INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 22, No. 2, p. 74-82, 2023
http://www.innspub.net

RESEARCH PAPER

OPEN ACCESS

Species composition, diversity and community structure of mangroves in Barangay Fabio, Tagana-an, Surigao Del Norte, Philippines

Sheila Marie Y. Plimaco*, Genevie P. Pinton, Cesar G. Demayo

Department of Biological Sciences, College of Science and Mathematics, Mindanao State University, Iligan Institute of Technology, Andres Bonifacio Ave., Iligan City, Lanao del Norte, Philippines

Article published on February 14, 2023

Key words: Diversity, Mangrove forest, Relative abundance, Species composition

Abstract

Mangrove ecosystems serve a crucial environmental role in protecting coastlines from storms, floods, and erosion, and they aid as a breeding ground for many marine life. Mangrove forests are declining due to relentless anthropogenic activities. Thus, the assessment of mangrove species plays a crucial part in the upkeep and protection of the forest. This study aimed to determine species composition, diversity, and community structure of mangrove forests in Barangay. Fabio, Surigao del Norte using the line quadrat method. Results revealed that the area has very low diversity belonging to only three families, three genera, and three different species. Among the three other species, *Rhizophora apiculata* obtained the highest abundance. Results showed that the area is not diverse in terms of species composition and abundance, as shown by several indices of diversity.

***Corresponding Author:** Sheila Marie Y. Plimaco ✉ sheilamarie.yap@nmsc.edu.ph

Introduction

Mangrove ecosystem plays a crucial role in maintaining environmental sustainability. Mangroves serve as a breeding ground for many marine life as well as exporters of both organic and inorganic carbon (Suman, 2019; Chen *et al.,* 2017). Mangrove forests sequester large amounts of carbon from the atmosphere and into their biomass and soils, four times as much carbon per unit area compared to terrestrial forest ecosystems (Sippo *et al.,* 2018; Simard *et al.,* 2019).

With rising sea levels and unpredictable tropical storms brought upon by the changing climate, tropical and subtropical nations like the Philippines can inevitably benefit from the buffering capabilities of the root systems of mangrove trees that reduce coastal erosion rates and inland flooding (Zhang *et al.,* 2012). It can inevitably benefit from the buffering capabilities of the root systems of mangrove trees that reduce coastal erosion rates and inland flooding (Zhang *et al.,* 2012). Mangroves also provide economic support to the community. Mangrove trees are used for firewood, charcoal production, and timber for construction.

Despite these, populations of many mangrove forests are in continual decline due to anthropogenic activities, which has a detrimental effect on both ecological and economic perspectives. Mangrove sites are being converted into settlements, industrial areas, and shrimp and fish farms. All these have resulted in massive fragmentation, degradation, and pollution (Gevana *et al.,* 2019).

The Philippines has at least 39 mangrove species, but there has been about a 60% decline in mangrove forests over the past eight decades (Garcia *et al.,* 2014; Dangan-Galon *et al.,* 2016). To date, the remaining mangrove cover is estimated at 153,577 ha from the early record of 400,000 ha (FMB, 2011). The Philippines is also made up of approximately 7,600 islands which experienced frequent natural disasters such as typhoons, earthquakes, and volcanic eruptions because of their geographic locations.

Small islands also encounter other environmental issues and concerns resulting from their vulnerability to climate change and sea level rise (Szekielda, 2017). Despite the possibility that these islands are more susceptible to the detrimental effects of climate change, they are very resilient due to their high degree of hazard awareness, which may be linked to their local knowledge and experiences (Sumeldan *et al.,* 2021; Añasco *et al.,* 2021).

Surigao del Norte, composed of many small islands, was recognized as one of the areas with the most extensive mangrove cover in the Philippines (Jumawan *et al.,* 2013). One of these islands is Barangay Fabio, a relatively small community that is vulnerable to habitat degradation, impacts of climate change, and forest exploitation.

The total mangrove area in Barangay Fabio declined from 162.623 ha in 2004 to 104.15 ha in 2010. However, through combined efforts implemented by the local government and the community, there was a reported increase in mangrove cover in 2015, with an area of 185.07 ha. Nevertheless, there is still a need to develop and implement effective mangrove conservation programs. One way to achieve this is through mangrove assessment studies which can help visualize how mangrove diversity and composition have changed across space and through time and locate communities that require immediate protection (Sarker *et al.,* 2018; Sarker *et al.,* 2019).

In line with this, this study aims to determine the Diameter at Breast Height (DBH), species composition and conservation status, diversity, and community structure of mangrove forests in Barangay Fabio, Tagana-an, Surigao del Norte, Philippines.

Materials and methods

Study Area

Surigao del Norte is a province of the Philippines located in the Caraga region (Fig. 1). It comprises three major islands: Siargao, Dinagat Islands, and Bucas Grande in the Philippine Sea, and a small region at the northernmost tip of the island of Mindanao.

It is a mosaic of islands at the rim of the Asian continental shelf. One of its many islands is Barangay Fabio (9.71923° N 125.63519° E), where the study was conducted. The primary vegetation of the barangay's coastal areas is the mangroves. A variety of marine and terrestrial ecosystems can also be seen in the area, like the lush seagrass beds, coral reefs, and caves and tunnels in its islands. The total mangrove cover in Barangay Fabio from 2004-2015 is shown in Fig. 2.

Fig. 1. Geographical location of Barangay Fabio,Tagana-an, Surigao del Norte.

Physico-chemical Parameters

The different physicochemical parameters measured were dry and wet temperature, pH, and humidity.

Mangrove Survey

A 100 m baseline was first established parallel to the shoreline. Three transect lines were set perpendicular to the baseline at a 50 m distance apart. In each transect, five 10 m x 10 m quadrats were laid-out at 20-meter distance end to end seaward.

The three quadrats established parallel to the baseline were constructed 10 meters from it (Fig. 3). Trees greater than or equal to 4 cm were identified and recorded, and the breast height diameter (DBH) was measured in each quadrat. Mangrove seedlings within each quadrat area were counted separately and recorded.

Plant Identification

Individual plants found within the plot were identified following the nomenclature of Tomlinson (1986), Feller and Sitnik (1996), Primavera *et al.* (2004), and Primavera and Sadaba (2012). For each transect line, basic vegetation parameters such as the diameter at breast height (dbh), and basal area were measured.

Data and Analysis

The diversity indices such as species richness, relative abundance, Shannon-Weiner diversity index, and evenness were calculated using the Paleontological Statistical Software Package (PAST) developed by Hammer *et al.* (2001).

Basal Area (m^2)

The Diameter at Breast Height (DBH) was used to calculate the Basal Area with the formula:

Basal Area = pi ∗ [(Average DBH ÷ 2) ÷ 100]2

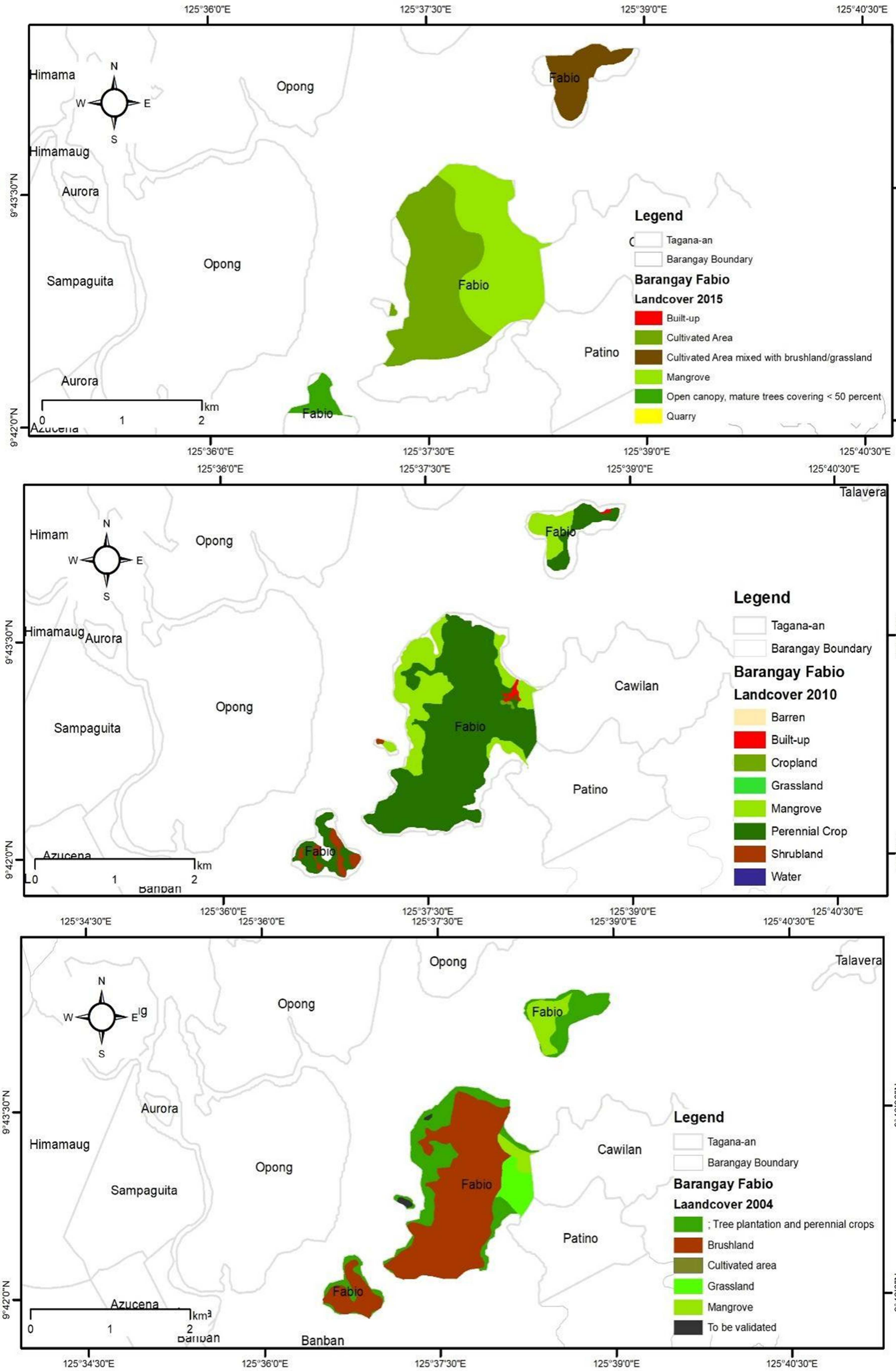

Fig. 2. The total mangrove cover in Barangay Fabio from 2004-2015.

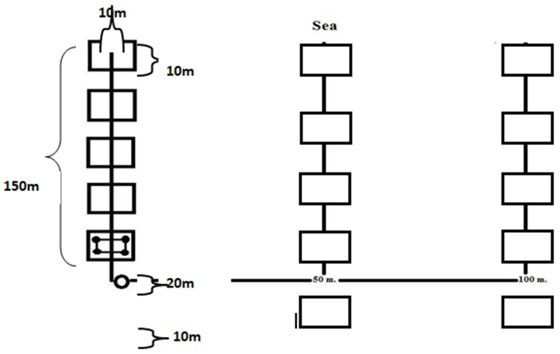

Fig. 3. The three transect lines and the five quadrats with their corresponding measurement and position

Results and discussion

Three (3) mangrove species are identified in Barangay Fabio, Surigao del Norte mangrove forest, namely *Rhizophora apiculata, Aegiceras corniculatum* and *Rhizophora mucronata*. These species are from two (2) families: Rhizophoraceae and Primulaceae (Table 1). All three species of mangroves are categorized as Least Concern (LC) which means that these species are still not the focus of species conservation efforts.

The number of mangrove species found in Barangay Fabio is lower than other mangrove areas in the Philippines because this is a reforested area. A study conducted in Barangay Imelda, Dinagat Island, identified a total of 10 mangrove species, while another study conducted in an estuarine area of Maligaya, Palanan, Isabela revealed 14 species of mangroves (Canizares & Seronay, 2016; Baleta & Casalamitao, 2016; Cudiamat & Rodriguez, 2017; Castillo *et al.,* 2018; Lillo *et al.,* 2019).

Table 1. Species composition and conservation status of mangroves in Barangay Fabio, Taganaan, Surigao del Norte.

N	Family	Mangrove species	Local name	Conservation status (IUCN*)
1	Rhizophoraceae	*Rhizophora apiculata*	Bakhaw lalaki	Least concern
2	Primulaceae	*Aegiceras corniculatum*	Saging-saging	Least concern
3	Rhizophoraceae	*Rhizophora mucronata*	Bakhaw babae	Least concern

* www.iucnredlist.org

A total of 432 mangrove individuals were recorded in Barangay Fabio. Table 2 shows the total number of individuals of each of the three mangrove species found in Brgy. Fabio. Bakhaw-lalaki (*Rhizophora apiculata*) has the highest number of individuals compared to the other two species. Among the three transect lines, the highest total count of Bakhaw-lalaki is found in Transect 3, with a total of 163 individuals, followed by Transect 2, with 160 individuals and the lowest count was recorded in Transect 1, with 103 individuals.

Rhizophora mucronata mangrove species were only observed in Transect 2 with only two individuals while the remaining transects have zero counts of this mangrove species. Saging-saging (*Aegiceras corniculatum)* was only present in Transect 1 with only four individuals, while the rest of the remaining transects have no record of *Aegiceras corniculatum.*

The high number of *R. apiculata* is consistent with other studies conducted in Barangay Imelda, Dinagat Island, and Honda Bay, Philippines, which also showed this specific type of mangrove as the most abundant species (Canizares & Seronay, 2016; Castillo *et al.,* 2018). *R. apiculata,* locally known as Bakhaw lalaki, can withstand high currents and tides (Robertson and Alongi, 1992).

Table 2. Population of the three mangrove species: *Rhizophora mucronata, Aegiceras corniculatum* and *Rhizophora apiculata*.

Species	No. of Individual			Total
	Transect 1	Transect 2	Transect 3	
Rhizophora apiculata	103	160	163	426
Rhizophora mucronata	0	2	0	2
Aegiceras corniculatum	4	0	0	4
Total				432

Fig. 4 shows that *R. apiculata* species is the most abundant mangrove species in Zones 1-5. Zone 4 has the most *R. apiculata,* with a total of 112 individuals, followed by Zone 3, which covers 88 individuals. It is then followed by Zone 5 and Zone 2 with 81 and 78 individuals, respectively. Zone 1 contains the least number of trees, with 67 individuals of *R. apiculata* species.

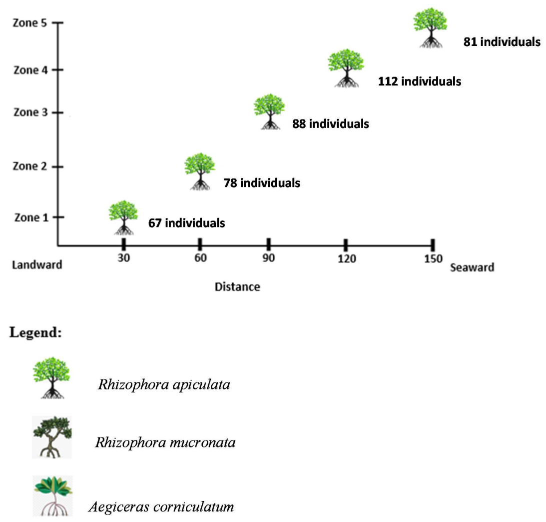

Fig. 4. Zonation of mangrove species from landward to seaward portions of the study site.

Table 3 shows the number of saplings that were found on the site. The saplings were only observed in Transect 3, while no saplings can be seen in Transects 1 and 2. The highest count of saplings in Transect 3 is in Quadrat 2, with 21 saplings, and the lowest number of saplings was in Quadrat 4 (3 saplings).

Many mangrove ecologists and planting practitioners have recommended moderate salinity conditions in obtaining mangrove saplings with optimum growth and high vigor in plant areas. Based on some studies, mangrove saplings' optimum growth changes their favorable salinity from low to moderate after 4 to 5 months of age (Kodikara *et al.*, 2017). According to other studies, as salinities increase, most of the settled mangrove saplings will die, and as the soil salinity decreases, new mangrove saplings grow. The more saline, the higher is the pH (Cardona & Botero, 1998). The saplings of mangrove species are affected by the site's chemical and physical attributes. Table 3 shows that the presence of saplings can only be found in transect three, which occurs in abundance compared to other transects with no saplings. However, the identification of the species of the saplings was not included in the study. Diameter at Breast Height is highest in Transect 1 at 9.86 followed by Transect 2 at 8.79cm and Transect 3 at 8.13cm (Table 4). The Basal Area was highest at Transect 1 with 0.007636m² followed by Transect 2 and Transect 3 with the recorded area of 0.006068m² and 0.005191m², respectively. The basal area, DBH, and the number of saplings can be used to assess how mature a mangrove area is (Snedaker and Snedaker, 1984). Transect 3 has the lowest basal area, which is also where the saplings are found, suggesting that Transect 3 contains young mangroves. The calculated mean basal area of the mangrove forest in Barangay Fabio was smaller than that of the mangrove forest in Calatagan, Batangas, Verde Island Passage which has a recorded basal area of 0.0164 m2 (Cudiamat and Rodriguez, 2017).

Table 3. Number of Mangrove saplings in Brgy. Fabio from Transect 1 to Transect 3.

	No. of saplings		
Quadrat	Transect 1	Transect 2	Transect 3
1	0	0	18
2	0	0	21
3	0	0	15
4	0	0	3
5	0	0	5

Table 4. Diameter at Breast Height and Basal Area of Mangroves.

Transect No.	Mean DBH (cm)	Mean Basal Area (m²)
1	9.86	0.007636
2	8.79	0.006068
3	8.13	0.005191
Grand Mean	8.93	0.006263

Among the three species that can be found in the study area from transect 1 to transect 3, *Rhizophora apiculata* mangrove species has the dominant number with a total of 426 species, while *Aegiceras corniculatum* mangrove species, only four were found in quadrat 1 of transect 1, followed by *Rhizophora mucronata* mangrove species which has the lowest number.

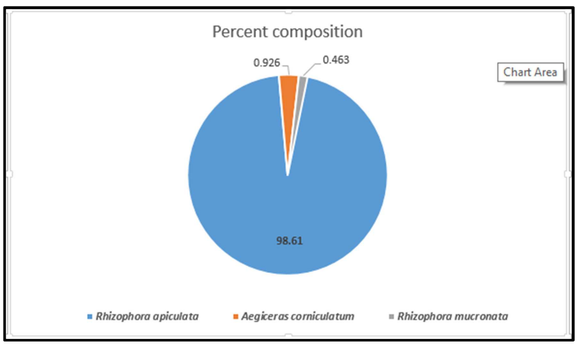

Fig. 5. Percent composition of mangrove families in Barangay Fabio, Surigao del Norte, Philippines.

Percent Relative Abundance

Fig. 5 shows the relative abundance of each mangrove species recorded in the sampling area. Among the three species of mangroves, *R. apiculata* obtained the highest percent relative abundance (98.61%). On the other hand, the two species received the lowest value, that is, *A. corniculatum* (0.926%) and *R. mucronata* (0.463%).

Most typical types of mangroves have gone through the progression of adaptation and evolution, being capable of enduring and precipitating sludge along with a screening of contaminated materials (Purnobasuki *et al.,* 2018). *Rhizophora apiculata* is one of the most prevalent plant species in the mangrove areas of Surigao del Norte had the highest relative abundance. Its wood has high intrinsic energy value, making it an attractive energy source as firewood and for producing charcoal.

River mangrove or *Aegiceras corniculatum* grows well on drained mud intermittently swamped by saline or brackish water. Their roots are exposed to air at low tide and aid oxygen uptake. This species offers spawning grounds for juvenile commercial and recreational fish and is appropriate for restoring and maintaining river banks and estuaries. *Rhizophora mucronata* has the lowest relative abundance; this red mangrove wood is identified as very firm, dense with no water permeability, and impervious to borer invasion.

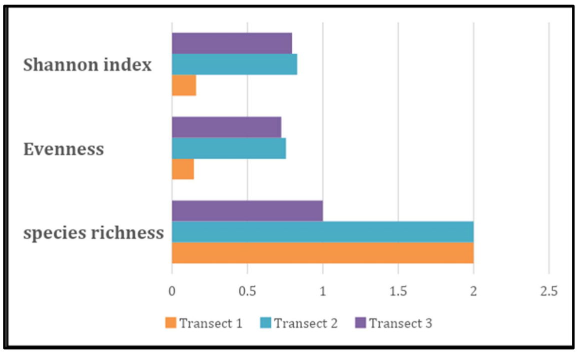

Fig. 6. Diversity indices in 3 transect lines of mangrove area in Barangay Fabio, Surigao del Norte, Philippines.

The sampling site has a species richness of 3 which means three species of mangroves are present in the area.

Species richness measures the number of species found in a sample, indicating that the more species present in a sample, the richer the sample. In addition, evenness is a measure of the relative abundance of the different species making up the richness of an area. Transect one recorded a species richness of 2, evenness 0.1453, and Shannon index of 0. 15966, while transect two recorded a species richness of 2, evenness 0.7555, and Shannon index of 0.83024. On the other hand, transect three recorded the least species richness of 1, evenness 0.7246, and Shannon index of 0.7964 (Fig. 6).

Conclusion

In conclusion, the mangrove forest of Brgy. Fabio, Surigao del Norte falls under very low diversity belonging to only three families. Among the three different species, *Rhizophora apiculata* is the most dominant plant species with the utmost percent relative abundance of 98.61. Of the three stations, transect 3 has the most number of saplings with a mean pH of 5.46, which favors the growth of many saplings. The three species vary in abundance in relation to the three other stations. Results showed that the area is not diverse in terms of species composition and abundance, as shown by numerous diversity indices. As a recommendation, mangrove planting activities that will be conducted in the study area should emphasize increasing the diversity of the mangrove forest, which can be done through additional research on mangrove ecology.

References

Amaliyah S, Hariyanto H, Purnobasuki H. 2017. Roots morphology of *Rhizophora apiculata* Blume as an adaptation strategy of waterlogging and sediment. Journal of Biological Sciences **17(4),** 1-9.

Amaliyah S, Hariyanto H, Purnobasuki H. 2018. Growth responses of *Rhizophora apiculata* Blume in different soil and sediment conditions. AACL Bioflux **11(2),** 379.

Añasco CP, Monteclaro HM, Catedrilla LC, Lizada JC, Baylon CC. 2021. Measuring small island disaster resilience towards sustainable coastal and fisheries tourism: The case of Guimaras, Philippines. Human Ecology **49(4),** 467-479.

Baleta FN, Casalamitao RS. 2016. Species composition, diversity, and abundance of mangroves along the estuarine Area of Maligaya, Palanan, Isabela, Philippines. International Journal of Fisheries and Aquatic Studies **4(2),** 303-307.

Canizares LP, Seronay RA. 2016. Diversity and species composition of mangroves in Barangay Imelda, Dinagat Island, Philippines. AACL Bioflux **9(3).**

Cardona P, Botero L. 1998. Soil Characteristics and Vegetation Structure in a Heavily Deteriorated Mangrove Forest in the Caribbean Coast of Colombia. Biotropica

Castillo JA, Apan A, Maraseni TN, Salmo SG. 2018. Tree biomass quantity, carbon stock and canopy correlates in mangrove forest and land uses that replaced mangroves in Honda Bay, Philippines. Regional Studies in Marine Sciences.

Chen G, Azkab MH, Chmura GL, Chen S, Sastrosuwondo P, Ma Z, Dharmawan IWE, Yin X, Chen B. 2017. Mangroves as a major source of soil carbon storage in adjacent seagrass meadows. Scientific Reports 7:42406
DOI: 10.1038/ srep42406

Costa R, Coelho de Araujo E, Lopes de Aguiar E, Fernandes M, Daher R. 2016. Survival and Growth of Mangrove Tree seedlings in different types of substrate on the Ajuruteua Peninsula on the Amazon Coast of Brazil. DOI: 10.4236/oalib.1102777

Cudiamat MA, Rodriguez RA. 2017. Abundance, structure and diversity of Mangroves in a Community-managed forest in Calatagan, Batangas, Verde Island Passage, Philippines. Asia Pacific Journal of Multidisciplinary Research **Vol. 5, No. 3,** August 2017.

Dangan-Galon F, Dolorosa RG, Sespene JS, Mendoza NI. 2016. Diversity and structural complexity of mangrove forest along Puerto Princesa Bay, Palawan Island, Philippines. Journal of Marine and Island Cultures **5,** 118-125

Davison GWH. 2008. The Singapore Red Data Book: threatened plants and animals of Singapore. Singapore: Nature Soc.

Dharmawan IWE, Pramudji. 2020. Mangrove Community Structure in Papuan Small Islands, Case Study in Biak Regency IOP Conf. Ser.: Earth Environ. Sci. 550 012002

English S, Wilkinson C, Bakers V(Eds.). 1997. Survey Manual for Tropical Marine Resources. Australian Institute of Marine Science, Townville, Australia.

Feller IC, Sitnik M. 1996. Mangrove Ecology: A Manual for a Field Course. Smithsonian Institution, Washington, DC, USA.

FMB. 2011. Forestry Statistics 2011. Forest Management Bureau, Department of Environment and Natural Resources, Quezon City, Philippines.

Garcia K, Malabrigo P, Gevana D. 2014. Philippines' mangrove ecosystem: status, threats and conservation. In: Hakeem, *et al.*, (Ed.), Mangrove Ecosystem in Asia: Current Status, Challenges and Management Strategies. Springer, New York pp. 81-94.

Gevana DT, Pulhin JM, Tapia MA. 2019. Coastal Management Chapter 13: Fostering Climate Change Mitigation Through a Community-Based Approach: Carbon Stock Potential of Community-Managed Mangroves in the Philippines.

Jumawan JH, Demetillo MT, Seronay RA. 2013. Mangrove community structure as influenced by mining activities in Claver, Surigao del Norte. Transactions of the National Academy of Science and Technology **35(1),** pp.43.

Kodikara A, Kodikara S, Jayatissa L, Huxham M, Dahdouh-Guebas F, Koedam N. 2017. The effects of salinity on growth and survival of mangrove seedlings changes with age. ISSN 0102-3306. http://dx.doi.org/10.1590/0102-33062017abb0100

Lillo EP, Fernando ES, MJR Lillo. 2019. Plant diversity and structure of forest habitat types on Dinagat Island, Philippines. Journal of Asia-Pacific Biodiversity **12,** 83e105

Little EL. 1984. Common fuelwood crops: A handbook for their identification. Morgantown, WV: Communi-Tech Associates.

Mackie ED, Matthews RW. 2006. Forest Mensuration, a handbook for practitioners. HMSO, Edinburgh. ISBN 0-85538-621-5

Ng PKL. Sivasothi N. 1999. A guide to the mangroves of Singapore Ii: Animal diversity. Singapore: Singapore Science Centre.

Primavera JH, Esteban JMA. 2008. A Review of Mangrove Rehabilitation in the Philippines: Successes, Failures and Future Prospects. Wetlands Ecol. Manage. DOI 10.1007.

Primavera JH, Sadaba RB. 2012. Beach Forest Species and Mangrove Associates in the Philippines. Southeast Asian Fisheries Development Center (SEAFDEC), Philippines.

Primavera JH, Sadaba RB, Lebata MJH, Altamirano JP. 2004. Handbook of Mangroves in the Philippines: Panay. Southeast Asian Fisheries Development Center (SEAFDEC), Philippines.

Quisthoudt K, Schmitz N, Randin CF, Dahdouh-Guebas F, Robert EMR, Koedam N. 2012. Temperature variation among mangrove latitudinal range limits worldwide. Trees **26,** 1919-1931

Robertson AL, Alongi DM. 1992. Tropical mangrove ecosystems. Coastal and Estuarine Studies 41. Washington, DC, American Geophysical Union **30,** 24-34

Sarker SK, Matthiopoulos J, Mitchell SN, Ahmed Z, Mamun MBA, Reeve R. 2019. 1980s–2010s: The world's largest mangrove ecosystem is becoming homogenous. Biological Conservation **236,** 79-91. https://doi.org/10.1016/j.biocon.2019.05.011

Sarker SK, Reeve R, Paul NK, Matthiopoulos J. 2018. Modelling spatial biodiversity in the world's largest mangrove ecosystem- The Bangladesh Sundarbans: A baseline for conservation. Diversity and Distributions **25,** 729-742.

Simard M, Fatoyinbo L, Smetanka C, Rivera-Monroy VH, Castañeda-Moya E, Thomas N, Van der Stocken T. 2019. Mangrove canopy height globally related to precipitation, temperature and cyclone frequency. Nature Geosc Ience. Vol. 1240, 40-45. www.nature.com/naturegeoscience

Sippo JZ, Lovelock CE, Santos IR, Sanders CJ, Maher DT. 2018. Mangrove mortality in a changing climate: An overview, Estuarine, Coastal and Shelf Science. DOI: https://doi.org/10.1016/j.ecss.2018.

Snedaker SC, Snedaker JG(Eds). 1984. The Mangrove ecosystem: research methods. UNESCO.

Suman D. 2019. Chapter 31: Mangrove Management: Challenges and Guidelines. https://doi.org/ 10.1016/B978-0-444-63893-9.00031-9

Sumeldan JD, Richter I, Avillanosa AL, Bacosa HP, Creencia LA, Pahl S. 2021. Ask the locals: a community-informed analysis of perceived marine environment quality over time in Palawan, Philippines. Frontiers in psychology 12.

Szekielda KH. 2017. Environmental Concerns in Small Islands with Reference to the Philippines. International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081 **7(1)** January-April, pp. 17-27/Szekielda

Verheyden A, De Ridder F, Schmitz N, Beeckman H, Koedam N. 2005a. High-resolution time series of vessel density in Kenyan mangrove trees reveal link with climate. New Phytologist **167,** 425-435.

Zhang K, Liu H, Li Y, Xu H, Shen J, Rhome J. 2012. The role of mangrove in attenuating storm surges. Estuarine, Coastal and Shelf Science **102e103,** 11e23.