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Mangrove forest composition, diversity, and disturbances in Carcar City and Sibonga Municipality, Southern Cebu Island, Philippines

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[1]Department of Forestry, College of Agriculture, Forestry and Environment. Cebu Technological University Argao. Argao Campus, Argao 6021, Cebu, Philippines. Tel.: +63-32-4858290, ♥email: lillo.edgardopabia@gmail.com

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Abstract. *Lillo EP, Malaki AB, Alcazar SMT, Chavez MLM, Rosales R, Tomol CJ, Pantinople EM, Redoblado BR, Margate MA, Diaz JL, Isabelo JL, Cagara BNR, Abrigana M, Mago JE, Cañarijo III DM, Sanchez IRG, Obando ME, Belañizo J, Beceril R, Carreon J, Diaz GGG, Gonzaga CFO, Davirao CR, Revillas MJS, Lim JM, Lillo EP. 2024. Mangrove forest composition, diversity, and disturbances in Carcar City and Sibonga Municipality, Southern Cebu Island, Philippines. Biodiversitas 25: 2035-2043.* Mangrove forests are one of the world's most vulnerable tropical ecosystems. The study assessed the mangrove forest composition, diversity, and disturbances in Sibonga Municipality and Carcar City, Cebu Island, Philippines, as a basis for its conservation planning. A transect line was established for a minimum length of 1000 m and a maximum of 2000 m (seaward, middleward, and landward), at an interval of 100 meters. A 10 × 10 m quadrant was established within the transect line at 250 m intervals resulted in a total of 108 plots. Disturbances and threats in two sampling sites were evaluated through direct field observations and interview, and analyzed using the Beynen and Townsend disturbance index. The study identified 22 true mangrove species categorized into 11 families and 14 genera with *Excoecaria agallocha* L., *Sonneratia alba* Sm., *Rhizophora apiculata* Blume, and *Avicennia marina* (Forssk.) Vierh dominating both sites. The endangered *Pemphis acidula* J.R.Forst. & G.Forst. was recorded in Sibonga. Aside from low diversity, both sites exhibited a high disturbance index due to illegal activities such as cutting, charcoal production, and land conversion. Such disturbances affects biodiversity and threatens coastal community. Urgent local government action is needed to preserve these ecosystems, emphasizing awareness and community involvement for long-term survival.

Keywords: Coastal community, mangrove ecosystem, mangrove species, protection, Rhizophora

INTRODUCTION

Mangroves are unique coastal ecosystems that bestow a myriad of goods and services, playing a pivotal role in sustaining lives and securing the well-being of coastal communities. Remarkably, despite accounting for less than one percent of all tropical forests worldwide, mangroves offer a wealth of invaluable ecosystem services (UNEP 2014). Mangroves deliver cultural ecosystem services, ranging from tangible benefits like recreation to intangible qualities like aesthetic appeal and spiritual values (James et al. 2013; Thiagarajah et al. 2015; Spalding and Parrett 2019). Beyond their cultural significance, mangroves play a pivotal role in providing ecological services, serving as habitat for numerous terrestrial and marine species, a rich source of food and shelter, and a critical site for fertilization of various aquatic fauna, contributing to extraordinary biodiversity (Kumari et al. 2020). Moreover, mangroves serve as natural fortifications, protecting lives and property in vulnerable coastal areas during natural disasters such as storms (Mahmud et al. 2022). They also fulfill various regulatory functions, including coastal protection (Ranjan 2019), pollutant filtration, macroclimate regulation, and mitigating of global climate change through carbon storage and sequestration (Adame et al. 2013).

Despite their vital ecological and socio-economic significances, mangroves have experienced significant loss and degradation (Carrie et al. 2022), which has dire consequences for coastal ecosystems, biodiversity, and community resilience (Hai et al. 2020). Alarming trends of mangrove loss persist in the Philippines the rate of losing mangroves is up to 50% (Gevaña et al. 2019). Approximately 356,000 hectares of mangrove forests exist, but they are experiencing a decadal deforestation rate of 0.5 percent (Gevaña et al. 2018). As a result, more number of mangrove forest are on the brink of complete collapse (Gevaña et al. 2019). Overexploitation of forest wood products, pollution, and conversion to other land uses have been identified as the primary causes of this devastation (Murray 2012).

Effective management of mangrove forests is essential for their long-term sustainability. Therefore, to comprehend the status of mangroves and facilitate biodiversity conservation, it is imperative to conduct floristic surveys and diversity assessments (Jayakumar 2019). Knowledge of mangrove species composition and diversity is crucial for understanding their carbon storage potential and devising effective climate change mitigation strategies and sustainable coastal management (Adame et al. 2013).

However, despite the urgent need for this knowledge, Cebu Island, Philippines particularly the Sibonga Municipality and Carcar City, remains unexplored regarding the data on mangrove species composition, diversity, and disturbances. While there have been some studies in the nearby regions, such as Camotes Island, which identified 31 true mangrove species (Lillo et al. 2022), and Argao, Cebu, which reported 22 species (Lillo and Buot 2016), no scientific journal has published data on mangrove species in Sibonga and Carcar. Remarkably, this area which is situated in the southern part of Cebu Island encompasses nearly 245 hectares, a larger expanse than the Municipality of Argao, Cebu.

Understanding the composition, diversity, and disturbances of mangrove forest in Sibonga and Carcar is paramount. This knowledge will facilitate strategically matching of species to sites for reforestation and restoration efforts. Identifying the species that naturally thrive in the region will significantly enhance the success and effectiveness of such initiatives, thus aiding in the restoration of degraded mangrove habitats (Lillo et al. 2022; Lillo and Buot 2016). Moreover, it will provide essential guidance for formulating of appropriate management strategies (James et al. 2013). Besides these imperatives, this study aims to uncover the composition and diversity of mangrove species in the Sibonga Municipality and Carcar City, Cebu, Philippines, serving as a fundamental basis for comprehensive conservation planning.

MATERIALS AND METHODS

Study area and period

The study was conducted in the mangrove forest of the Sibonga Municipality and Carcar City in the southern part of Cebu Island, Philippines (Figure 1). Sibonga is located at coordinate of 10.0431°N; 123.5952°E, with a total mangrove area of 188.35 ha. This municipality has a larger intact mangrove forest than the municipality of Argao (Lillo and Buot 2016). While, Carcar is 4.1 km from Sibonga, which is located at coordinate of 10.0542°N; 123.6036°E, with a total mangrove area of 56.16 ha. Its intact mangrove forest was smaller than that of Sibonga. However, these two intact mangrove forests were connected, leading to one larger area, serving as a habitat for more marine organism. The study spanned the initial two quarters of the calendar year 2023.

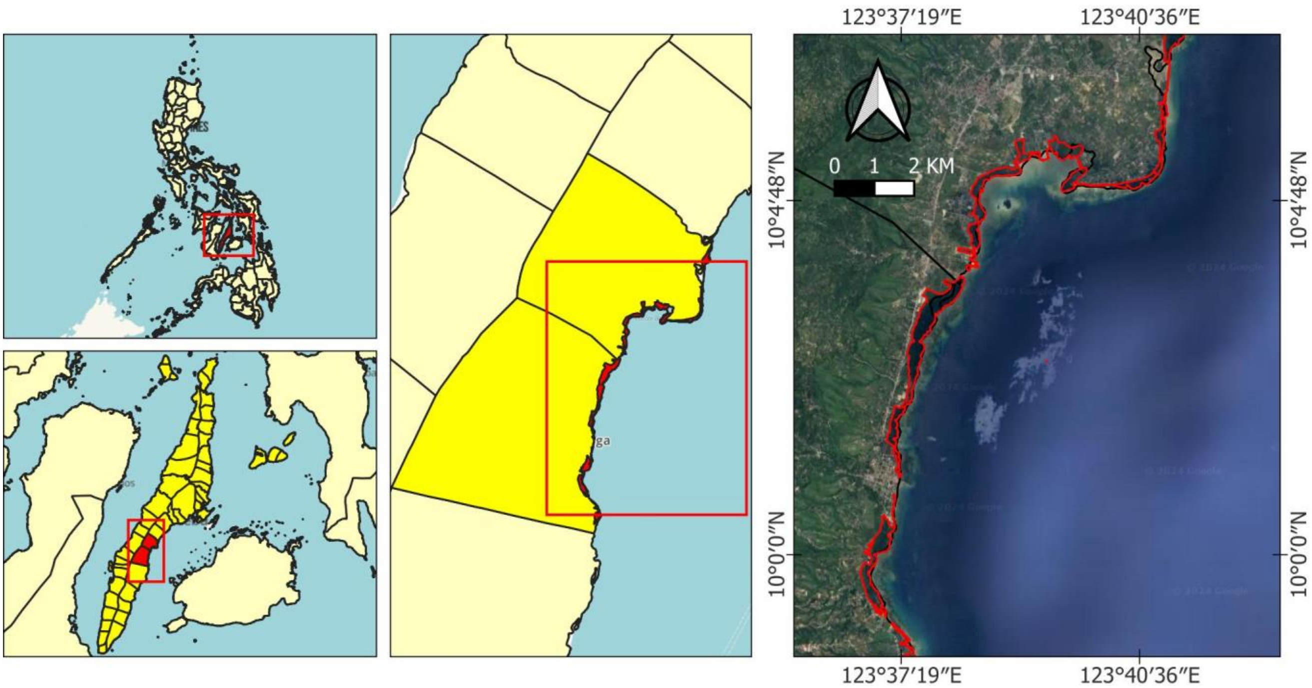

Figure 1. Map showing the study area in mangrove forest of the Sibonga Municipality and Carcar City, Cebu Island, Philippines

Data collection procedure

A belt-in-line transect method was used in the study. This method offered valuable insights into the mangrove ecosystem's composition and health (Lillo et al. 2022). To comprehensively sample the area, three line transects with a minimum length of 1000 m and a maximum of 2000 m were established (landward, middle, and seaward) in each sampling site at an interval of 100 m (Lillo et al. 2022). Quadrats of 10 x 10 m dimension were then established within the transect line, at an interval of 250 m, to 108 plots/quadrats for 12 transect lines, representing 10% of the total area of the two sampling sites. The plant species present in the quadrats were documented and identified using the taxonomy system outlined by Primavera and Sadaba (2014). The sample specimens were also verified from manuals, herbarium, and online literature (Co-digital flora of the Philippines, and others) to identify the species accurately.

The species' conservation status was determined based on the Department of Environment and Natural Resources Red List of Threatened Species (DENR-DAO 2017-11) and the IUCN Red List (IUCN 2023-1). This inclusive approach ensures a robust evaluation of the species' conservation requirements.

For trees with a diameter of 10cm and above, crucial measurements were conducted to gauge their ecological significance. Diameter Breast Height (DBH) was meticulously measured in centimeters (cm), utilizing both diameter tape for larger trees and tree calipers for smaller ones. Moreover, the total height of these trees was quantified in meters (m) using an Abney hand level. The computation of basal area (m^2) for relative dominance analysis adhered to the DENR formula (basal area = 0.7854 D^2), providing a comprehensive understanding of species dominance within the ecosystem.

Human-induced perturbations within the mangrove forest were diligently evaluated through direct field observations by the research team. These observations were subsequently corroborated through a two-pronged approach: Focused Group Discussions (FGD) and Key Informant Interviews (KII) involving local coastal residents. This multi-faceted approach ensures the accurate identification and verification of disturbances, contributing to a nuanced comprehension of the anthropogenic impacts on the mangrove ecosystem.

Data analysis

All data collected during the field surveys were recorded and stored in a structured microsoft excel database. The Shannon Diversity Index (H') and Simpson Diversity Index were computed using the Multi-Variant Statistical Package (MVSP) software to assess species diversity (Lillo and Fernando 2017).

Vegetation analysis was performed using various indices, including Density, Relative Density, Dominance based on Basal Area, Relative Dominance, Frequency, Relative Frequency, and the Importance Value Index (IVI). The IVI was calculated to assess the ecological significance of individual species in the entire mangrove community. The ecological importance of each species concerning the total forest community was calculated by summing its Relative Density, Relative Dominance, and Relative Frequency. Species diversity and vegetation analysis provide valuable insights into the intricate forest ecosystems dynamics (Lillo and Fernando 2017). Diversity metrics were utilized to gain insights into the complex dynamics of the mangrove ecosystems in Sibonga and Carcar, Cebu, Philippines. The Beynen and Townsend (2005) disturbance index was utilized to evaluate the impact of disturbance and threats on mangrove forest in Sibonga and Carcar.

RESULTS AND DISCUSSION

Species composition

The study revealed, 33 mangrove species recorded in the two sampling sites. Of the 33 mangrove species, 22 were considered true mangrove (Table 1, Figure 2) and 11 were mangrove associate (Table 1). The twenty-two (22) true mangrove species (belonging to 11 families and 14 genera) were equivalent to 54% of the 39 true mangroves in the Philippines (Sinfuego and Bout 2014). Of 22 true mangrove species, 16 were recorded in Carcar, and 20 in Sibonga (Table 1). The result of the study similar to a study in Taloot, Argao, which found 22 true mangrove species (Lillo and Buot 2016), but is lower compared to the number of true mangrove species identified on Camotes Island with 31 (Lillo et al. 2022) and on Palawan Island with 23 (Dangan-Galon et al. 2016). However, the result is higher than that in Dinagat Island with 10 species, 8 families and 9 genera (Lillo and Fernando 2017). The result of the study signifies that Carcar and Sibonga mangrove forest provides an environment, ecosystem or habitat for different kinds of mangrove species.

Rhizophoraceae was the most represented family, and *Rhizophora* was the most dominant genera. The dominant species were *Sonneratia alba* Sm., *Rhizophora apiculata* Blume and *Avicennia marina* (Forssk.) Vierh. These dominant species were present at all the sampling sites. The study results compliment Raganas and Magcale-Macandog (2020) findings that *Sonneratia alba* Sm, together with *Rhizophora apiculata* Blume and *Avicennia marina* (Forssk.) Vierh grow in ecotypes with medium to higher salinities, such as in estuarine and seaward zones.

The presence of *Pemphis acidula* J.R.Forst. & G.Forst highlighted the result of the study; categorized as an endangered species from the DENR redlist (DENR-DAO 2017-11) and the IUCN Red List (IUCN 2023-1). The species was recorded only in Sibonga. The presence of this endangered species underscores the ecological significance and vulnerability of this mangrove ecosystem, necessitating the implementation of conservation efforts to protect not only *P. acidula* but the entire mangrove ecosystem in Sibonga and Carcar. In addition, it is essential to recognize these mangrove forests significance as they provide shelter and sustenance for various species of flora and fauna.

Table 1. List of species recorded in the studied area in Carcar City and Sibonga Municipality, Cebu Island, Philippines

Family name	Species name	Common name	Sampling site	
			Carcar	Sibonga
True mangroves species				
Acanthaceae	*Avicennia marina* (Forssk.) Vierh.	Bungalon	●	●
Combretaceae	*Lumnitzera littorea* (Jack) Voigt	Kulasi	●	●
	Lumnitzera racemosa Willd	Tabao	●	●
Euphorbiaceae	*Excoecaria agallocha* L., Syst	Buta-buta		●
Lythraceae	*Pemphis acidula* J.R.Forst. & G.Forst	Bantigi		●
	Sonneratia alba Sm.	Pagatpat	●	●
Meliaceae	*Xylocarpus granatum* Koen	Tabigi		●
	Xylocarpus moluccensis (Lam.) M.Roem	Piag-ao		●
Myrtaceae	*Osbornia octodonta* F. Muell.	Tawalis		●
Nypoideae	*Nypa fruticans* Wurmb	Nipa	●	●
Primulaceae	*Aegiceras corniculatum* (L.) Blanco	Saging-saging	●	●
Pteridaceae	*Acrostichum speciosum* Willd	Palaypay	●	●
Rhizophoraceae	*Bruguiera cylindrica* (L.) Blume.	Pototan	●	
	Bruguiera gymnorhiza (L.) Savigny in Lam	Busain	●	●
	Bruguiera parviflora (Roxb.) Wight & Arn. ex Griff	Langarai	●	●
	Ceriops tagal (Perr.) C.B.Rob	Tangal	●	●
	Ceriops zippeliana Blume.	Baras-baras	●	●
	Rhizophora apiculata Blume.	Bakhaw lalaki	●	●
	Rhizophora lamarckii Montrouz.	Bakhaw lamarki	●	
	Rhizophora mucronata Poir.	Bakhaw babae	●	●
	Rhizophora stylosa Griff.	Bakhaw bato	●	●
Rubiaceae	*Scyphiphora hydrophylacea* C.F.Gaertn	Nilad	●	
Sub-Total:			16	20
Associated species				
Anacardiaceae	*Spondias purpurea* L.	Seneguelas		●
Arecaceae	*Cocos nucifera* L.	Coconut	●	●
Asteraceae	*Chromolaena odorata* Linn.	Hagonoy	●	●
Combretaceae	*Terminalia catappa* L.	Talisay		●
Euphorbiaceae	*Euphorbia tirucalli* L.	Trucali	●	●
Fabaceae	*Leucaena leucocephala* (Lam.)	Ipil-ipil	●	●
	Pithecellobium dulce (Roxb.) Benth	Kamatchile		●
	Tamarindus indica L.	Sambag	●	●
Rhamnaceae	*Colubrina asiatica* L. Brongn	Mansanitas	●	●
Rubiaceae	*Morinda citrifolia* L.	Bangkoro	●	●
Verbenaceae	*Vitex parviflora* Juss.	Molave	●	●
Sub-total:			8	11
Grand total:			24	31

Note: ●: present

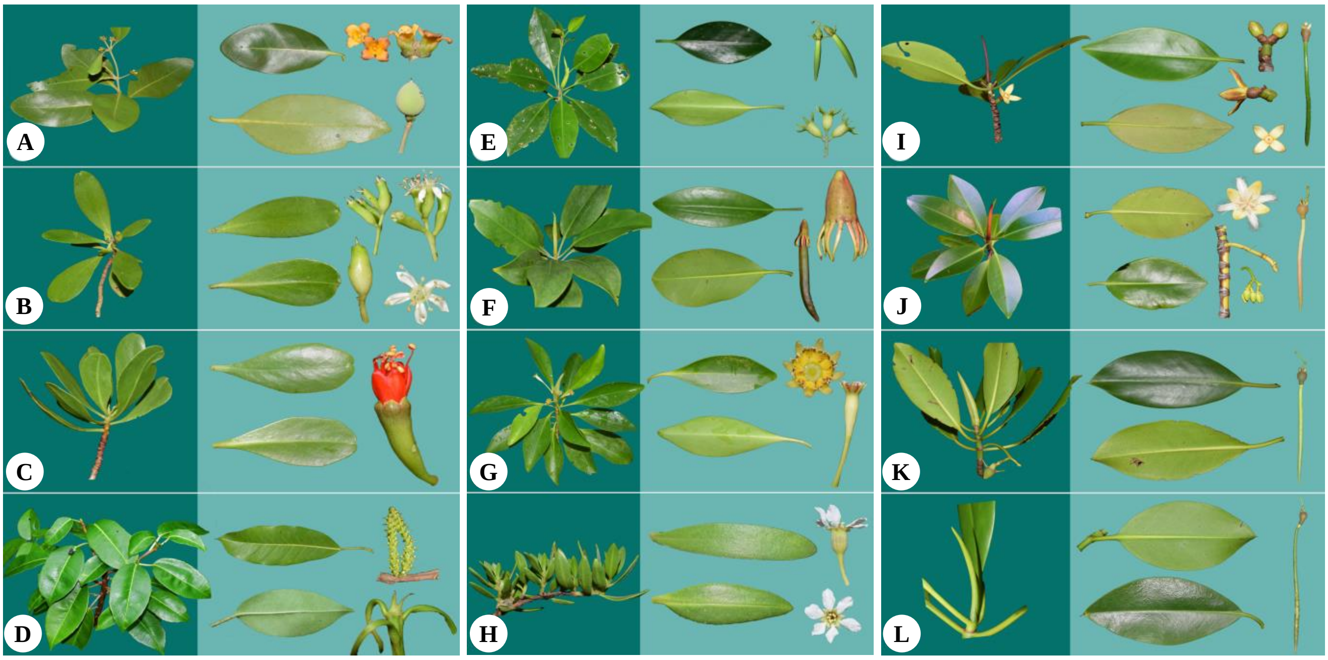

Figure 2. True mangrove species: A. *Avicennia marina* (Forssk) Veirh.; B. *Lumnitzera racemosa* Willd; C. *Lumnitzera littorea* (Jack) Voigt; D. *Excoecaria agallocha* L.; E. *Bruguiera cylindrica* (L.) Blume.; F. Bruguiera gymnorhiza (L.) Savigny in Lam; G. *Bruguiera parviflora* (Roxb.) Wight & Arn. Ex Griff; H. *Pemphis acidula* J.R.Forst. & G. Forst; I. *Rhizophora apiculata* Blume; J. *Rhizophora lamarckii* Montrouz; K. *Rhizophora stylosa* Griff; L. *Rhizophora mucronata* Lam (Photo by Marvin Margate and John Lou Diaz)

Species diversity

The diversity of species in a given ecosystem is a fundamental attribute that significantly influences ecosystem stability, productivity, and trophic structure (Lillo et al. 2019). Moreover, areas with high species diversity tend to host more stable and productive ecosystems (Lillo et al. 2022). Diverse communities are also known to provide a wider range of ecosystem services. This study examined the species diversity of mangroves in two distinct sampling sites: Sibonga and Carcar, with a particular focus on the implications for habitat conservation and ecosystem recovery.

Sibonga sampling site had the Shannon diversity index (H') of 1.965, indicating relatively low species diversity. Similarly, the Carcar sampling site yielded the diversity value of 1.785 (low species diversity). However, the Simpson's diversity index (D) revealed an opposing result, indicating high species diversity across all sampling sites. The divergence in these diversity indices results from their inherent sensitivities. The Shannon Diversity Index primarily sensitive to species diversity, whereas the Simpson diversity index is concerned more with the overall vegetation cover (Lillo et al. 2022). In this study, the Shannon Diversity Index will be given greater weight, as it aligns better with the research objectives.

Observations in both sampling areas highlight the significant impact of anthropogenic activities. Local communities have been utilizing mangrove trees for firewood, fishing posts, and as building materials for their homes (Salma and Bengen 2022). These practices have contributed to the low species diversity observed in both sites. Anthropogenic activities, such as deforestation, aquaculture development, pollution, coastal development, and unsustainable resource extraction, have been identified as major contributors to the decline in mangrove species diversity (Salma and Bengen 2022).

Therefore, to ensure the protection and conservation of mangrove species, the Local Government Units of Sibonga, and the City of Carcar must undertake proactive conservation efforts and educational campaigns within coastal communities. These initiatives can raise awareness among local residents about the critical importance of preserving mangrove ecosystems and encourage them to participate in their protection actively. These efforts extend beyond safeguarding the habitat and species. Restoring and conserving mangroves in Sibonga and Carcar can have far-reaching consequences for ecosystem recovery. Healthy mangrove ecosystems play a vital role in stabilizing coastal areas, providing breeding grounds for various marine species, mitigating the impacts of climate change, and supporting local livelihoods.

This study's, findings underscore the urgency of addressing the threats to mangrove species diversity in both Sibonga and Carcar. Through conservation and education initiatives, the local communities can become stewards of these invaluable ecosystems, contributing to habitat preservation and the broader goals of ecosystem recovery and sustainability.

Species density, dominance, frequency and Importance Value Index (IVI)

The Importance Value Index (IVI) serves as a pivotal ecological metric, enabling the assessment of the significance of various plant species within a defined ecosystem. In this context, a thorough evaluation of the IVI for mangrove species in Sibonga and Carcar offers essential insights into the dominant and critical species for the local ecosystem. This information holds paramount importance for prospective reforestation programs aimed at conserving and enhancing the mangrove forests on Cebu Island.

Notably, *Excoecaria agallocha* L., emerges as the most vital species at the two sampling sites, boasting an impressive IVI of 64.81 (Table 2). This species exhibits a substantial relative dominance but also distinguishes itself from other regions where different species dominate. This observation implies that *Excoecaria agallocha* L., is pivotal in shaping the ecological dynamics of Sibonga and Carcar mangrove ecosystem. However, this species exhibit a smaller diameter with a maximum measurements of 20 cm.

Sonneratia alba Sm (IVI: 39.05) and *Rhizophora apiculata* Blume (IVI: 35.46) also present notably high IVIs (Table 2), underscoring their ecological significance. Significantly, these species demonstrate dominance both in terms of relative dominance and relative frequency across all sampling plots, signifying their paramount role in maintaining the structural integrity of the mangrove ecosystem in Sibonga and Carcar. Alongside *Avicennia marina* (Forssk.) Vierh (IVI: 26.82), these dominant species become excellent candidates for reforestation initiatives due to their adaptability to the local environment (Raganas and Magcale-Macandog 2020).

Notably, these findings align with research in other regions, further emphasizing the ecological importance of certain mangrove species. For instance, the dominance of *Rhizophora apiculata* Blume, *Rhizophora mucronata* Poir., *Rhizophora stylosa* Griff., and *Sonneratia alba* Sm in Palawan Island's mangrove forest, as reported by Dangan-Galon et al. (2016), mirrors the dominance observed in Cebu Island. Similarly, the dominant species identified in Dinagat Island's mangrove forest, as highlighted by Lillo and Fernando (2017), exhibits similarities with those in Sibonga and Carcar. These consistencies across different regions underscore the broader ecological significance of these specific mangrove species.

This research implies that, for reforestation programs targeting mangroves in Cebu Island, especially in Sibonga and Carcar, the identified dominant and high IVI species, such as *Excoecaria agallocha* L., *Sonneratia alba* Sm., *Rhizophora apiculata* Blume., and *Avicennia marina* (Forssk.) Vierh., should be prioritized. These species have already proven their adaptability to the local environment, as evident in the area. However, in dealing with the species diversity of the area, the two sites should also be planted with other true mangrove species, considering on species zoning preferences (Primavera and Sadaba 2014). Planting these species can substantially enhance the region health and biodiversity of mangrove ecosystems. Furthermore, the success of these species in various regions suggests their suitability for broader mangrove restoration efforts (Raganas and Magcale-Macandog 2020, 2022).

A comprehensive understanding of the Importance Value Index, Dominance, and adaptability of mangrove species is indispensable for the success of reforestation initiatives. The research’s findings offer invaluable guidance on the specific species to target for mangrove conservation and restoration efforts on Cebu Island, particularly in Sibonga and Carcar. Ultimately, these efforts contribute significantly to preserving of this vital coastal ecosystem.

Table 2. Importance Value Index (IVI) of mangrove species in Carcar City and Sibonga Municipality, Cebu Island Philippines

Dominant species in both Sibonga and Carcar	Relative density	Relative dominance	Relative frequency	IVI
Excoecaria agallocha L., Syst	0.150	62.10	2.56	64.81
Sonneratia alba Sm.	29.474	1.88	7.69	39.05
Rhizophora apiculata Blume.	25.865	1.90	7.69	35.46
Avicennia marina (Forssk.) Vierh.	16.541	2.59	7.69	26.83
Lumnitzera littorea (Jack) Voigt	0.301	17.11	5.13	22.54
Rhizophora stylosa Griff.	9.624	1.80	7.69	19.12
Rhizophora mucronata Poir.	5.263	2.23	7.69	15.19
Ceriops zippeliana Blume.	3.759	0.65	7.69	12.10
Rhizophora lamarckii Montrouz.	4.662	0.09	5.13	9.88
Ceriops tagal (Perr.) C.B.Rob	0.752	2.29	5.13	8.17
Aegiceras corniculatum (L.) Blanco	0.752	0.52	5.13	6.40
Lumnitzera racemosa Willd	1.053	0.04	5.13	6.22
Bruguiera gymnorhiza (L.) Savigny in Lam	0.301	0.62	5.13	6.05
Bruguiera parviflora (Roxb.) Wight & Arn. ex Griff	0.301	0.62	5.13	6.05
Xylocarpus moluccensis (Lam.) M.Roem	0.150	2.01	2.56	4.73
Bruguiera cylindrica (L.) Blume.	0.150	0.89	2.56	3.61
Osbornia octodonta F. Muell.	0.150	0.89	2.56	3.61
Scyphiphora hydrophylacea C.F.Gaertn	0.150	0.89	2.56	3.61
Xylocarpus granatum Koen	0.150	0.62	2.56	3.3
Pemphis acidula J.R.Forst. & G.Forst	0.451	0.20	2.56	3.21
Total	100.00	100.00	100.00	300.00

Disturbances and threats

The impact of disturbance and threats on mangrove species diversity and habitat are a critical issue with far-reaching implications for species and habitat conservation and protection. The Beynen and Townsend (2005) disturbance index was utilized to evaluate the impact of disturbance and threats on mangrove ecosystems in Sibonga and Carcar. This assessment revealed that both areas experienced high levels of disturbance, or both areas were categorized as highly disturbed, as indicated in Table 3. The primary causes of disturbance include illegal cutting, charcoal production, garbage disposal, reclamation projects (in Sibonga), forage collection, and converting mangrove forests into fishponds (Figure 3). These activities have led to significant mangrove forest loss, ecosystem degradation, and biodiversity decline (Orchard et al. 2015). The deterioration of mangrove species directly impacts the entire biodiversity within the coastal environment. This has implications not only for the flora and fauna of the mangroves but also for the local community's well-being in the coastal areas (Lillo et al. 2022 and Lillo et al. 2019).

The findings align with previous studies by Lillo et al. (2022 and Lillo et al. 2019), including research on Camotes Island (Lillo et al. 2022), and the Municipality of Argao (Lillo and Buot 2016). These studies underscore the urgent need for conservation and protection measures to safeguard mangrove species and their habitat. Therefore, to mitigate these threats, it is imperative to enforce stringent conservation measures, raise awareness among local communities, and collaborate with relevant authorities to ensure the long-term survival of mangrove ecosystems in these areas.

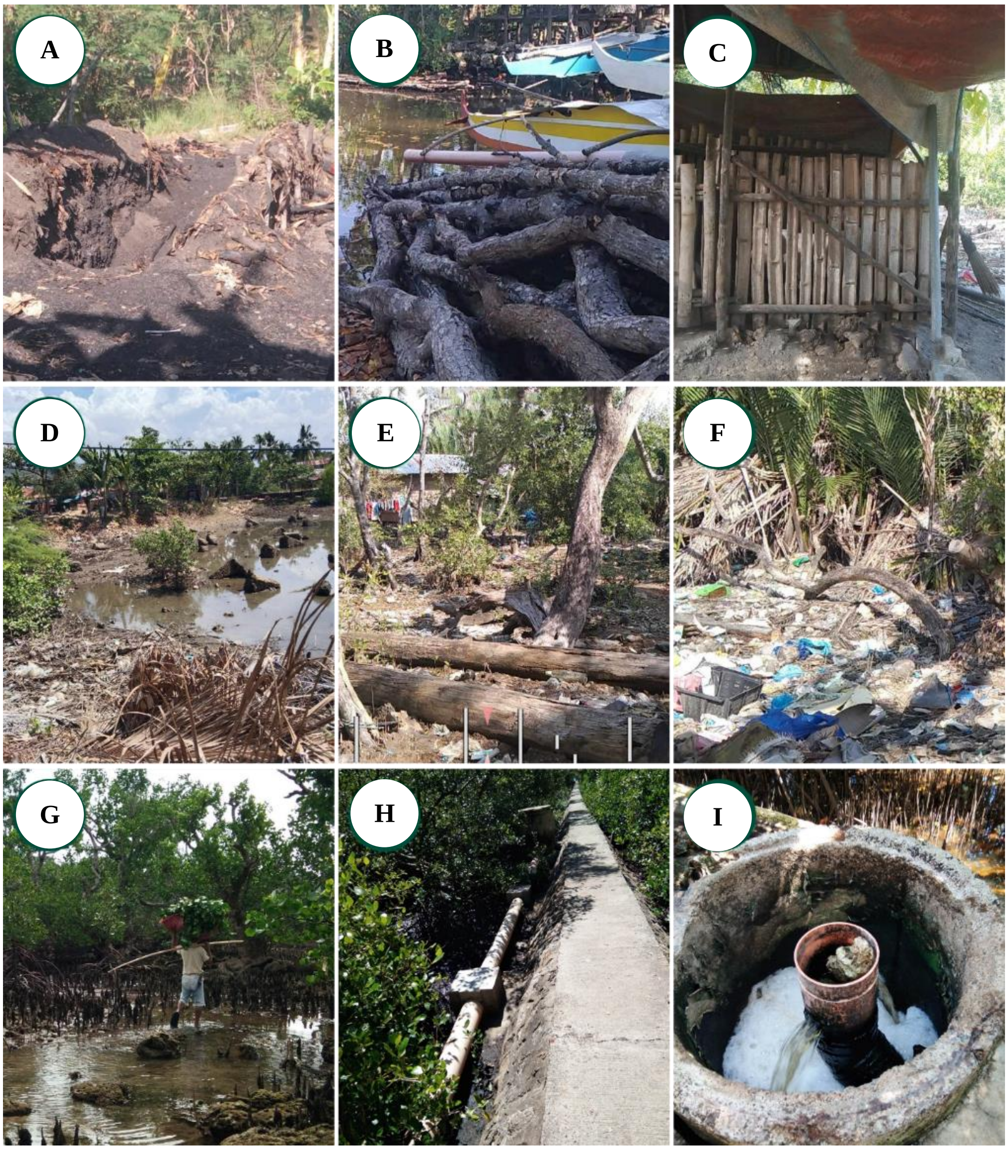

Figure 3. Disturbance and threats in both Carcar City and Sibonga Municipality, Cebu Island, Philippines. A-C. Firewood and charcoal, D-F. Wastes, G. Exploitation, H. Embankment, I. Water extraction (Photo: Marvin Margate and John Lou Diaz)

Table 3. Causes of forest degradation in the mangrove forest of both Sibonga Municipality and Carcar City, Cebu Island Philippines

Respondent's perception on the causes of forest degradation	Local scoring	Beynen and Townsend 2005 (scoring)	Ranking
Charcoal making	63	63	3
Firewood	24	24	7
Forage	32	48	5
Garbage disposal	116	174	1
Illegal cutting	36	54	4
Fishpond	96	96	2
Reclamation	27	27	6
Total	394	486	
Disturbance value (Beynen and Townsend 2005)	0.81 (highly disturbed)		

In conclusion, the findings from the study conducted in the degraded mangrove forests of both Sibonga and the City of Carcar underscore the urgent need for robust conservation efforts. The Local Government Units (LGUs) in these areas should spearhead comprehensive Information Education Campaigns (IECs) to raise awareness about the critical state of the mangrove ecosystems. Furthermore, strict enforcement of existing policies, such as the protection of mangrove species mandated by Proclamation No. 2152, s. 1981, is paramount to halt further degradation. The mangrove forest's designation as a protected area emphasizes the need for LGUs to take decisive action.

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