated by NGOs and local organizations, were cited as effective strategies for engaging local communities in conservation activities. These initiatives empower communities to actively participate in decision-making, resource management, and alternative livelihood development. Through capacity building, training, and support, communities are equipped with the knowledge and tools necessary to sustainably manage mangrove resources.

Awareness-raising campaigns and environmental education programs were recognized as valuable tools for promoting public awareness and understanding of mangrove conservation. Informants highlighted the importance of education in fostering a sense of stewardship and responsibility towards mangrove ecosystems. By raising awareness about the ecological importance of mangroves and the threats they face, these initiatives aim to mobilize support for conservation efforts among diverse stakeholders.

Policy and institutional support for mangrove conservation were identified as critical components of existing conservation efforts. Informants highlighted the role of government agencies in developing and implementing regulations to protect mangrove habitats. Additionally, partnerships between government, NGOs, academia, and local communities were cited as essential for coordinating conservation activities and leveraging resources effectively.

4.4 Recommendations for Improvement

Based on the findings, several recommendations were proposed to enhance

mangrove conservation efforts in Coastal Sulawesi. These include:

- a. Strengthening enforcement of existing environmental regulations to combat illegal logging, land conversion, and pollution.
- b. Promoting sustainable aquaculture practices that minimize the environmental impact on mangrove ecosystems.
- c. Enhancing community engagement and participation in mangrove management through capacity building, training, and resource allocation.
- d. Integrating traditional ecological knowledge and indigenous practices into conservation strategies to enhance their effectiveness and relevance.
- e. Fostering multi-stakeholder partnerships and collaboration to leverage resources, expertise, and local knowledge for mangrove conservation.

DISCUSSION

The results of this qualitative analysis highlight the complex interplay of socio-economic, institutional, and environmental factors shaping mangrove conservation in Coastal Sulawesi. While there are challenges and constraints, there are also opportunities for innovative solutions and collaborative approaches to address the drivers of mangrove degradation and promote sustainable management practices.

By integrating the perspectives and experiences of diverse stakeholders, this study provides valuable insights into the underlying dynamics of mangrove conservation in the region. Moving forward, concerted efforts are needed to translate these findings into actionable strategies and policies that prioritize the long-term health and resilience of Coastal Sulawesi's mangrove ecosystems. Only through collective action and shared stewardship can we ensure the preservation of these invaluable coastal habitats for future generations.

5. CONCLUSION

The findings of this qualitative analysis shed light on the complex interactions between human activities and mangrove conservation in Coastal Sulawesi. Despite the numerous challenges facing mangrove ecosystems, there are also opportunities for collaborative action and innovative solutions. By integrating stakeholder perspectives, strengthening policy frameworks, and supporting community-based initiatives, it is possible to enhance mangrove conservation efforts in the region. Moving forward, concerted efforts are needed to address the underlying drivers of mangrove degradation, promote sustainable management practices, and ensure the long-term resilience of Coastal Sulawesi's mangrove ecosystems. Through collective action and shared stewardship, we can safeguard these invaluable coastal habitats for future generations.

REFERENCES

- [1] R. Aprilina and R. Hastijanti, "Penerapan Konsep Solid Nature pada Penataan Ekowisata Mangrove di Gunung Anyar Surabaya," *Selasar*, vol. 19, pp. 61–70, May 2023, doi: 10.30996/selasar.v19i2.8535.
- [2] E. S. Bindiya, P. M. Sreekanth, and S. G. Bhat, "Conservation and Management of Mangrove Ecosystem in Diverse Perspectives," in *Conservation and Sustainable Utilization of Bioresources*, Springer, 2023, pp. 323–352.
- [3] S. Cadena and J. Ochoa-Gómez, "MANGROVES: 'SUPERHERO' ECOSYSTEMS".
- [4] J. Lai, W. Cheah, K. Palaniveloo, R. Suwa, and S. Sharma, "A systematic review of the physicochemical and microbial diversity of well-preserved, restored, and disturbed mangrove forests: What is known and what is the way forward?," *Forests*, vol. 13, no. 12, p. 2160, 2022.
- [5] A. Mukhopadhyay, "Mangrove the Head of an Intricate Joint Family," *Int. J. online Humanit.*, vol. 8, Dec. 2022, doi: 10.24113/ijohmn.v8i6.264.
- [6] R. Djameluddin *et al.*, "Point of (no) return? Vegetation structure and diversity of restored mangroves in Sulawesi, Indonesia, 14–16 years on," *Restor. Ecol.*, vol. 31, no. 7, p. e13963, 2023.
- [7] A. H. P. Hamzah, M. Marzuki, N. Nurhasanah, and S. Nurmawati, "ENVIRONMENTAL RISK ANALYSIS IN MAGROVE AND CRAB CONSERVATION AREAS IN PAMUSIAN VILLAGE DUE TO LAND USE CHANGE IN TARAKAN CITY," *J. Ilm. Glob. Educ.*, vol. 4, no. 2, pp. 980–995, 2023.

- [8] M. I. Ali, A. Malik, and A. Rahim, "Environmental Knowledge and Attitude of Coastal Community in Decision Making to Participate in Mangrove Rehabilitation in Sinjai District South Sulawesi Indonesia," *Int. J. Sustain. Dev. Plan.*, vol. 17, no. 8, pp. 2579–2584, 2022.
- [9] M. Hakim, D. Lubis, M. Harefa, M. Damanik, and A. Suciani, "Analysis Changes in Mangrove Forest Cover Using Multi-Sensor Image in North Luwu District South Sulawesi 2015-2020," *Tunas Geogr.*, vol. 11, Dec. 2022, doi: 10.24114/tgeo.v11i2.41349.
- [10] P. D. Harsono, S. Abadi, and K. Sulandjari, "Partisipasi Masyarakat Dalam Pelestarian Hutan Mangrove Di Pesisir Tangkolak Desa Sukakerta Kecamatan Cilamaya Wetan Kabupaten Karawang," *Mimb. Agribisnis J. Pemikir. Masy. Ilm. Berwawasan Agribisnis*, vol. 9, no. 1, pp. 40–55, 2023.
- [11] A. M. Maulana, P. Angga Wiradana, I. Kadek Wisma Yudha, N. Sutiadipraja, C. Gilang Qur'ani, and H. Baral, "Assessing impact of land-use changes on carbon stock dynamics in coastal mangrove ecosystem in Bali Island, Indonesia," in *EGU General Assembly Conference Abstracts*, 2023, p. EGU-13684.
- [12] A. L. K. Amel and D. A. Lestari, "MAPPING THE DISTRIBUTION OF MANGROVES IN SERANG REGENCY USING REMOTE SENSING (CASE STUDY OF PULAU PANJANG)," *J. Teknol. Inf. DAN Komun.*, vol. 14, no. 1, pp. 153–158, 2023.
- [13] D. D. Suryono, H. L. Salim, T. Solihuddin, S. Husrin, N. Sudirman, and A. Heriati, "Assessment of The Antropogenic Impact on Mangrove Ecosystem and Endemic Fauna in Muaragembong, Bekasi, West Java," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2023, p. 12016.
- [14] Y. Yamamoto, "Living under ecosystem degradation: Evidence from the mangrove–fishery linkage in Indonesia," *J. Environ. Econ. Manage.*, vol. 118, p. 102788, 2023.
- [15] V. Venkateswarlu and C. Venkatrayulu, "Review on mangrove restoration: Re-greening the sea coast," *GSC Biol. Pharm. Sci.*, vol. 22, no. 3, pp. 130–143, 2023.
- [16] G. V. Limmon, E. Waardenburg, W. Lengkeek, P. Vodegel, and Y. A. Noya, "RESTORASI EKOSISTEM MANGROVE PADA MEDIA BIODEGRADABLE DI PESISIR DESA WAAI: Restoration Of Mangrove Ecosystem On Biodegradable Media On The Coast Of Waai Village," *MESTAKA J. Pengabd. Kpd. Masy.*, vol. 2, no. 2, pp. 99–103, 2023.
- [17] D. Liangliang, C. Xin, N. Chen, X. Liu, and L. Zhang, "Mangrove forest fragmentation and its ecological service value in Tongming Sea of Zhanjiang, Guangdong, China during 2000-2018," *Ying Yong Sheng tai xue bao= J. Appl. Ecol.*, vol. 34, no. 2, pp. 415–422, 2023.
- [18] P. Kumari and B. Pathak, "Effect of Climate Change and Urbanization on Mangrove Ecosystem," in *Climate Change and Urban Environment Sustainability*, Springer, 2023, pp. 293–301.
- [19] G. M. da Costa *et al.*, "Effects of degradation on microbial communities of an Amazonian mangrove," *Microorganisms*, vol. 11, no. 6, p. 1389, 2023.
- [20] R. Merven, C. Appadoo, F. B. V. Florens, and P. Iranah, "Dependency on Mangroves Ecosystem Services is Modulated by Socioeconomic Drivers and Socio-Ecological Changes–Insights From a Small Oceanic island," *Hum. Ecol.*, vol. 51, no. 6, pp. 1141–1156, 2023.
- [21] N. A. S. Taufieq, A. Arfan, S. Side, R. Maru, and P. H. Salsabila, "The Strategy of Management of Mangrove Forests Area as a Sustainable Production Area in Coastal of Takalar Regency, South Sulawesi," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2023, p. 12017.
- [22] G. Krishna and N. Aiman, "Review of the mangrove conservation behaviour from environmental psychological perspectives," *Malaysian J. Sustain. Environ.*, vol. 10, no. June, pp. 193–215, 2023.
- [23] M. L. Salampessy, I. Lidiawati, and E. Metkono, "Failure of local institutions of coastal communities to conserve mangroves," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2023, p. 12033.
- [24] M. I. AIPASSA, M. E. SIAHAYA, H. S. E. S. APONNO, Y. RUSLIM, and R. KRISTININGRUM, "Participation of community in mangrove conservation in coastal area of the Valentine Strait, West Seram, Maluku, Indonesia," *Biodiversitas J. Biol. Divers.*, vol. 24, no. 4, 2023.