Mangrove in the grove: diversity, species composition, and habitat in Pamintayan, Dumanquillas Bay, Philippines

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Abstract. The diversity, species composition, habitat and utilization of mangrove were analyzed in Pamintayan, Dumanquillas Bay, Philippines. Mangrove species is in low diversity (H' = 1.1445) with four species which include *Rizophora mucronata*, *Rizophora apiculata*, *Sonneratia alba*, and *Avicennia alba*. Habitat assessment of the sampling area revealed that the percent crown cover (96.03%) and average mangrove height (6.51) are in excellent category while regeneration per m^2 is in good category (0.77). Mangroves are used as fishing fence and poles, houses fence and firewood. Policy formulation through barangay ordinance is needed to protect and manage the mangrove forest in the area.

Key Words: dominance, frequency, importance value, regeneration, true mangrove.

Introduction. Mangrove is a kind of forest virtually confined in the tropics. They are dicotyledonous shrubs or trees growing along tidal mudflats and on shallow coastal water frequently consisting of monospecific patches or belts (Melana & Gonzalez 1996; Hogarth 2015). They are an important area as hatchery and nursery habitat for juveniles of fish and a large amount of organisms like insects, reptiles, amphibians, birds and mammals live in this habitat (Kathiresan & Bingham 2001). Mangrove trees supply timber for construction, firewood, charcoal, fishing poles, pulp and tannin (Hamilton & Snedaker 1984). Many parts of the mangrove can also be utilized as medicines (Bandaranayake 1998). Moreover, they reduce coastal erosion and flooding, cushion salinity changes and intrusion, supply and regenerate nutrients and decelerate run-off (Lugo & Snedaker 1974; Othman 1994; Tri et al 1998). The diverse flora and fauna associated with mangrove ecosystems can also provide opportunities for nature education, tourism and scientific study, thereby providing additional social and economic benefits (Benecario et al 2016).

The Philippines is an archipelago country of around 7,107 islands bordered by 36,289 km of coastline. It has been recognized as the world's epi-center of marine biodiversity (Springsteen et al 1986; Carpenter & Springer 2005). It has a territorial waters of about 220 million hectares of marine area including 200 miles exclusive economic zone (Camacho et al 2001). An estimated total mangrove area of 500,000 hectares was determined within the Philippine coastlines in 1918 (Brown & Fischer 1920) and it decreased to 100,000 hectares in 1994–1995 (Primavera 2000). Primary factors on the decline of mangroves include cutting of trees for production of firewood, charcoal, and building materials. Other factors of mangrove depletion include urban and industrial development, conversion to agriculture and housing projects (Maneja 2006). In the Philippines, 50% of estimated mangrove deforestation can directly account for aquaculture development for fish and shrimp production (Primavera 1995; Deguit et al

2004). Despite greater conservation and localized replanting efforts, mangrove declination in the Philippines is still expected (Samson & Rollon 2008).

Pamintayan is one of the coastal barangays of Dumanquillas Bay. It has a total land area of 225.89 hectares with an estimated mangrove area of 11 hectares. This mangrove ecosystem plays an important role in the fisheries production in the area. However, there has been little scientific works undertaken to study this habitat. In this study, the diversity, species composition, habitat, and utilization of mangroves were analyzed. The assessment of the remaining mangrove forest is essential in preserving and protecting the remaining mangrove forest in the area. The information is useful for future monitoring and proper management of this important marine resource.

Material and Method. The study was conducted in Barangay Pamintayan in the municipality of Buug, Zamboanga Sibugay along Dumanquillas Bay, Philippines (Figure 1). The estimated coastline in the area is about 5 kilometers. The coastal community in the area rely on the marine environment when it comes to source of food and livelihood (CRM-Buug 2013).

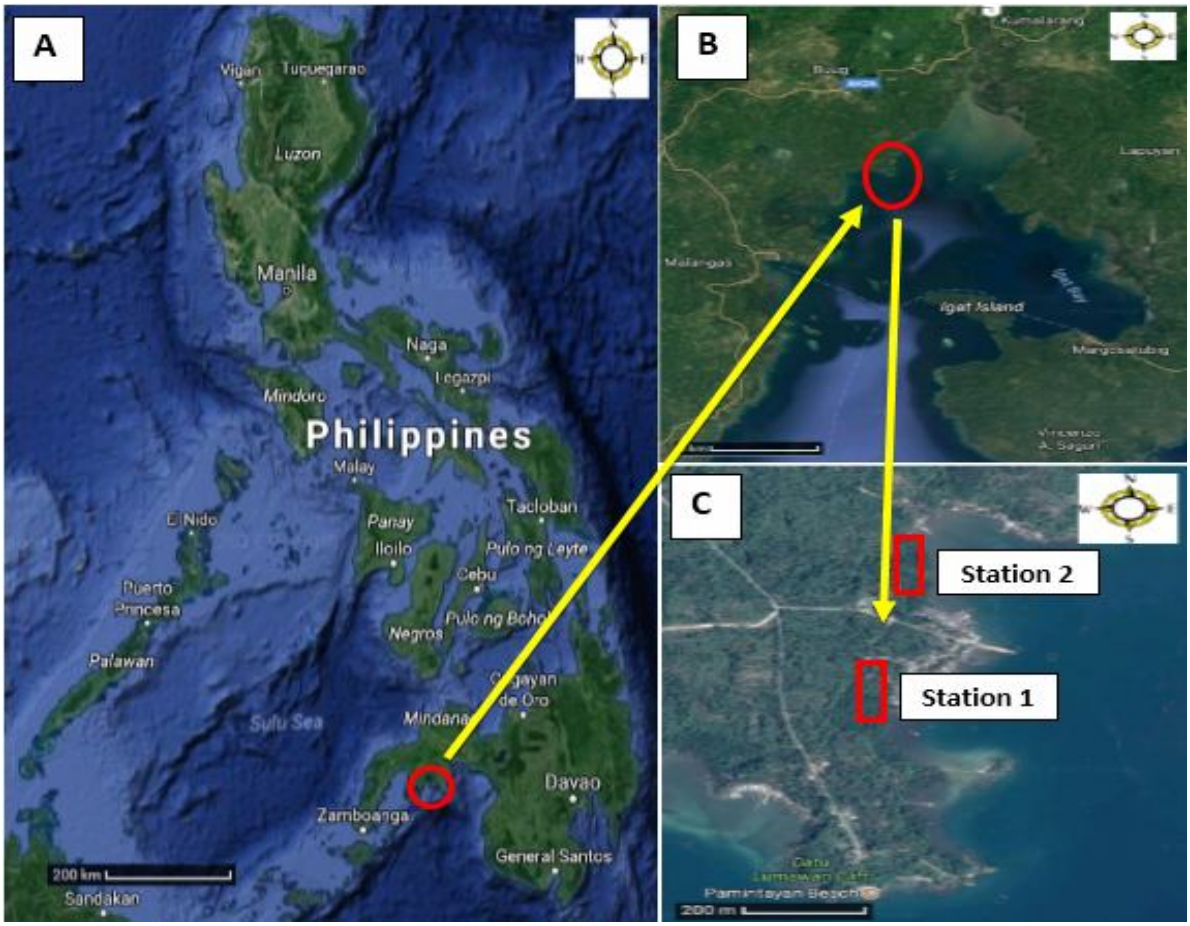

Figure 1. Map showing the sampling area in Pamintayan: A. Map of the Philippines; B. Map of Dumanquillas Bay; C. Map where the sampling sites in Pamintayan were located (https://www.maps.google.com.ph).

The study was conducted on March 5-10, 2017. Two sampling stations were established. For each station, a transect line which ranged 150 meters was laid perpendicular to the shoreline: station 1 (7º68'66'' N, 123º08'24'' E), and station 2 (7º68'33'' N, 123º08'12'' E). Within the transect line, a 10x10 meter plots for the sampling of the mangroves trees were set up with an interval of 20 meters in every plot resulting to five 10x10 meter plots laid in each station. The mangrove inside the plots were identified and counted: the diameter at breast height (DBH) in cm, basal area (BA) in cm and density. The DBH was calculated using the formula: circumference/3.1416 and the BA was calculated by the

formula: 3.1416 $(DBH)^2/4$ (English et al 1997). For the regeneration of mangroves, three 1x1 meter sub-plot were established in each plot. All the seedlings and saplings of mangroves inside the sub-plot were identified and counted. Each mangrove within the sub-plots and plots were characterized as seedling (< 1 m), sapling (1-4 m) and mature tree (> 4 m) based on the definition of Ashton & Macintosh (2002). Height of trees (meter) was measured using a marked bamboo poles.

The mangroves in each sub-plots and plots were identified and classified taxonomically in-situ. The mangrove species were identified using the field guide manual to Philippines Mangroves by Primavera et al (2004).

The diversity indices such as species richness, relative abundance, and Shannon-Wiener diversity index were calculated using the following formulas:

Species richness = number of species present;
Relative abundance = the number of individual per species;
Shannon-Wiener diversity = (H') = $- \sum [p_i \times \ln(p_i)]$

where: Pi = proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals (N);
ln = natural log;
$\sum$ = the sum of the calculations;
S = the number of species.

The vegetation analysis was determined by using the parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance and the importance value. This type of analysis gives a better index than density alone concerning the importance on function of a species in its habitat. It also provides rank or order for a particular species inside the forest community.

For the habitat assessment of mangrove, percent crown cover, regeneration per m^2 and average height were determined using the formulas:

Crown diameter (m^2) = the average crown width at the widest point and second with the measurement of 90^o to the diameter at the widest point. The crown cover was calculated using the $3.1415/d^2$.

$$\text{Percent crown cover} = \frac{\text{Total crown cover of all trees}}{\text{Total numbers of trees recorded}}$$

$$\text{Regeneration per } m^2 = \frac{\text{Total regeneration count}}{\text{Total of regeneration plots}}$$

$$\text{Average height} = \frac{\text{Total heights of trees recorded}}{\text{Total number of trees recorded}}$$

Utilization of mangroves was identified by interviewing 30 respondents who are the locals in the area. They were chosen purposively based on the following criteria: at least two years residing in the place; legal age; willing to be interviewed; and, individuals who get their daily livelihood in the coastal area, such as fishermen.

Result and Discussion. In the sampling site, a total of four mangrove species were identified which belonged to three different families. An additional of four species of mangroves were identified outside the sampling stations. This totaled to eight true mangrove species found in Pamintayan. In the sampling stations, family *Rhizophoraceae* obtained the highest species composition with two mangrove species: *Rhizophora apiculata* and *Rhizophora mucronata*. Regarding the conservation status, out of eight species of mangroves, all were assessed by the IUCN with the least concern status except *Aegiceras floridum* with a near threatened conservation status.

The number of mangrove species in Pamintayan Dumanquillas Bay is lower compared with the rich mangrove ecosystems in the country, such as Imelda, Dinagat Island [10 species (Canizares et al 2016)], Bacolod, Lanao del Norte [11 species (Benecario et al 2016], and Davao Gulf [30 species (Flores 2003)] in Mindanao; Ibajay, Aklan Province [22 species (Primavera 2000)], Samar Island [22 species (Mendoza & Alura 2001)], Bohol [26 species (Mapalo 1992)], Guimaras [30 species (Sadaba et al 2009)], and Panay [34 species (Primavera et al 2004) in Visayas; and, Palawan [22 species (Arquiza 1999)] and Pagbilao Bay, Quezon Province [37 species (Almazol et al 2013)] in Luzon. This difference in mangrove species richness could be attributed to the environmental factors present in each area (Tomlinson 1986), and likewise the size of the mangrove forest area. The Philippines have at least 40 species belonging to 14 families of around 54 true mangrove species worldwide (Primavera et al 2004). This means that mangrove species in Pamintayan is considered very low in terms of diversity from the total number of the Philippine mangroves. The list of observed mangrove species, mangrove family, and conservation status is shown in Table 1.

Table 1

Species composition and conservation status of mangroves in Pamintayan

No	*Family*	*Mangrove species*	*Local name*	*Conservation status (IUCN)*
1	Rhizophoraceae	*Rhizophora mucronata*	Bakauan-babae	Least concern
2	Rhizophoraceae	*Rhizophora apiculata*	Bakauan-lalake	Least concern
3	Rhizophoraceae	*Ceriops tagal**	Tangal/Tungog	Least concern
4	Avicenniaceae	*Avicennia alba*	Piyapi	Least concern
5	Lythraceae	*Sonneratia alba*	Pagatpat	Least concern
6	Lythraceae	*Sonneratia caseolaris**	Pedada	Least concern
7	Myrsinaceae	*Aegiceras corniculatum**	Tinduk-tindukan	Least concern
8	Myrsinaceae	*Aegiceras floridum**	Saging-saging	Near threatened

*Mangroves not found in the sampling sites.

Relative abundance percent. The relative abundance of each mangrove species recorded in the sampling area shows that species *R. mucronata* obtained the highest percent relative abundance (47.5%), followed by *S. alba* (26.35%), then *R. apiculata* (20%), and *A. alba* (6.25%). *R. mucronata* is a small to medium size evergreen tree growing to a height to above 20-25 meters (66-82 ft.) on the banks of rivers while on the fringes of the sea 10 or 15 meters (33 or 49 ft.) is the more typical height. The tallest trees are closest to the water and shorter trees are farther in land. The natural habitats of *R. mucronata* are estuaries, tidal creeks and flat coastal areas subject to daily tidal flooding. It seems to be more tolerant of inundation than other mangrove species and often forms an evergreen fringe to mangrove areas. It sometimes occurs as a pure stand or may grow with *R. apiculata* (Primavera et al 2004; Giesen et al 2006). The Figure 2 shows the relative abundance of each species.

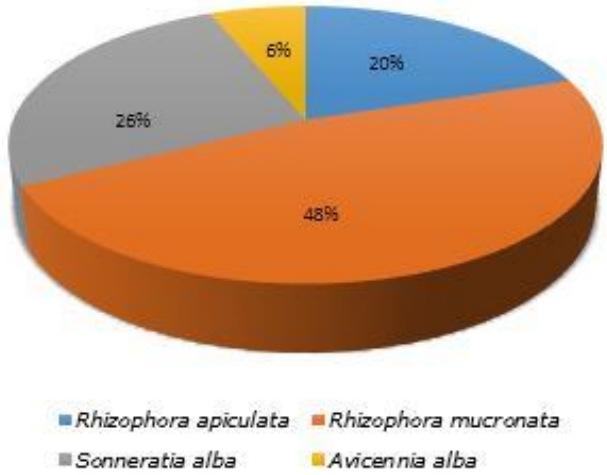

Figure 2. The relative abundance of mangrove species recorded in Brgy. Pamintayan, Dumanquillas Bay, Philippines.

Mangrove diversity indices. The sampling site has species richness of 4 which means 4 species of mangroves were found in the area. The dominance has a value of 0.05434 and Shannon diversity obtained 1.1445 and based on the classification given by Fernando (1998), the area falls under low diversity category (Figure 3).

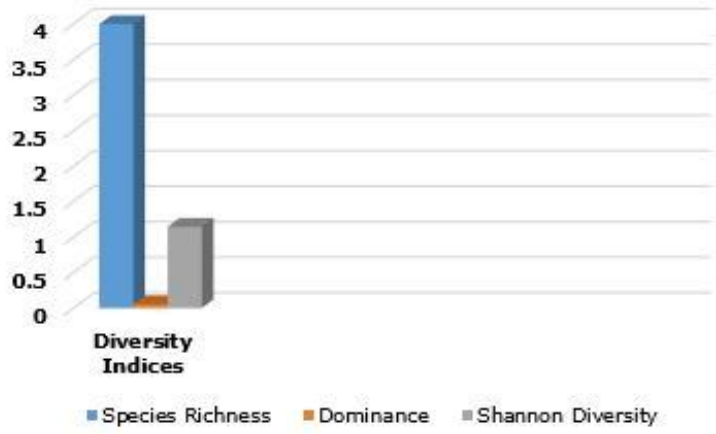

Figure 3. Diversity indices of mangroves in Pamintayan, Dumanquillas Bay, Philippines.

Mangrove vegetation structure. The community structure of the mangrove was assessed by applying the values of relative population density, frequency and dominance. The summations of these values were added to obtain species importance value (SIV) in the entire sampling area.

The species *R. mucronata* was noted of having the highest population density indicating that this species has the highest count per unit area, followed by *Sonneratia alba*, then *R. apiculata* and the last *A. alba* (Figure 4). The highest relative frequencies were *R. mucronata* and *S. alba* (Figure 5) while the most dominant species was *R. mucronata* (Figure 6). Among the four mangrove species, *R. mucronata* have the highest importance value (56.08%) (Figure 7).

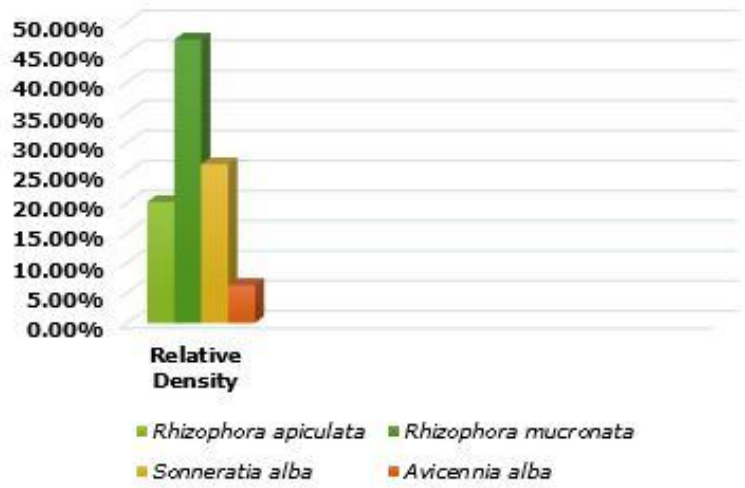

Figure 4. Relative density of mangroves in Pamintayan, Dumanquillas Bay, Philippines.

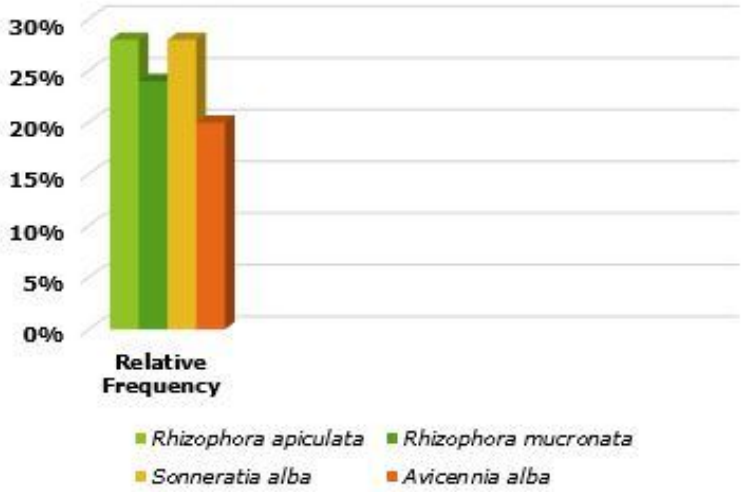

Figure 5. Relative frequency of mangroves in Pamintayan, Dumanquillas Bay, Philippines.

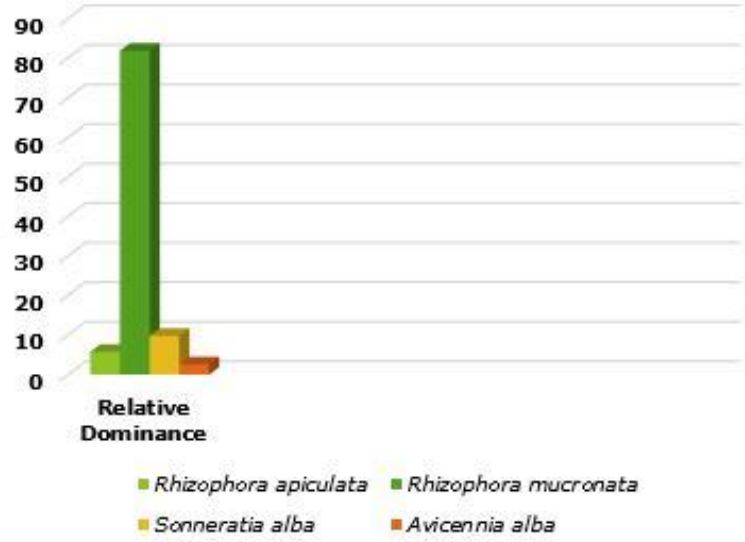

Figure 6. Relative dominance of mangrove in Pamintayan, Dumanquillas Bay, Philippines.

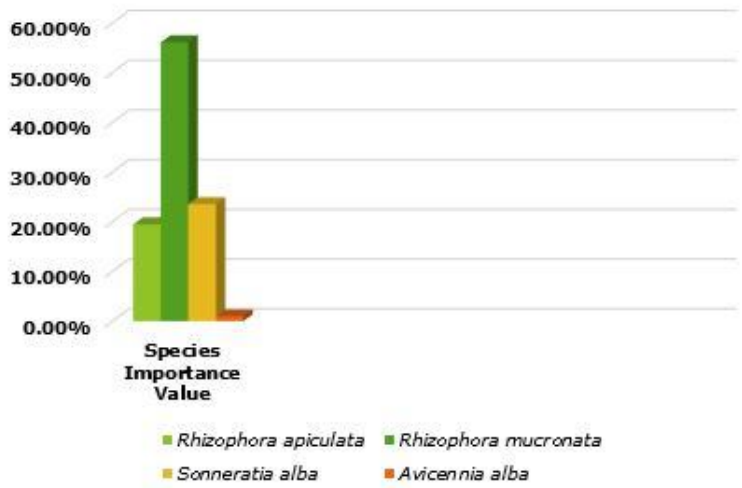

Figure 7. Calculated species importance value of mangroves in Pamintayan, Dumanquillas Bay, Philippines.

Mangrove habitat assessment. The mangrove habitat assessment includes the evaluation of percent crown cover, regeneration per m^2 and an average height of the mangroves. Figure 8, revealed the value of percent crown cover (96.035%), regeneration per m^2 (0.77) and the average height of mangroves (6.519 m). Based on the classification given in Deguit et al (2004), percent crown cover fall under the excellent category, regeneration per m^2 is in good category and the average height of mangroves is in excellent category. Excellent means undisturbed to negligible disturbance while good means slight disturbance and few cuttings.

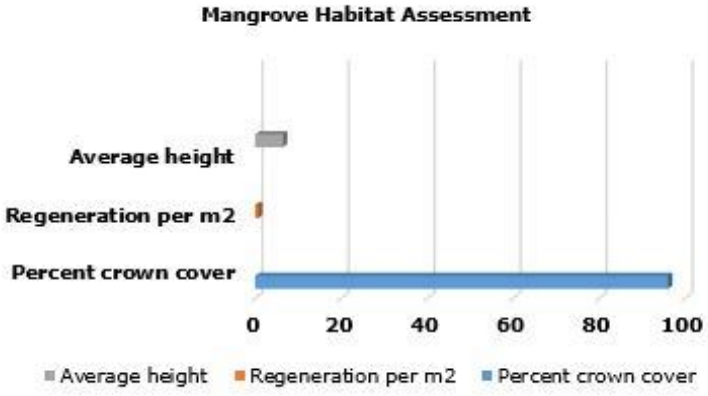

Figure 8. Mangrove habitat assessment of mangrove species noted in Pamintayan, Dumanquillas Bay, Philippines.

Utilization of mangroves. Among 30 respondents interviewed, 13 (43.34%) said they do not utilized mangroves because it is prohibited by the barangay local government. Four (13.33%) respondents said, they utilized the mangroves as house fence. Six (20%) said, they utilized mangrove as fishing fence and poles, and seven (23.33%) respondents said, they used mangroves as a firewood (Figure 9). Charcoal from mangrove trees was known for its high heating value (Melana & Gonzalez 1996) and has long been preferred for both domestic cooking fuel and fuel for commercial bakeries (Walters 2004). A total of 17 respondents (56.67%) utilized mangroves either as firewood, post and fence on their houses and fish coral. This calls an immediate action for mangrove protection and management in the area.

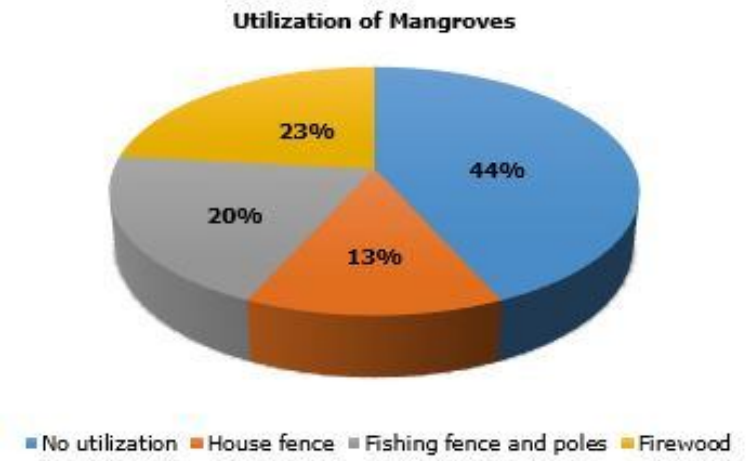

Figure 9. Utilization of mangroves in Pamintayan, Dumanquillas Bay, Philippines.

Conclusions. Based on the findings of the study, it was concluded that the mangroves in Pamintayan, Buug, Dumanquillas Bay falls under very low diversity (H category with four true mangrove species, belongs to three families). Among the 4 species of mangroves, *R. mucronata* got the highest species importance value (56.08%). On the other hand, habitat assessment shows that the sampling area percent crown cover fall under the excellent category (96.035%) while regeneration per m^2 (0.77) is in good category and average height of mangroves (6.159) are in excellent category. Majority (56.67%) of the respondents utilized mangroves either as firewood, fishing post and fence and fence on their houses.

Recommendations. Based on the study, the following are the recommendations: 1) For the conservation of mangroves, strengthen the barangay and municipal ordinance prohibiting the cutting of mangroves; 2) Add ordinance in the provision of higher fines and penalties; 3) Conduct information, and education campaign regarding on the importance of mangroves in the coastal environment; 4) For future studies, revalidate the assessment of mangroves in the area by using different methodologies and high technology instruments; and 5) Include associated flora and fauna in the assessment of mangroves.

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References

Almazol A. E., Cervancia C. R., Buot Jr. I. E., Pampolina N. M., 2013 Floristic composition and physiognomy of Pagbilao mangrove, Quezon Province, Philippines. International Journal of Ecology and Conservation 7:25-39.

Arquiza Y. D., 1999 Rhythm of the sea: coastal environmental profile of San Vicente, Palawan. Coastal Resource Management Project, Cebu City, Philippines, 131 pp.

Ashton E. C., Macintosh D. J., 2002 Preliminary assessment of the plant biodiversity and community ecology of the Sematan mangrove forest, Sarawak, Malaysia. Forest Ecology and Management 166:111-129.

Bandaranayake W. M., 1998 Traditional and medicinal uses of mangroves. Mangroves and Salt Marshes 2:133-148.

Benecario J. B., Torregosa K. M. Y., Orbita M. L. S., Orbita R. R., 2016 Composition, abundance and distribution of mangroves in Bacolod, Lanao del Norte, Mindanao, Philippines. AES Bioflux 8(1):42-49.

Brown W. H., Fischer A. F., 1920 Philippine mangrove swamps. In: Minor products of Philippine forests I. Brown W. H. (ed), Bureau of Forestry Bulletin No. 22, Bureau of Printing, Manila, pp. 9-125.

Canizares L. P., Seronay R. A., 2016 Diversity and species composition of mangroves in Barangay Imelda, Dinagat Island, Philippines. AACL Bioflux 9(3):518-526.
Camacho A. S., Abella T., Tayamen M. M., 2001 Fish genetics research and development in the Philippines. In: Fish genetics research in member countries and institutions of the International Network on Genetics Aquaculture. Gupta M. V., Acosta B. O. (eds), ICLARM Conference Proceedings 64:71-76.
Carpenter K. E., Springer V. G., 2005 The center of the center of marine shore fish biodiversity: the Philippine Islands. Environmental Biology of Fishes 72:467-480.
Deguit E. T., Smith R. P., Jatulan W. P., White A. T., 2004 Participatory coastal resource assessment training guide. DENR-CRMP Document No. 16-CRM/2004, pp. 1-134.
English S., Wilkinson C., Baker V., 1997 Survey manual for tropical marine resources. Chapter 3 - Mangrove Survey. Australian Institute of Marine Science, Townsville, pp. 119-196.
Fernando E. S., 1998 Forest formations and flora of the Philippines: Handout in FBS 21. College of Forestry and Natural Resources, University of the Philippines at Los Baños (Unpublished).
Flores J., 2003 Final report: status of mangrove ecosystem in Davao Gulf, Philippines. In: Resource and social assessment of Davao Gulf, Philippines. FRMP, pp. 83-117.
Giesen W., Wulffraat S., Zieren M., Scholten L., 2006 Mangrove guidebook for Southeast Asia. Rap Publication, Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok, 769 pp.
Hamilton L. S., Snedaker S. C., 1984 Handbook for mangrove area management. Honolulu, HI: United Nations Environment Program and East West Center, Environment and Policy Institute, pp. 2-4.
Hogarth P. J., 2015 The biology of mangroves and seagrasses. Third edition, Oxford University Press, pp. 1-5.
Kathiresan K., Bingham B. L., 2001 Biology of mangroves and mangrove ecosystems. Advances in Marine Biology 40:81-251.
Lugo A. C., Snedaker S. C., 1974 The ecology of mangroves. Annual Review of Ecology and Systems 5:39-64.
Maneja R. H., 2006 Analysis of the responses of mangrove ecosystems in the Philippines to climate change. Agusan River Basin Mangrove Wildlife Conservation Network Website (http://www.freewebs.com/arbmwcnetwork/). Accessed: May, 2007.
Mapalo A. M., 1992 Mangrove species distribution in Bohol, Phillipines. Ecosystems Research Digest 3(2):55-62.
Melana E. E., Gonzalez H. I., 1996 Field guide to the identification of some mangrove plant species in the Philippines. Department of Environment and Natural Resources, Ecosystems Research and Development, Mandaue, Cebu City, Phillipines, pp. 1-29.
Mendoza A. B., Alura D. P., 2001 Mangrove structure on the Eastern Coast of Samar Island, Philippines. In: 10th International Soil Conservation Organization Meeting. Stott D. E., Mohtar R. H., Steinhard G. C. (eds), Purdue University & USDA-ARS National Soil Erosion Research Laboratory, pp. 423-425.
Othman M. A., 1994 Value of mangroves in coastal protection. Hydrobiologia 285:277-282.
Primavera J. H., 1995 Mangroves and brackishwater pond culture in the Philippines. Hydrobiologia 295:303-309.
Primavera J. H., 2000 Development and conservation of Philippine mangroves: institutional issues. Ecological Economics 35:91-106.
Primavera J. H., Sadaba R. B., Lebata M. J. H. L., Altamirano J. P., 2004 Handbook of mangroves in the Philippines – Panay. SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, pp. 1-106.
Sadaba R. B., Barnuevo A. P., Madas C. S., Biñas J., Hortillosa E., 2009 Assessment of the short-term damage in the Guimaras mangrove forests by the M/T Solar I oil spill. University of the Philippines, Visayas, J Nat Sci Oil Spill Issue, pp. 71-82.
Samson M. S., Rollon R. N., 2008 Growth performance of planted mangroves in the Philippines: revisiting forest management strategies. Ambio 37(4):234-240.

Springsteen F. J., Leobrera F. M., Leobrera C. B., 1986 Shells of the Philippines. Manila: Carfel Seashell Museum, 377 pp.
Tomlinson P. B., 1986 The botany of mangroves. Cambridge University Press, Cambridge, UK, 441 pp.
Tri N. H., Adger W. N., Kelly P. M., 1998 Natural resource management in mitigating climate impacts: the example of mangrove restoration in Vietnam. Global Environmental Change 8:49-61.
Walters B. B., 2004 Local management of mangrove forests in the Philippines: successful conservation or efficient resource exploitation? Human Ecology 32(2):177-195.
*** Coastal Resource Management Plan - Municipality of Buug, Zamboanga Sibugay, Philippines 2013.

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