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Mangroves under pressure: Local threats and management realities in Malamawi Island, Basilan, Philippines

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ABSTRACT

Mangrove forests are among the most productive coastal ecosystems, yet they remain highly vulnerable to anthropogenic pressures. In the Philippines, these habitats provide essential services ranging from coastal protection and carbon storage to fisheries support. Despite their importance, the extent of mangrove degradation and the factors contributing to it remain poorly documented. This study examined the status, threats, and existing management initiatives of mangrove forests in the three barangays of Malamawi Island, Basilan Province, Philippines. Fieldwork was conducted from July to August 2024 and involved direct observation, a transect-walk survey for coastal threats, photo documentation, and key informant interviews (n=15). Five major threats were recorded, with infrastructure development being the most prominent, followed by household garbage accumulation, mangrove cutting for charcoal and firewood, and the presence of abandoned fishponds. The local government and community had established mangrove nurseries and conducted tree-planting activities, reflecting their awareness of mangroves' roles in coastal protection, livelihood support, erosion control, and biodiversity conservation. Awareness of permit requirements and anti-illegal-cutting ordinances indicates that these regulations are visible and generally enforced. However, the effectiveness of reforestation and cutting policies remains limited by inadequate manpower and monitoring. Thus, this study provides a baseline that can inform stronger governance and a more integrated, community-centered management to support the long-term sustainability of the mangrove forests in the island. This thrust supports the global sustainable development goals 12 (Responsible Consumption and Production) and 15 (Life on Land).

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INTRODUCTION

Mangroves are salt-tolerant intertidal plants found in over 120 countries and form productive ecosystems that support coastal communities (Abdullah *et al.*, 2021). Mangroves stand out as one of the most diverse and biologically significant natural systems (Akram *et al.*, 2023). Globally, there are approximately 75 species of mangrove (Rosario *et al.*, 2021), 35 of which are found in the Philippines (Bhowmik *et al.*, 2022). With the country's estimated mangrove cover of approximately 311,400 ha (DENR-FMB, 2020), this reflects the ecosystem's vital role in coastal protection, biodiversity support, and sustaining local livelihoods (Agduma and Cao, 2023). These mangrove ecosystems provide multiple functions and services that support both ecological health and human well-being, including: provisioning services that supply food and other goods, such as fisheries, fuel, and medicinal resources (Das *et al.*, 2022). Regulating services involve carbon sequestration and storage, as well as protection from natural disasters such as storm surges and coastal erosion (Taillardat *et al.*, 2018; Lovelock *et al.*, 2022). Supporting services encompass nutrient cycling and nursery habitats, providing critical shelter and breeding grounds for local flora and fauna (Ma *et al.*, 2020), and cultural services include recreational and tourism opportunities that contribute to the social and economic well-being of local communities (Bimrah *et al.*, 2022).

Despite their importance, mangroves remain among the most threatened ecosystems worldwide. Roughly one-third of the mangrove extent has been lost in the past fifty years due to overexploitation, land conversion, and coastal management (Gouvêa *et al.*, 2022). In regions across Asia, Africa, and South America, mangroves have historically been harvested for fuelwood, charcoal, and construction materials, shifting from a major livelihood source to mainly subsistence use (Hamza *et al.*, 2024). In the Philippines, mangrove degradation is further accelerated by coastal development, logging, climate change impacts, and conversion of mangrove areas for aquaculture and agriculture (Feller *et al.*, 2017; Mendoza, 2017). Moreover, patterns of dependence and exploitation vary across regions. In Davao del Norte, most coastal residents reportedly avoid destructive harvesting for fuelwood and charcoal because of their awareness of existing environmental regulations (Alimbon and Manseguiao, 2021). Conversely, other areas struggle to rehabilitate mangrove forests because of ongoing pressures from aquaculture development, which remains the leading driver of mangrove degradation (Garcia *et al.*, 2013). In Cebu Island, anthropogenic pressures likewise contributed substantially to mangrove degradation. Local coastal communities utilized various mangrove species for construction poles, fences, forage, and houses, as well as for fuelwood, thereby intensifying resource extraction and habitat disturbance (Lillo and Buot, 2016).

Although mangroves provide essential ecological, cultural, and economic benefits, significant knowledge gaps remain; the absence of site-specific information continues to constrain effective conservation planning and livelihood-support strategies (Dencer-Brown *et al.*, 2018). In Basilan Province, Philippines, mangrove forests are vital for sustaining local communities, yet information on their status, threats, and management is limited. This study documents the condition and pressures on mangroves in three barangays of Malamawi Island and evaluates existing community and local government level management efforts, providing baseline data to guide future coastal planning and an island-wide mangrove management strategy. The ecological information produced through this study contributes to protection, restoration, and evidence-based management efforts, aligning with global targets under SDG 14.2 for coastal ecosystem conservation, SDG 15.1 for the sustainable management of wetland and forest habitats, and SDG 13.1 for strengthening community resilience.

MATERIALS AND METHODS

Sampling area

Malamawi Island lies within the coast of Basilan, at the coordinates 6°43'53.0"N, 121° 57' 47.9"E (Fig. 1),

with a land area of approximately 1,754 ha and an estimated coastline length of 18.33 km (PhilAtlas, 2020). The island is composed of six barangays, but only three were selected as sampling sites due to their distinct mangrove forest types: the riverine mangroves in Barangay Marang-Marang (Fig. 2a), the fringe mangroves in Barangay Diki (Fig. 2b), and the basin mangroves in Barangay Panigayan (Fig. 2c) (Pototan *et al.*, 2020).

Fig. 1. Study site map of the selected barangays in Malamawi Island, Basilan, Philippines (generated using QGIS 3.36.3)

Fig. 2. Sampling sites in Malamawi Island: (a.) Marang-Marang, (b.) Diki, (c.) Panigayan

Barangay Marang-Marang contains about 217 ha of mangrove forest, bordered by reef flats and seagrass beds. Barangay Diki, on the other hand, has an estimated mangrove area of 143 ha, situated adjacent to seagrass beds and coral reefs along its seaward boundary. Barangay Panigayan covers approximately 118 ha and is surrounded by man-made fishponds with a muddy substrate.

Entry protocol and permits

All research activities were conducted in accordance with national and institutional ethical guidelines. A Wildlife Gratuitous Permit (No. IX-2025-08) was obtained from the Department of Environment and Natural Resources (DENR) Region IX Office in Balintawak, Pagadian City, Zamboanga del Sur. Additional research authorizations were obtained from the City Mayor and Barangay Chairpersons of the selected sampling sites to authorize the conduct of social assessment and sample collection. Ethical clearance (E.O. No. 00006-2024) and Board of Regents (BOR) Resolution No. 161, s. 2023 was secured from the University Ethics Review Board (UERB) through the MSU-IIT Research Integrity and Compliance Office. All research activities were carried out in accordance with the National Ethical Guidelines for Research Involving Human Participants (NEGRIHP) 2022 and relevant national and international standards. Informed consent was obtained from all participants prior to data collection, and responses were recorded, tabulated, and maintained in strict anonymity.

Field observation

To document the status and condition of mangrove forests in the three selected barangays, data were collected through direct observation, photo documentation, and key informant interviews (Rahmadi *et al.*, 2023). Fieldwork was conducted from July to August 2024.

Coastal threats identification

Coastal threats were assessed using a transect-walk approach. In each transect, all observable disturbances and anthropogenic activities were recorded. These included tree cutting, fishpond conversion, accumulated marine debris, extraction of firewood, establishment of beach resorts, construction of bridges, harvesting of trunks for posts and fencing, and charcoal production.

These observations were used to categorize and compare types of threats across sites following the procedures described by Gonzalez *et al.* (2022).

Key informant interviews

Participants were selected based on their familiarity with mangrove use and local governance. A total 15 key informants were selected and interviewed; 2 representatives for the City Agriculture office, 7 barangay officials including the barangay chairman of

each barangays, and 6 from the local residence (i.e. gleaners, local elders, fisherfolks) across the sampling area. Interviews focused on their perceived importance of mangroves, the existing management policies, enforcement practices, resource extraction, community compliance, and perceived challenges in preserving the mangrove forests of the island. Semi-structured interviews were conducted, incorporating open-ended questions on regulations, common violations, negative impacts, and suggested management strategies, along with a Likert scale to assess the perceived importance of mangroves.

RESULTS AND DISCUSSION

Status of the mangrove forest of Malamawi Island, Basilan

The mangrove forest of Malamawi Island exhibited notable species diversity across its 478 ha. area. It encompassed several mangrove species, including *Aegiceras floridum*, *Bruguiera cylindrica*, *Ceriops tagal*, *Excoecaria agallocha*, *Lumnitzera littorea*, *Lumnitzera racemosa*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Scyphiphora hydrophylacea*, *Sonneratia alba*, and *Xylocarpus granatum* (Table 1).

Table 1. Mangrove species composition and their conservation status across three sampling sites in Malamawi Island, Basilan

Family	Scientific name	Conservation status	DENR Administrative Order
Combretaceae	*Lumnitzera littorea* (Jack) Voigt.	Least concern	Not yet assessed
	Lumnitzera racemosa Willd.	Least concern	Not yet assessed
Euphorbiaceae	*Excoecaria agallocha* L., Syst	Least concern	Not yet assessed
Lythraceae	*Sonneratia alba* J. Smith	Least concern	Not yet assessed
Meliaceae	*Xylocarpus granatum* Koen	Least concern	Not yet assessed
Myrsinaceae	*Aegiceras floridum* Roem. And Schult.	Near threatened	Not yet assessed
Rhizophoraceae	*Bruguiera cylindrica* (L.) Blume	Least concern	Not yet assessed
	Ceriops tagal (Perr.) C.B. Rob.	Least concern	Not yet assessed
	Rhizophora apiculata Blume.	Least concern	Not yet assessed
	Rhizophora mucronata Lam.	Least concern	Not yet assessed
	Rhizophora stylosa Griff.	Least concern	Not yet assessed
Rubiaceae	*Scyphiphora hydrophyllacea* C.F Gaertn.	Least concern	Not yet assessed

Note: IUCN Red List Threatened Species 2021-3 (Manual *et al.*, 2022); DAO 2017-11 (https://www.philippineplants.org/dao-2017-11.pdf)

Among these species, *A. floridum* was classified as Near Threatened (NT), whereas the remaining identified species were considered Least Concern (LC) under the International Union for Conservation of Nature (IUCN) Red List (Ellison *et al.*, 2010). The twelve mangrove species recorded in the area had not yet been assessed under the Philippines Department of Environmental and Natural Resources Administrative Order 2017-11.

Perceived mangrove local importance

Most respondents in Malamawi Island indicated the importance of mangroves on a 1–5 scale (Fig. 3), with the majority assigning a score of 5 (very important) because they protected homes, provided food and livelihood, prevented erosion, supported biodiversity, and ensured resources for future generations; others scored 4 (important) for reducing flooding, supplying resources, and offering moderate coastal protection, while some assigned 3 (moderately important), recognizing benefits to fisheries and wood, though not used daily. Similarly, the residents of Baler, Aurora recognize the importance of mangroves for coastal protection during frequent typhoons, water filtration, soil stabilization, and as a nutrient-rich nursery supporting high marine biodiversity, which they utilize as an additional source of food and income (Reciproco *et al.*, 2023). In addition, mangroves served as natural barriers that reduced waves, wind, and coastal erosion, protecting nearby communities from storms and sea-level rise and highlighting their importance in coastal management (Rahmadi *et al.*, 2023). Thus, this result reflects high awareness of the locals on mangrove contribution in protecting their communities from natural disturbances such as

waves, typhoons, and flooding and erosion, as well as the importance of the forest as their secondary source of resources such as fisheries products, construction materials, and fuelwoods.

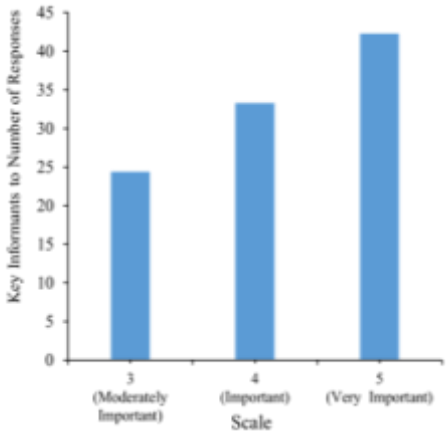

Fig. 3. Key informants' rating (1-5) of mangrove importance in Malamawi Island

Coastal threats in the mangrove forest communities of Malamawi Island, Basilan

A total of five major coastal threats were recorded across the three barangays sampled in Malamawi Island (Table 2; Fig. 4). Although the specific stressors varied by site, infrastructure development was the most consistently observed disturbance. In Marang-Marang, charcoal production was widespread. Residents reported that mangrove wood is preferred for charcoal because it burns longer than other fuel sources and provides a source of income. Mangroves were also used to construct footbridges connecting Marang-Marang and Diki, providing residents with easier access to school, work, and neighboring barangays. In Diki, the most common threat was the accumulation of household garbage under stilt houses. This was followed by the construction of houses and bridges using mangrove wood. Abandoned fishponds were also observed, while some residents collected mangrove firewood for cooking. In Panigayan, mangrove cutting was the primary disturbance, with wood being used for beach cottages, fences, boat shelters, bridges, and house repairs. Residents reported that they were permitted by barangay officials to collect limited amounts of mangrove wood. Garbage accumulation was also present near the forest area.

Table 2. Checklist of coastal threats in mangrove forest communities of Malamawi Island, Basilan, Philippines

Barangay	Cutting for other uses	Fishpond	Garbage	Infrastructure	Charcoal	Firewood
Marang-Marang	✓	✓	-	✓	✓	-
Diki	✓	✓	✓	✓	-	✓
Panigayan	✓	-	✓	✓	-	-

Note: (✓) threats observed across the three sites, (-) no threats observed

Fig. 4. Captured threats in mangrove forest of Malamawi Island, Basilan, Philippines which includes (a) cutting of trees, (b) fishpond conversion (c) washed out garbage, (d) firewood collection, (e) beach cottages/resort, (f) bridge, (g) cut trunk for post or fence, (h) charcoal making

These findings show that the mangrove forests of Malamawi Island are under continuous pressure from human activities. The frequent cutting of mangroves for the construction materials (e.g., bridges, beach cottages, house repair, fence posts, boat repair), along with the clearing of mangrove area for board walk, road network, residential structures, and various subsistence and livelihood uses such as charcoal production, firewood collection, access path clearing and aquaculture or fishpond expansion indicates a high dependence on mangrove resources and weak enforcement of protection laws. The presence of garbage, abandoned fishponds, and unregulated harvesting also suggests limited waste management and poor local resource management. If these threats continue, the ecological condition of the mangrove ecosystem and the important benefits it provides, such as coastal protection, habitat for wildlife, and support for community livelihoods, will continue to decline. Similarly, a study in Sarangani Province found that residents harvested mangroves for fuelwood, charcoal, and timber (Agduma *et al.*, 2023), while in other coastal communities, the accumulation of garbage around mangroves has been identified as a direct threat to both mangrove health and the marine organisms that depend on these ecosystems (Rahmadi *et al.*, 2023). In Cebu Island, similar anthropogenic pressures contributed to mangrove degradation, including illegal cutting for fuelwood and charcoal, gathering leaves and branches for forage, improper waste disposal, debarking trees for tan bark, and coastal reclamation (Lillo *et al.*, 2022). In the Philippines, the harvesting of all mangrove species is prohibited under the Revised Forestry Code, and the conversion of mangrove areas for fishponds or any other use is illegal according to Republic Act No. 10654 (Alimbon *et al.*, 2021).

Despite the implementation of management measures in Malamawi Island, unsustainable harvesting and fishpond expansion continue to occur, violating the Philippine Mangrove Greenbelt Law. Although the Philippines has multiple laws intended to protect mangrove ecosystems, these regulations are spread across various presidential decrees and administrative orders, resulting in fragmented enforcement and limited coordination among responsible agencies. As a consequence, mangrove areas are often cleared or damaged in favor of development and profit, leading to long-term ecological and social consequences (John Costenbader, Ed.).

Mangrove forest conservation initiatives

The mangrove forest management initiatives in the 3 barangays of Malamawi Island includes reforestation activities through the establishment of mangrove nurseries (Fig. 5), organized tree-planting led by local government units and community members, and community-based tourism.

Fig. 5. Mangrove nursery in Malamawi Island facilitated by the agriculture office of Isabela City, Basilan

The mangrove nursery is maintained by the City Agriculture Office of Isabela City, Basilan, which supports ongoing reforestation efforts across the island. These local seedlings are used in the conduct of community tree-planting activities across the province, fostering local biodiversity conservation. Similar results were reported in the study in Davao City, which showed a strong community involvement in mangrove initiatives, with residents actively collecting seedlings, participating in planting activities, and monitoring the proper establishment of newly planted trees, reflecting a shared sense of responsibility toward mangrove conservation (Jadloc *et al.*, 2025).

In addition to reforestation initiatives, the local government utilized their mangrove forests for community-based tourism activities. Situated in a

tranquil mangrove area near the Port of Isabela, the Marang-Marang Floating Cottages incorporated eco-friendly practices by using locally sourced materials such as bamboo and nipa palm and employing waste management systems to protect the surrounding mangrove environment. The project also involved local women in managing and operating the cottages, thereby enhancing livelihoods while supporting the preservation of cultural heritage (Chatterjee, 2025). These efforts of the Marang-Marang Women's Association (MMWA) received the ASEAN Community-Based Tourism Award for 2025 for its leadership in community participation, sustainability, and cultural preservation (Villareal, 2025).

Mangrove forest management assessment

The management of mangrove forests in Malamawi Island involves several approaches as identified by key informants: First, the Local Government (LGU) of Isabela City imposed a strict implementation of "no permit, no cutting" policy, in accordance with the Philippine Fisheries Code of 1998, where Section 71 of Republic Act 7161 prohibits the commercial cutting of all mangrove species for timber or firewood (Pulhin *et al.*, 2017). Residents who cut mangroves without authorization are fined Php 500 (USD 9) for every mangrove tree cut. Consequently, most residents comply, valuing mangrove protection for their subsistence uses, including medicinal collection, and for coastal protection during typhoons and flooding. While collection of dead trees for charcoal is permitted.

Second, stricter penalties are imposed on non-residents who illegally harvest mangroves. Individuals caught poaching will be fined Php 10,000 (USD 180) or face imprisonment, in accordance with the Revised Forestry Code, which bans the harvesting of all mangrove species (Alimbon *et al.*, 2021). Informants noted that this higher cost of penalty is imposed since most of the violators are outsiders poaching their resources.

Third, mangrove areas serve as important gleaning grounds for coastal communities, where collecting marine invertebrates provides both a source of livelihood and food security (Sahidjan *et al.*, 2025). In Marang-marang, gleaning is regulated due to observed overharvesting of macroinvertebrates affecting their species composition and overall ecological dynamics. The overharvesting of gleaned mangrove resources in Marang-marang is particularly driven during the period of heightened tourism activity in the area, highlighting the need for improved monitoring and adaptive management interventions.

Lastly, the local government unit established a mangrove nursery to support reforestation and rehabilitation efforts, reflecting similar observations reported by Reciproco *et al.* (2023), who documented the need for mangrove management interventions and extension programs in coastal areas of Baler, Aurora. Such initiatives are particularly important for restoring fragmented mangrove areas affected by past charcoal production and harvesting for construction/ housing materials, especially for the case of Panigayan mangrove forest.

Among the existing regulations on mangrove extraction in Malamawi Island, the barangay permit requirement was the most recognized (35.6%), followed by the anti-illegal cutting ordinance (31.3%). Mangrove reforestation (13.3%) and the establishment of mangrove nurseries (11.1%) were less frequently cited, while the gleaning ordinance was the least recognized (8.9%) (Fig. 6). This suggests that formal regulatory measures, such as permits and anti-cutting laws, are more prominent in the community's awareness than restoration and management initiatives. The high awareness of permit requirements and anti-illegal cutting ordinances indicates that these rules are more visible and likely frequently enforced. Likewise, these regulations could be actively participated in by local residents hence making this high-ranked form of community involvement in mangrove management (Reciproco *et al.*, 2023). In contrast, the low recognition of reforestation programs, nurseries, and gleaning ordinances highlights the need for increased community engagement, education, and promotion of

active mangrove restoration and sustainable use practices.

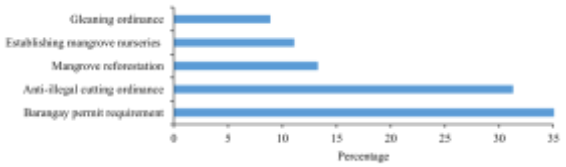

Fig. 6. Existing regulations or resolution from the LGU and barangay on mangrove extraction in Malamawi Island

Meanwhile, respondents suggest that an effective mangrove management in Malamawi Island should focus on combining livelihood support (28.9%) and education (24.4%) to encourage community participation, complementing with strict law enforcement (11.1%), regular forest monitoring (20%), and ecotourism initiatives (15.6%)(Fig. 7). These findings are consistent with previous studies, which recognize mangrove management as a strategy to conserve ecosystems while sustaining the livelihoods of adjacent communities, involving interventions such as natural mangrove protection, regular maintenance, mangrove planting, nursery establishment, and educational programs on the ecological and socioeconomic importance of mangroves (Reciproco *et al.*, 2023).

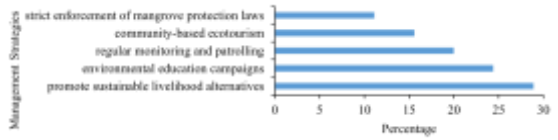

Fig. 7. Suggested management strategies for mangrove forest in Malamawi Island

While the communities' shared commitment to restore and conserve their mangrove ecosystems through these participatory management dynamics could empower locals in their responsibilities as resource users and managers of the mangroves, thus enhancing long-term success of such conservation initiatives (Garcia *et al.*, 2013), the mangrove forest management of the island remains challenged by institutional and structural constraints.

The involvement of multiple stakeholders (i.e. local government units, barangay government units, provincial tourism office, private resort owners, private fishpond owners, local community resource users, organized group i.e. MMWA, unorganized groups e.g. gleaners, charcoal makers, and others), often with overlapping interests and responsibilities, leads to coordination difficulties, inefficient resource allocation, and fragmented implementation of conservation programs. Limited logistical and financial resources further constrained the scope and effectiveness of conservation initiatives. In addition, legal and policy frameworks governing mangrove conservation were frequently poorly enforced, further complicating management efforts. Compounding these challenges was the lack of comprehensive data on the ecological and economic value of mangrove forests, which hindered informed decision-making and the development of context-specific management strategies (Rahmadi *et al.*, 2023).

CONCLUSION

The mangrove forests of Malamawi Island, Basilan, play a critical role in sustaining coastal biodiversity and supporting local livelihoods. Despite the presence of diverse mangrove species, these forests were increasingly threatened by fishpond conversion, garbage accumulation, charcoal production, firewood collection, and infrastructure development such as resorts, houses, bridges, and tourism facilities. Although community-led restoration efforts, mangrove nurseries, local ordinances related to mangrove, and tree planting were already in place, field observations indicate that unregulated wood and mangrove faunal harvesting and fishpond conversion continue to occur. These pressures heighten the island's vulnerability to climate-related hazards and contribute to the gradual decline of fisheries and other ecosystem services. Addressing these challenges requires the strict enforcement of laws governing mangrove protection, restoration, and aquaculture practices, alongside the active participation of local communities as key stakeholders. Collaboration between government

agencies, non-governmental organizations, and residents enhances awareness of mangrove importance, provides alternative livelihoods, and supports monitoring and restoration initiatives. Long-term sustainability of mangrove ecosystems and preservation of their biodiversity depend on integrated management strategies that strengthen legal frameworks, recognize the ecological and economic value of mangroves, ensure adequate resource allocation, and promote public awareness.

RECOMMENDATION(S)

Future mangrove conservation programs should prioritize strengthening education and awareness of the ecological and economic importance of mangroves. Local communities should be actively involved in managing these resources, supported by training, technical guidance, and alternative livelihood opportunities. Conservation initiatives should integrate research, education, and coordinated action across local and institutional levels to be more effective and sustainable.

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