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Assessment of mangroves affected by super typhoon Pablo in Barangay Lucod, Baganga, Davao Oriental

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ABSTRACT. This study investigates the impact of super typhoon Pablo on mangrove forests in Barangay Lucod, Baganga, Davao Oriental. The mangroves in this area were severely affected by the typhoon, causing damage to individual trees and altering the overall ecosystem structure. The study aimed to assess the damaged and recovered mangroves in the affected area by measuring various parameters such as tree height, canopy branch length, and density. The study also assessed the density, relative density, frequency, and relative frequency of mangrove species, providing insights into their distribution patterns and abundance within the study area. Mangrove measurements were conducted using standard quadrat sampling methods, with four quadrats established within the study area. The results showed that the mangrove of quadrat 2 had the tallest tree which reached 8.5 m. among all quadrats. In canopy branch length, quadrats 3 and 4 have plants with longer branches (5.26 m and 3.6 m). In terms of density, *Rhizophora apiculata* and *Rhizophora stylosa* have (0.4 Ind/m^2) including *Xylocarpus granatum* (0.4 Ind/m^2). Additionally, the percentage of recovered (55%) and damaged mangroves (45%) in the different quadrats highlighted the ongoing recovery process following the super typhoon. The study contributes valuable information for understanding the impact of natural disasters on mangrove ecosystems and assessing their resilience and recovery mechanisms. The findings can aid in the development of effective conservation and rehabilitation strategies for mangrove forests in typhoon-prone regions in the Philippines.

Keywords: *Baganga, landward, mangroves, seaward, Typhoon Pablo*

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INTRODUCTION

Mangroves are woody plants that grow in tropical and sub-tropical latitudes. They exist in high salinity, extreme tides, high temperatures, and muddy areas (Alongi, 2015). It exists within the intertidal zone between high and low tide levels along tidal flats, coves, bays, and estuaries. It may extend several kilometers inland along the upper stretches of streams and rivers (Hopkinson et al., 2019). Mangroves are a type of forest, tree, shrub, palm, or ground fern that exceed one-half meter in height and grow above sea level in the intertidal zone (Duke and Schmitt, 2015). Approximately a fourth of the tropical coastline of the mangrove ecosystem is estimated to contain an area between 167,000 km² and 181,000 km² in 112 countries (Kumar, 2019). About 50 to 60 known mangrove species, and 35 of them are present in the Philippines (Daupan, 2016). In the Philippines, the reforestation of mangroves started in the early 1990's in response to continuing mangrove decline (Primavera et al., 2016). Mangroves are vulnerable to typhoons because of their position in the coastal zone (Hogarth, 2007).

Mangrove forests play a vital role in the development of coastal communities and in preserving the coastal environment. Mangroves provide various services linked to coastal ecosystems and communities: preventing coastal erosion, safeguarding coral reefs from silt accumulation, controlling pollutants, producing food, timber, and traditional medicines, and offering shelter to indigenous populations alongside diverse flora and fauna (Osti et al., 2009). Economically, mangroves are a source of charcoal, tannin, construction materials, household equipment, medicines, fish, shrimp, crab, vegetables, and raw materials for pulp and paper (Baba et al., 2013). The impact of super typhoon Pablo on December 4, 2012, devastated the province of Davao Oriental with intense rainfall and powerful winds, reaching an average velocity of 185 (kph) and gusts peaking at 210 kph (Lagmay et al., 2013). Resulting in widespread destruction, the typhoon affected over six million people, claimed at least 1,000 lives, damaged 200,000 homes, and caused over US$1 billion in agricultural and infrastructure losses (Ranke, 2015). Particularly devastating was the damage to the mangrove ecosystem in Barangay Lucod, Baganga, according to the Department of Environment and Natural Resources (DENR) Baganga. The loss of mangroves raised significant concerns, as these ecosystems provide critical services such as flood protection, nutrient processing, sediment control, and support for fisheries (Friess and Webb, 2014). Despite this, no study was previously conducted to assess the damaged and recovered mangroves in Barangay Lucod following super typhoon Pablo. Therefore, this study aims to assess the recent impact of the typhoon on mangroves in Barangay Lucod using standard tree parameter data, including tree height, canopy branch length, and density The findings of this study will be essential for developing rehabilitation strategies and establishing baseline information for future monitoring efforts.

MATERIALS AND METHODS

Description of the study site

This research was conducted in the mangrove area of Barangay Lucod, Baganga, Davao Oriental (see Figure 1). Permission for the study was grantedby the Mangrove Association of Barangay Lucod Rural Women Associations (LUMARWA) in Bougainvillea, Barangay Lucod. The study site is located in the northern part of the province of Davao Oriental. Covering approximately 91 ha in Baganga, the Lucod mangroves are protected by the Department of Environment and Natural Resources (DENR). The site is characterized with a muddy substrate on the ground where freshwater meets the sea.

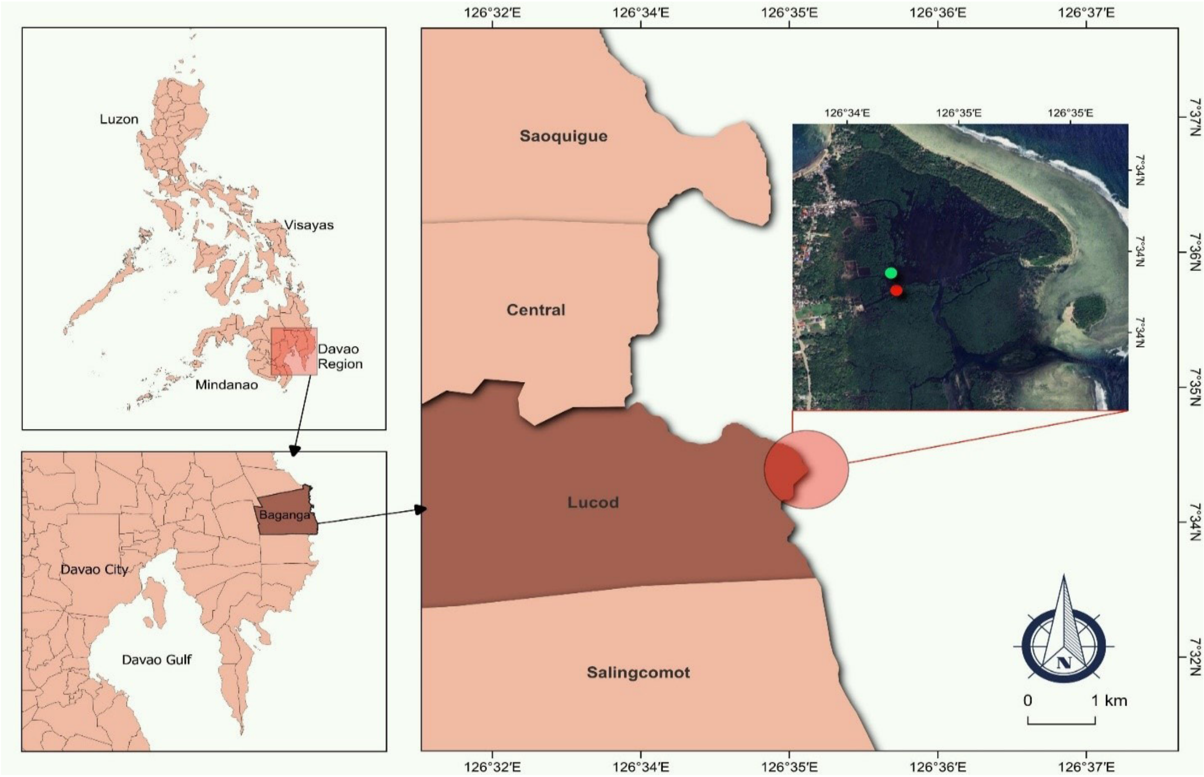

Figure 1. Map of study area in Barangay Lucod, Baganga, Davao Oriental.

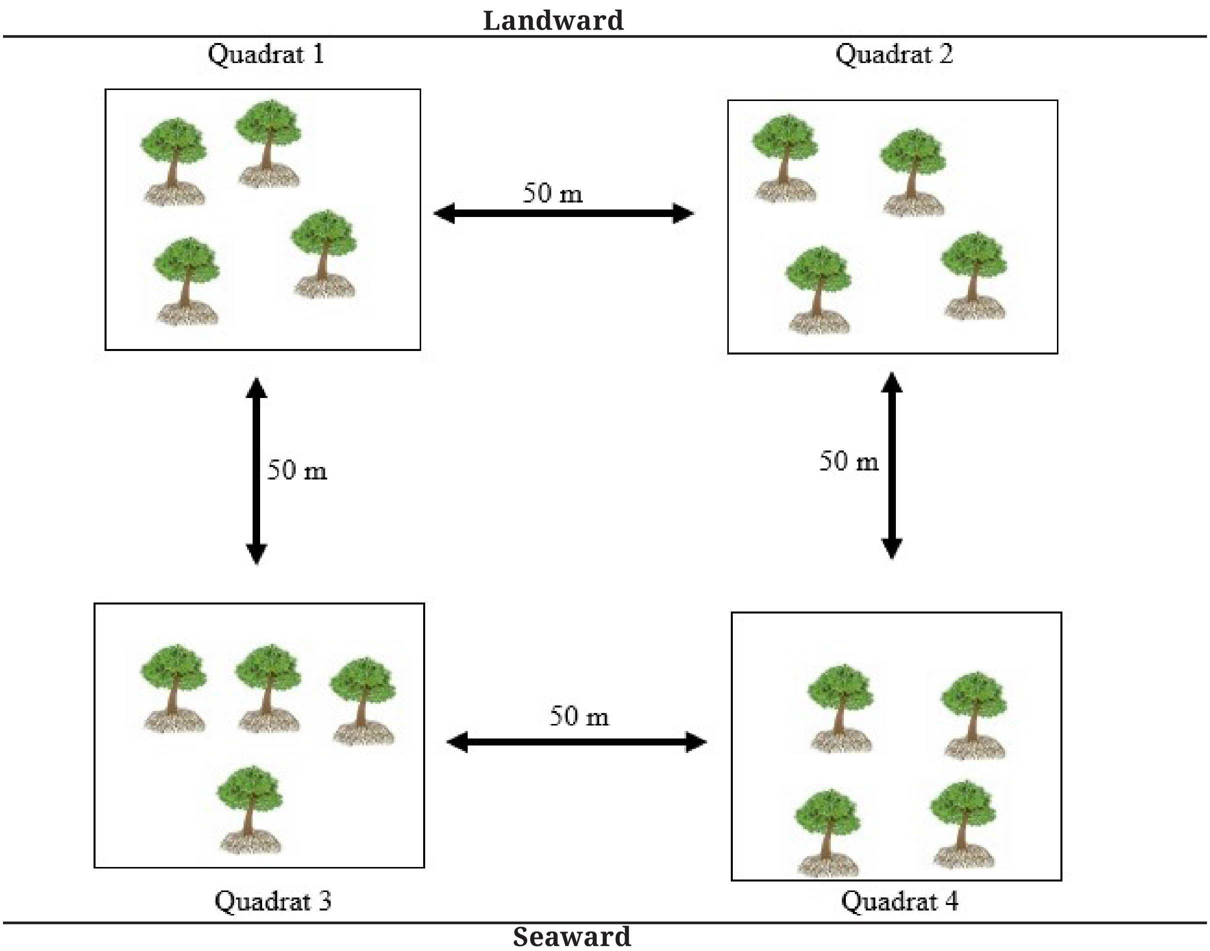

Figure 2. The following set-up was carried out for the affected mangroves during super typhoon Pablo in Barangay Lucod, Baganga, Davao Oriental.

Mangrove measurement setup

A standard method was used wherein four quadrats were established within the 20 x 20 m quadrat, which was used for sampling collection and these four quadrats were divided into two in which the two quadrats face the landward side and the other two face the seaward side. The distance between each quadrat was 100 m away from each other. Variables that were measured in each plot included the following: tree height, canopy branch length, and density considered as impacts of the typhoon counted and measured for each tree (Figure 2).

Data analysis

Tree height measurement calculation

The tree heights were measured using steel tape. This tool is used to measure distance, angles, and the tree heights of mangroves.

The calculations of tree height were done using trigonometry:

$$h = \tan A \times d$$

Wherein:

h = tree height
A = the angle to the top of the tree
d = the distance from the tree

Density

$$D = n_i/A$$

Wherein:

D = Density; number of individuals per unit area
n_i = Total number of individuals of species sampled
A = Total area of all transects sampled

Relative density

$$RD_i = n_i/\sum n$$

Wherein:

RD_i = Number of individuals of a given species as a proportion of the total number of individuals of all species
n_i = Total number of individuals of species sampled
$\sum n$ = Total number of individuals counter for all species

Frequency

$$f_i = j_i/K$$

Wherein:

f_i = Chance of finding a given species in a plot
j_i = Number of line intercept intervals containing species
K = Total number of intervals on the transects

Relative frequency

$$Rf_i = f_i/\sum f$$

Wherein:

f_i = Frequency of species *i*
$\sum f$ = Sum of the frequencies of all species

Coverage

$$C_i = a_i/A$$

Wherein:

a_i = Total area covered by species (basal area)
A = Total area sampled

Relative coverage

$$RC_i = LC_i/\sum LC_i$$

Wherein:

LC_i = Linear coverage index for species *i*
$\sum LC_i$ = Sum of the values of the linear coverage index for all species

Important value

$$IV_i = RD_i + Rf_i + RC_i$$

Wherein:

RD_i = Relative density
Rfi = Relative frequency
RC_i = Relative coverage

RESULTS

Taxonomic identification

The study area revealed the presence of six (6) species of mangrove trees. In the landward side, quadrat 1, *Rhizophora apiculata, Xylocarpus granatum, Rhizophora stylosa,* and *Lumnitzera littorea* were identified, while quadrat 2 featured *Rhizophora stylosa, Lumnitzera*

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littorea, and *Rhizophora apiculata*. On the other hand, seaward side quadrats 3 and 4 exhibited *Sonneratia alba, Xylocarpus mollucensis,* and *Rhizophora apiculata.*

Rhizophora apiculata

Rhizophora apiculata is a medium-sized tree. Stilt roots are distinct. Leaves are opposite with acuminate apex. Stipules and petioles sometimes include midribs, often reddish or purplish. Inflorescence on axils of fallen leaves. Flowers on short, stout stalks. *Rhizophora* means "root bearing," referring to the stilt roots, and "*apiculata*" means to end abruptly, referring to the left apex. This plant is used to treat pain and inflammation and reduce blood glucose levels (Mahmud et al., 2018).

Figure 3. Fallen *Rhizophora apiculata* observed in the study area.

Rhizophora stylosa

Rhizophora stylosa or Bakhaw bato is a small tree, with stilt roots that are distinct, leaves are opposite, simple, light or dark green, obovate, leathery, and bluntly cute apex. The flowers are perfect, and the bark is gray to dark gray and heavily fissured, occasionally red-brown and smooth. Prop roots are sturdy even when relatively thin.

Figure 4. Crooked *Rhizophora stylosa* (Bakhaw bato) observed in the study area.

Rhizophora stylosa is not reported in traditional medicine. The dyeing of cotton fabric using tannin extracted from the bark remains a vital cottage industry on Iriomote Island, Japan. It was sold in souvenir shops to tourists as ornamentals. In the Pacific Island countries, the species is used as fuelwood. In Australia, the Aborigines use its wood to make boomerangs, spears, and ceremonial items. (Chan et al., 2015). The trees of *Rhizophora stylosa* are large on the landward side, and since they were wrath by the typhoon, most of them were recovered. A bunch of leaves, but the scars of the typhoon on the branches and stems are still there.

Lumnitzera littorea

Lumnitzera littorea or tabao/culasi is a medium to large tree, bark fissured, the leaves are simple, alternate, obovate, and generally fleshy. Inflorescence terminal with reddish, shortly pedicellate flowers. *Lumnitzera littorea* is a non-viviparous mangrove species distributed in tropical Asia and Australia, present in landward side, high-salinity areas, often in association with other mangrove species (Huang et al., 2007). This culasi tree was very affected by the typhoon as you can see the branches., stema, and even the unarranged leaves and the scars of the stems were still there.

Figure 5. Fallen *Lumnitzera littorea* (tabao or culasi) observed in the study area.

Xylocarpus granatum

Xylocarpus granatum or tabigi is a medium-sized, evergreen tree that grows up to 20 m in height found on the landward side of a mangrove forest. It was supported by buttresses and plank roots; the trunk had a hollow core. The bark is light brown, tin, and flaky. Borne on dark brown twigs, leaves are compound, spirally arranged and leafletsare 1-2 pairs. Each leaflet is green, ovate, thick, and leathery with a rounded tip. Flowers are clustered, and small with four lobed yellowish-green calyx and four creamy to white oval-shaped petals. Fruits are large, round, woody and resemble a cannonball. Green when young and brown when mature, fruits have four compartments, containing up to corky seeds that are buoyant for water dispersal (Baba et al., 2016). This tree is uncommon and it is located at the shoreline, most of it was recoered. The leaves, the branches but the scars in the stems are still there.

Figure 6. *Xylocarpus granatum* (Tabigi) observed in the study area.

Sonneratia alba

Sonneratia alba or Pagatpat is a medium-sized tree. Pneumatophores are prominent, leaves are simple, opposite, green on both surfaces, fleshly, and generally blunt at the apex. The inner side of the sepals is greenish or yellowish. Calyx flattened in fruit. It has great potential as a source of natural antioxidants and confirms its function in traditional use as a preservative and wound medicine.

Figure 7. *Sonneratia alba* (Pagatpat) observed in the study area.

Sonneratia alba can effectively withstand conditions of wind exposure and wave actions and is excellent for coastal protection. These are used for reforestation and propagated in nurseries, and particularly for Pagatpat, there is limited information on how to propagate its fruits and seeds. These trees were located on the seaward side, since the impact was very strong, the trees of Pagatpat did not grow, the scars were still there but the leaves were growing well.

Xylocarpus mollucensis

X*ylocarpus moluccensis* known as Piag-ao or Pussur wood. It is a small size deciduous tree with a relatively sparse canopy. The bark is light brown, peeling in longitudinal flakes. Roots are pencil-like, stout pneumatophores. Leaves are compound with 2 to 6 pairs of opposite leaflets. Leaflets are elliptic to ovate with blunt or pointed tips. The flowers are small and creamy white. The fruit is globular, woody, orange-sized, and a tetrahedral seed. This tree was also the highest and largest tree on the seaward side. As you can see the branch of the tree was unrecovered, because of the super typhoon the largest tree became the shortest, the leaves did not recover well and there were scars on the stems of the tree (Figure 8).

Figure 8. *Xylocarpus mollucensis* (Piag-ao or Pussur) observed in the study area.

Tree height

There were two quadrats situated on both the landward side (quadrats 1 and 2) and seaward side (quadrats 3 and 4), with different species of mangrove trees (Figures 9 and 10). Among the four quadrats, quadrat 1 was observed to have the shortest mangrove tree height. The mangrove tree (number 3), reaching a height of 5.8 m, was observed as the tallest within quadrat 1. The mangrove tree (number 15), reaching a height of 8.5 m, was observed as the tallest within quadrat 2. On the other hand, quadrat 3 on the seaward side has the tallest mangrove tree (number 6) reaching a height of 5.9 m, and quadrat 4 has the tallest mangrove tree (number 18) reaching a height of 7.1 m.

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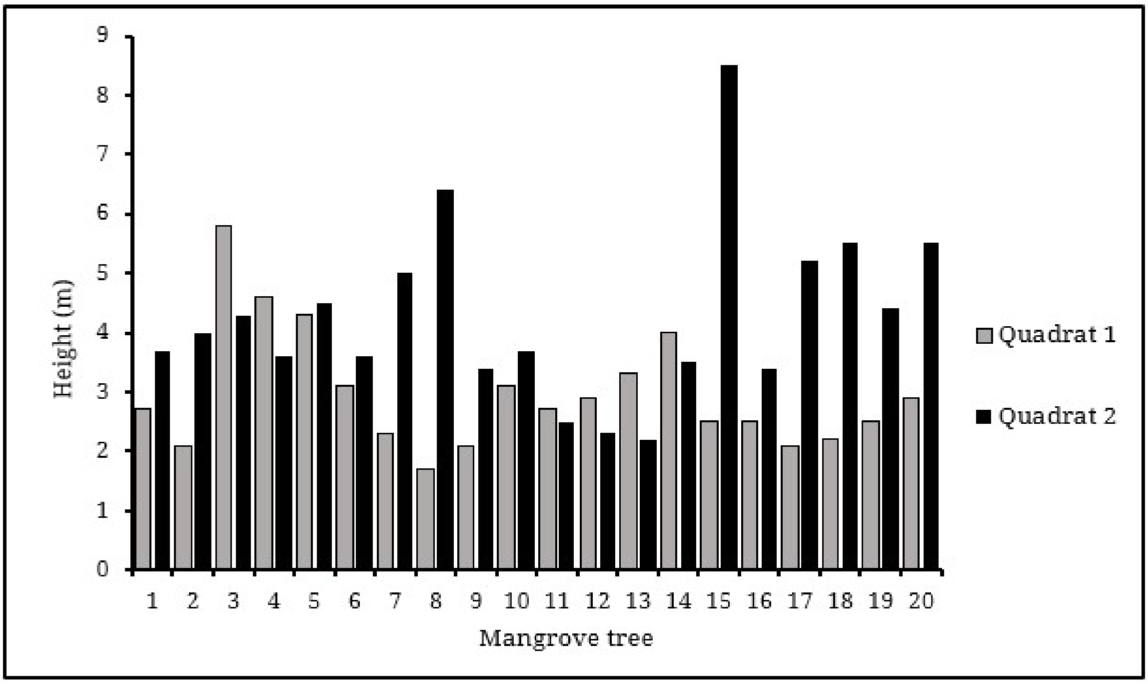
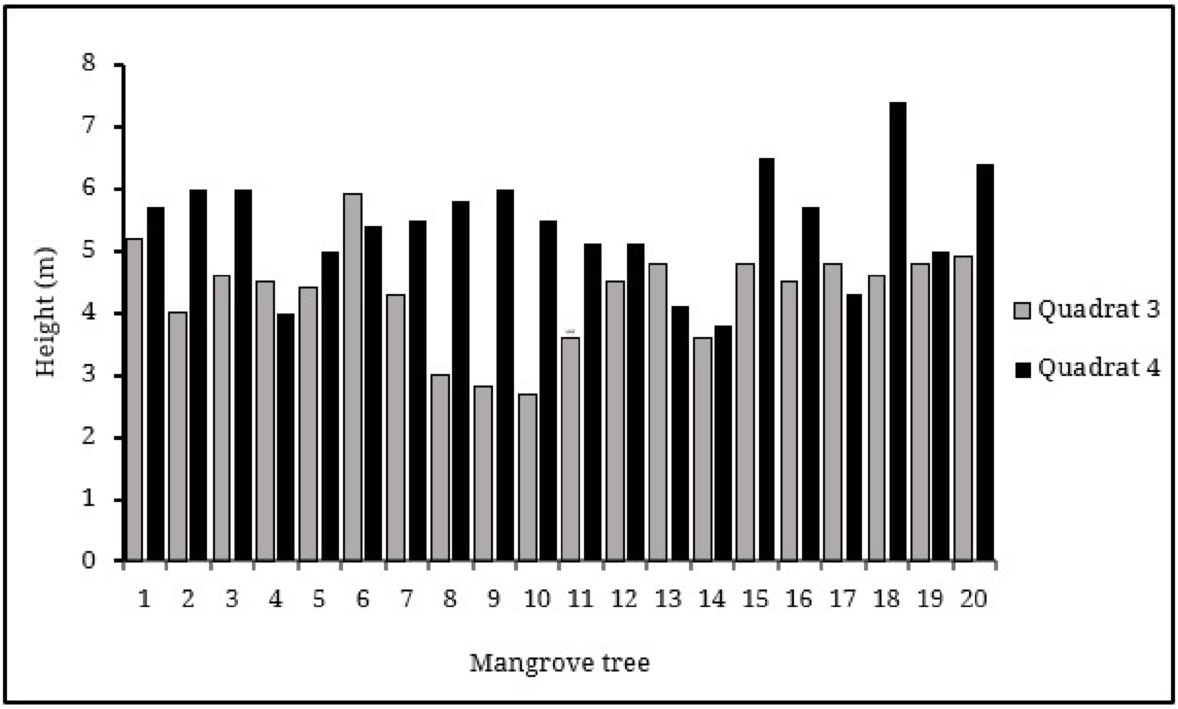


Figure 9. The tree height of mangrove found in the landward side (quadrat 1 and 2) in the study area



study area.

Canopy branch length and tree height

The landward side that has two quadrats where quadrat 1, mangrove 3 (2.9 m) and mangrove 4 (2.7 m) had the most extended canopy branch length among the 20 mangroves in the entire quadrat while quadrat 2, mangrove 20 has the most extended canopy branch length of 6.8 m (see Table 1). In addition, most of the trees are undamaged and potentially recovered from the typhoon.

Table 1. Measurements of the canopy branches found in quadrats 1 and 2 of the landward side.

	Mangrove	Canopy branch (m)	Tree height (m)
Quadrat 1	1	0.92	2.74
	2	0.28	2.1
	3	2.9	5.8
	4	2.74	4.6
	5	1.84	4.3
	6	1.48	3.1
	7	1.73	2.3
	8	1.03	1.7
	9	1.1	2.1
	10	2.2	3.1
	11	1.9	2.7
	12	0.92	2.9
	13	1.0	3.3
	14	1.33	4.0
	15	0.62	2.5
	16	1.04	2.5
	17	0.46	2.1
	18	0.79	2.2
	19	0.56	2.5
	20	0.89	2.9
Average	**10.5**	**1.29 m**	**2.97 m**
Quadrat 2	1	2.6	3.7
	2	2.6	4.0
	3	3.4	4.3
	4	4.1	3.6
	5	2.4	4.5
	6	2.04	3.6
	7	3.8	5
	8	3.8	6.4
	9	2.5	3.4
	10	2.05	3.7
	11	1.52	2.5
	12	1.04	2.3
	13	1.03	2.2
	14	1.5	3.5
	15	2.6	8.5
	16	1.8	3.4
	17	2.7	5.2
	18	2.8	5.5
	19	3.9	4.4
	20	6.8	5.5
Average	**10.5**	**2.75 m**	**4.26 m**

The seaward side also has 2 quadrats where quadrat 3, mangrove 7 (5.2 m) has the longest canopy branch length among the 20 mangroves of quadrat 3, and mangrove 11 (3.6 m) has the longest canopy branch length in the entire area of quadrat 4 (Table 2). On the seaward side, most of the mangrove branches were broken and did not recover after the typhoon.

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Table 2. Measurements of the canopy branches found in quadrats 3 and 4 in the seaward side.

	Mangrove	Canopy branch (m)	Tree height (m)
Quadrat 3	1	4.3	5.2
	2	4.96	4.0
	3	3.25	4.6
	4	3.24	4.5
	5	3.06	4.4
	6	4.07	5.9
	7	5.26	4.3
	8	2.83	3.0
	9	2.94	2.8
	10	3.28	2.7
	11	2.96	3.6
	12	2.3	4.5
	13	5.15	4.8
	14	2.23	3.6
	15	4.94	4.8
	16	4.83	4.5
	17	4.2	4.8
	18	3.26	4.6
	19	1.66	4.8
	20	2.54	4.9
Average	**10.5**	**3.56 m**	**4.31 m**
Quadrat 4	1	1.5	5.7
	2	2.3	6
	3	2.1	6
	4	1.7	4.8
	5	1.1	5.4
	6	2.1	5.5
	7	2.7	5.8
	8	1.4	6
	9	1.2	5.1
	10	2	5.5
	11	3.6	4.1
	12	1.1	5.1
	13	1.5	3.9
	14	1.2	6.4
	15	1.7	5.6
	16	1.2	4.2
	17	1.14	7.1
	18	2	5.1
	19	1.9	6.7
	20	1.5	6.7
Average	**10.5**	**1.75 m**	**5.53 m**

Density and relative density

Results on the density and relative density of trees in the study area were tabulated in Table 1. This data revealed on the four quadrats in which in transect 1 of quadrat 1 and 4, *Rhizophora apiculata* has a higher density, *Rhizophora stylosa* in *quadrat 2, Xylocarpus mollucensis* in quadrat 3. In transect 2, in quadrat 1, 2, and 3 the *Rhizophora apiculata* has a higher density, Sonneratia alba and *Xylocarpus mollucensis* as an equal density in quadrat 4.

Table 3. Density and relative density in the study area.

Transect 1	Scientific name	Count	Density (Ind/m²)	Relative density (Ind/m²)
Quadrat 1	*Rhizophora apiculata*	4	0.2	0.4
	Xylocarpus granatum	3	0.15	0.3
	Rhizophora stylosa	3	0.15	0.3
Quadrat 2	*Lumnitzera littorea*	3	0.15	0.3
	Rhizophora stylosa	7	0.4	0.7
Quadrat 3	*Sonneratia alba*	6	0.3	0.46
	Xylocarpus mollucensis	7	0.4	0.7
Quadrat 4	*Xylocarpus mollucensis*	3	0.15	0.3
	Rhizophora apiculata	7	0.4	0.7
Average		**4.78**	**0.25 Ind/m²**	**0.46 Ind/m²**
Transect 2				
Quadrat 1	*Rhizophora apiculata*	7	0.4	0.7
	Lumnitera littorea	3	0.15	0.3
Quadrat 2	*Rhizophora apiculata*	10	0.5	1
Quadrat 3	*Rhizophora apiculata*	7	0.4	0.7
Quadrat 4	*Sonneratia alba*	5	0.25	0.5
	Xylocarpus mollucensis	5	0.25	0.5
Average		**6.17**	**0.32 Ind/m²**	**0.62 Ind/m²**

Frequency and relative frequency

The data in Table 2, shows the frequency and relative frequency of the mangrove trees in the study area. It was revealed that the *Rhizophora apiculata* in quadrat 1, 2, and 3 has a higher density attaining over 0.027 in quadrat 1 and 0.025 in quadrat 2 than the other species while in quadrat 4, the species of *Xylocarpus mollucensis* has a higher frequency. The *Xylocarpus granatum*, *Rhizophora stylos*a, *Lumnitzera littorea* in quadrat 1 has an equal frequency, as well as the *Lumnitzera mollucensis* and *Rhizophora apiculata* in quadrat 3.

Table 4. Frequency and relative frequency of the mangrove trees in the study area.

Quadrat	Scientific name	Count	Frequency	Relative frequency
1	*Rhizophora apiculata*	11	0.027	0.41
	Xylocarpus granatum	3	0.0075	0.11
	Rhizophora stylosa	3	0.0075	0.11
	Lumnitzera littorea	3	0.0075	0.37
2	*Rhizophora stylosa*	7	0.017	0.35
	Lumnitzera littorea	3	0.0075	0.15
	Rhizophora apiculata	10	0.025	0.5
3	*Xylocarpus mollucensis*	7	0.017	0.35
	Rhizophora apiculata	7	0.017	0.35
	Sonneratia alba	6	0.015	0.3
4	*Xylocarpus mollucensis*	8	0.02	0.4
	Rhizophora apiculata	7	0.017	0.35
	Sonneratia alba	5	0.012	0.25
Average		**6.15**	**0.015**	**0.31**

Coverage and relative coverage

This table shows the coverage and relative coverage of tree canopies in the study area. The data revealed that quadrat 3 and quadrat 4 have a higher coverage located at the seaward side than quadrat 1 and 2 which are located at the landward side.

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Table 5. Coverage and relative coverage of the mangrove trees in the study area.

Quadrat	Scientific name	Count	Coverage (m²)	Relative coverage (m²)
1	*Rhizophora apiculata*	11	0.028	0.0004
	Xylocarpus granatum	3	0.009	0.002
	Rhizophora stylosa	3	0.015	0.0007
	Lumnitzera littorea	3	0.017	0.0007
2	*Rhizophora stylosa*	7	0.028	0.002
	Lumnitzera littorea	3	0.041	0.0002
	Rhizophora apiculata	10	0.068	0.0009
3	*Xylocarpus mollucensis*	7	0.057	0.001
	Rhizophora apiculata	7	0.062	0.001
	Sonneratia alba	6	0.057	0.0007
4	*Xylocarpus mollucensis*	8	0.058	0.001
	Rhizophora apiculata	7	0.042	0.0005
	Sonneratia alba	5	0.038	0.0009
Average		**6.15**	**0.04 m²**	**0.0009 m²**

Importance value

The importance value is the sum of these three measures (relative density, coverage, and frequency), with results ranging from 0 to 3.0. A high importance value indicates that a species is well represented in an area because of some combination of a large number of individuals of a species compared with other species in the area, or a smaller number of individuals of a species (Salang, 2020), but trees are large compared with others in the area. The calculated importance value (IV) of the trees in the study area revealed that *Rhizophora apiculata* has a total of 2.05 followed by *Sonneratia alba* for a total of 0.79, *Xylocarpus mollucensis* has a total of 0.58, *Lumnitzera littorea* has a total of 0.55, *Xylocarpus granatum* has a total of 0.51 and lastly is the *Rhizophora stylosa* has a total of 0.49. Of these six different species only *Rhizophora apiculata* has a presence in both landward and seaward sides, since this species also has a larger number of existing mangrove trees in Barangay Lucod.

Table 8. Calculated the importance value of the six species on the landward and seaward sides.

Parameters	*Rhizophora apiculata*	*Xylocarpus granatum*	*Rhizophora stylosa*	*Lumnitzera littorea*	*Sonneratia alba*	*Xylocarpus mollucensis*	Average
Relative density (Ind/m²)	0.44	0.04	0.02	0.03	0.04	0.0275	0.099 Ind/m²
Relative frequency	1.61	0.11	0.46	0.52	0.75	0.55	0.67
Relative coverage (m²)	0.0025	0.0025	0.0015	0.0025	0.0025	0.0025	0.0023 m²
Importance value	2.05	0.51	0.49	0.55	0.79	0.58	0.83

Table 9. The percentage of recovered and damaged mangroves in different areas.

Quadrats	Damaged (%)	Recovered (%)
1	30	70
2	40	60
3	50	50
4	60	40
Average	45%	55%

This table shows the percentage of recovered and damaged mangroves on the landward side (quadrat 1 and 2) and seaward (quadrat 3 and 4). In quadrat 1, 70% of the mangroves are now fully recovered and 30% of it was still damaged. Quadrat 2 60% are recovered and 40% of it was still damaged. On the landward side, most of them recovered after the typhoon for a long year, abundant in leaves, the stem, and roots are growing well. On the other hand, there are mangrove trees that are still damaged, the branches are bending down and there is still a scar.

On the landward side, in quadrat 3, the recovered and damage was in the same percentage of 50%. The quadrat 4, 40% was recovered and 60% was damaged. In the seaward area, the mangroves are still in the stage of recovery, most of the trees are not growing well, a lot of branches are still broken and the leaves are not abundant as compared to the landward side. However, the seaward mangroves have a healthy substrate since the water is clean and there is no garbage or any plastic bottles that cope around the mangroves, you can see only the different invertebrates that rooming around the mangrove trees.

DISCUSSION

Taxonomic identification

Six species of mangrove trees were identified within the study area, all varying by traits and ecological purposes. Landward side quadrats 1 and 2 were home to *Rhizophora apiculata, Xylocarpus granatum, Rhizophora stylosa, and Lumnitzera* littorea, whereas the side facing the seaward was the quadrats 3 also 4 showed off *Sonneratia alba, Xylocarpus mollucensis and Rhizophora apiculata.* Each species plays a unique role in the mangrove ecosystem, with adaptations to specific environmental conditions (Alappatt, 2008).

Tree height

The study observed changes in height among mangrove trees within various sectors, showing clear variations from areas closer to land compared with those nearer the sea. Quadrat 1, situated landward side, was home to comparatively shorter mangroves, peaking at a height of around 5.8 m as observed. On the other hand, quadrat 2, which remained on the landward side, displayed higher-standing mangroves that reached up to 8.5 m. Towards the sea direction, quadrat 3 could boast about possessing the highest-reaching mangrove tree measured at approximately 5.9 m; meanwhile, quadrat 4 presented a peak tree altitude with a maximum height of 7.1 m. These findings suggest that environmental elements likely impacted tree stature due to factors such as how near the area is situated on coastlines or what their soil composition appears like (Krauss et al., 2008).

Canopy branch length and tree height

The canopy branch length and tree height data provided insights into the conditions encasing mangrove forests on both the seaward and landward sides. Quadrat 1 facing toward the landward side showed notable covering through canopies, with mangrove 3 having the most extended canopy among the observed

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trees. Quite similarly, quadrat 2 also showcased canopy branch length, with mangrove 20 displaying the most extensive canopy. Despite the impact of the typhoon, most trees showed resilience and potential for recovery, particularly on the landward side (Alongi, 2008). However, seaward mangroves suffered significant damage, with broken branches and reduced canopy branch length.

Density and relative density

Analysis of tree density and relative density across quadrats highlighted the distribution patterns of different mangrove species. *Rhizophora apiculata* dominated in landward side quadrats 1 and 4, while quadrat 2 was characterized by *Rhizophora stylosa*. In the seaward area, *Xylocarpus mollucensis* exhibited higher density in quadrat 3. These findings suggest habitat preferences and niche partitioning among mangrove species within the study area. Most mangrove species exhibit a distinct pattern of zonation influenced by tidal fluctuations, wind exposure, water currents, soil properties, and salinity levels in soil and water (Yap et al., 2018).

Frequency and relative frequency

The analysis further elucidated the distribution patterns of mangrove species. *Rhizophora apiculata* exhibited higher frequency in landward side quadrats 1, 2, and 3, indicating its prevalence in these areas. In quadrat 4, *Xylocarpus mollucensis* displayed a higher frequency, suggesting habitat specificity or competitive interactions shaping species distribution. Thus, the importance value, derived from measures of relative density, coverage, and frequency, provided a comprehensive assessment of mangrove species' significance within the study area. *Rhizophora apiculata* emerged as the most important species, with a total importance value of 2.05, indicating its widespread presence and ecological importance across both landward and seaward sides. Other species, such as *Sonneratia alba* and *Xylocarpus mollucensis*, also contributed significantly to the mangrove ecosystem's structure and function.

Furthermore, the recovery status of mangroves varied between landward and seaward sides, with landward side mangroves showing higher rates of recovery compared to seaward mangroves. On the landward side, in quadrats 1 and 2, 70% and 60% of mangroves, respectively, were reported as recovered, while in seaward quadrats 3 and 4, recovery rates were lower, with only 50% and 40% recovered, respectively. This difference may be attributed to environmental factors, such as water quality and wave action, influencing mangrove resilience and recovery capacity (Delfino et al., 2015).

The study assessed the recovery and damage percentages of mangrove trees after the typhoon, revealing varying degrees of resilience and vulnerability across quadrats. The landward side shows higher recovery compared to the seaward side, indicating differences in ecological resilience and environmental conditions. Furthermore, the study provides a detailed characterization of mangrove ecosystems, highlighting the importance of understanding species dynamics, ecological interactions, and environmental responses for effective conservation and management strategies (Cuenca-Ocay, 2019). Further research and monitoring efforts may help elucidate long-term trends and responses to environmental stressors, contributing to the sustainable management of mangrove habitats.

CONCLUSION

The study provides valuable insights into the structural and ecological dynamics of mangrove forests, highlighting the importance of considering both the landward and seaward sides in mangrove conservation and management efforts. Further research into the long-term resilience of mangrove ecosystems to natural disturbances, such as typhoons, is warranted to inform effective conservation strategies.

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REFERENCES

Alappatt, J. P. (2008). Structure and species diversity of mangrove ecosystem. In Biodiversity and Climate Change Adaptation in Tropical Islands (pp. 127-144). *Academic Press*.

Alongi, D. M. (2008). Mangrove forests: resilience, protection from tsunamis, and responses to global climate change. *Estuarine, coastal and shelf science*, 76(1), 1-13.

Alongi, D. M. (2015). The impact of climate change on mangrove forests. *Current Climate Change Reports*, 1, 30-39.

Baba, S., Chan, H. T., & Aksornkoae, S. (2013). Useful products from mangrove and other coastal plants. *ISME mangrove educational book series*, 3, 45-47.

Baba, S., Chan, H., Kainuma, M., Kezuka, M., Chan, E. W., & Tangah, J. (2016). Botany, uses, chemistry and bioactivities of mangrove plants III: Xylocarpus granatum. *ISME/GLOMIS Electronic Journal*, 14(1), 1-4.

Cuenca-Ocay, G. (2019). Mangrove ecosystems' role in climate change mitigation. *Davao Research Journal*, 12(2).

Daupan, S. M.-a. (2016). Community Participation in Mangrove Forest Management in the Philippines: Management Strategies, Influences to Participation and Socio-economic and Environmental Impacts. 1-2.

Delfino, R. J., Carlos, C. M., David, L. T., Lasco, R. D., & Juanico, D. E. O. (2015). Perceptions of Typhoon Haiyan-affected communities about the resilience and storm protection function of mangrove ecosystems in Leyte and Eastern Samar, Philippines. *Climate, Disaster and Development Journal*, 1(1), 15-24.

Duke, N. C., & Schmitt, K. (2015). Mangroves: unusual forests at the seas edge. *Tropical forestry handbook*, 1.

Friess, D. A., & Webb, E. L. (2014). Variability in mangrove change estimates and implications for the assessment of ecosystem service provision. *Global ecology and biogeography*, 23(7), 715-725.

Hogarth, P., 2007. The Biology of Mangroves and Seagrasses. *Oxford University Press, New York*.

Hopkinson, C. S., Wolanski, E., Cahoon, D. R., Perillo, G. M., & Brinson, M. M. (2019). Coastal wetlands: a synthesis. In Coastal wetlands (pp. 1-75). *Elsevier*.

Krauss, K. W., Lovelock, C. E., McKee, K. L., López-Hoffman, L., Ewe, S. M., & Sousa, W. P. (2008). Environmental drivers in mangrove establishment and early development: a review. *Aquatic botany*, 89(2), 105-127.

Kumar, B. (2019). A Study of Mangrove Ecosystem of Sundarbans, India. *Thematics Journal of Geography*, 8(3), 1-6.

Lagmay, A. M. F., Eco, R. N., Alconis, J., & Salvio, B. (2013). What hit barangay andap, new bataan, compostela valley (initial assessment). *Project NOAH Open-File Report, Manila,Philippines.*

Mahmud, I., Shahria, N., Yeasmin, S., Iqbal, A., Mukul, E. H., Gain, S., & Islam, M. K. (2018). Ethnomedicinal, phytochemical and pharmacological profile of a mangrove plant Ceriops Decandra GriffDin Hou. *Journal of Complementary and Integrative Medicine*, 16(1), 20170129.

Osti, R., Tanaka, S., & Tokioka, T. (2009). The importance of mangrove forest in tsunami disaster mitigation. *Disasters*, 33(2), 203-213.

Primavera, J., Dela cruz, M., M., M., Consunji, H., dela Paz, M., Rollon, R., Blanco, A. (2016). Preliminary Assessment of post-Haiyan mangrove damage and short term recovery in Eastern Samar,central Philippines. *Contents lists available at Science Direct, Marine Pollution Bulletin.*

Ranke, U. (2015). Natural disaster and society. In Natural Disaster Risk Management: Geosciences and Social Responsibility (pp. 13-54). *Cham: Springer International Publishing.*

Salang, R. Q. (2020). Quantifying tree height and canopy structure in a forest in Davao Oriental State College of Science and Technology, Mati City, Davao Oriental. *Davao Research Journal*, 12 (3), 33-42.

Yap, M., Yap, M. N.-M. F., & Seniel, J. G. (2018). Assessment of Mangroves in Guang-guang, Dahican, Mati City, Davao Oriental. *Davao Research Journal*, 12(1), 53–60.