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Cover: Mugger Crocodile basking on the banks of Savitri River at Mahad in Maharashtra, India. © Utkarsha M. Chavan.

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COMMUNICATION

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Status of mangrove forest in Timaco Mangrove Swamp, Cotabato City, Philippines

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Abstract: Mangrove forests are important coastal ecosystem considering its various ecosystem services. This study was conducted to generate an updated list and the current abundance of mangrove species in Timaco Mangrove Swamp located in Cotabato City, Bangsamoro Autonomous Region for Muslim Mindanao (BARMM). Three sampling plots measuring 5 x 40 m were established in three identified sampling sites. Based on the result of the study, 15 species of mangroves were identified in Timaco Mangrove swamp. This number of species is higher compared to the previous study wherein 12 species were identified. With this number of species, seven species were considered new in the area, and five species were not recorded which were identified in the previous study. A total of 115 individuals were recorded in the present study which indicates a decrease of 79% compared to the previous study. Furthermore, the present study recorded two threatened species, namely, *Aegiceras floridum* (Near Threatened) and *Avicennia rumphiana* (Vulnerable). Continuous anthropogenic activities were observed in the sampling sites which can be attributed to population decrease. Thus, the need for immediate local conservation is recommended.

Keywords: Anthropogenic activities, Bangsamoro Autonomous Region, biodiversity, conservation, Mindanao Island, restoration.

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Author contributions: ZA and BBM—field data collection and processing. CC-M—writing the paper.

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INTRODUCTION

Mangrove forest, similar to other forest ecosystems, provides an array of ecosystem services that directly and indirectly benefit humans. Among these, provisioning services is the most common. It is a good source of timber for construction materials, fuel wood, marine food, and medicine. On the other hand, regulating services can also be provided which include prevention of floods and erosion, and protection against severe impacts of storms and even tsunamis. Recently, mangrove forests are also utilized for their aesthetic values which include tourism, and educational activities, among others (Camacho et al. 2020). Mangrove forests are identified as the main ecosystem that supports life in coastal and marine areas (Suharno & Saraswati 2020). In 1920, Philippine mangrove is about 400,000–500,000 ha, however, a tremendous decline to 120,000 ha in 1994 was recorded (Primavera 2000) which becomes alarming.

Several studies showed (e.g., Long et al. 2014; Fortes & Salmo III 2017) that a decreasing trend of mangrove forest areas in the Philippines is evident and this is due to environmental and anthropogenic activities (Van Lavieren et al. 2012). Major factors identified that leads to the destruction of our mangrove ecosystem include the conversion of mangrove areas to fishponds and charcoal production (Eusebio et al. 1986; Primavera 1995; Melana et al. 2005). Aside from this, the constant increase in population put pressure on our coastal areas which directly and indirectly affect mangrove forests (WIlkie & Fortuna 2003). Accordingly, the lack of awareness of the community have resulted to exploitation and disturbances on mangrove areas. Dangan-Galon et al. (2016) revealed that increased human population, mangrove deforestation, and improper waste disposal are among of the human-related disturbances which have affected mangrove forests particularly in Puerto Princesa Bay, Palawan, Philippines. These activities, as indicated by Camacho et al. (2020), will place mangrove ecosystems on the verge of complete collapse.

Timaco mangrove swamp is situated in Cotabato City, Philippines which covers three barangays. Dimalen & Rojo (2018) conducted a floral assessment in Timaco mangrove swamp wherein they reported low diversity of mangroves in the area. This result was attributed to anthropogenic activities such as crab hunting, shell picking, timber cutting for charcoal production and conversion to fishpond. From the year of the first assessment, no studies have been conducted on the remaining species in the area. Thus, the study was conducted to have an updated checklist of mangrove species including the species' conservation status in Timaco mangrove swamp and to determine its abundance. Results of this study can be a useful tool in the effective implementation of policy for the restoration, protection, and conservation of this mangrove forests.

MATERIALS AND METHODS

The study was conducted in June–July 2021 in Timaco Magrove Swamps in Cotabato City, Philippines. This thin strip of mangrove forest lies within the coordinates of 7.2031 °N, 124.19 °E, 2.1 km (Image 1) within the elevation of 5 m. The mangrove swamp extends south-west traversing Timaco Hill, one of the highest elevated portions of Cotabato City, Philippines (Dimalen & Rojo 2018).

The sampling sites considered in the study were mangrove areas of (1) Kalanganan I, (2) Kalanganan II and (3) Kalanganan Mother. These areas were also the sites of the previous study conducted by Dimalen & Rojo (2018). Sampling plots were purposively established in the 'bakawan'-dominated part. A total of three (3) 5 x 40 m sampling plots were established in each site. All mangrove species found within each sample plot were identified and counted. Relative abundance was computed using the formula: Relative abundance = Total # of spp./ total # of spp. population x 100. Field notes were taken, and preliminary identifications of mangrove species were done on-site. Morphological characteristics of leaves, flowers, and propagules were noted and used in the confirmation of the identification of species. Key guides such as the Field guide to Philippine Mangrove by Primavera et al. (2004) and other published work were used to identify samples up to species level if possible. Samples were photographed for further identification of species. Anthropogenic activities observed in the sampling site were also noted.

RESULTS AND DISCUSSION

A total of 15 species of mangrove belonging to 10 genera and nine families are identified in Timaco Mangrove swamp. This number of species is higher compared to the study of Dimalen & Rojo (2018). Among the 12 species identified in the previous study, eight were still present in the area namely *Ceriops tagal, Aegiceras corniculatum, A. floridum, Lumnitzera littorea, Sonneratia alba, S. caseolaris, Rhizophora mucronata*, and *Xylocarpus granatum*. Moreover, 7 species were

Image 1. Satellite aerial view of Timaco Mangrove Swamp with 1-km radius showing the surrounding landscape.

newly recorded: *Acrostichum aureum, A. speciosum, A. rumphiana, Acanthus ebracteatus, Brugiuera cylindrica, Nypa fruticans, L. littorea*, and *Rhizophora stylosa* (Table 1).

The difference in the number of species identified in this paper compared to that of Dimalen & Rojo (2018) can be contributed to the sampling effort done in this study. A comprehensive accounting of species was done and did not limit only in the species found within the established sampling plots. In the identification of species, we used the guides and reference books authored by Primavera et al. (2004), in which *A. aureum, A. speciosum, A. ebracteatus*, and *N. fruticans* were listed as mangrove species. Moreover, the present mangrove species thriving in Timaco mangrove swamp is higher compared with the species identified from various coastal areas in Mindanao including Alabel and Maasim, Saranggani Bay Protected Seascape (Natividad et al. 2014), Butuan Bay, Agusan del Norte (Goloran et al. 2020). Despite being greatly affected by disturbances observed in the area, Timaco mangrove swamp still harbors a considerable number of species. This is an indicator that there is a high possibility of restoring the mangrove swamps as a considerable number of saplings have also been observed.

Among the 15 species identified, two (2) have conservation issues, 1 Vulnerable (VU) and 1 Near Threatened (NT). The Near Threatened species is *A. floridum* (Image 2A), while the vulnerable is the *A rumphiana* (Image 2B). However, three species listed – *A. rumphiana, L. littorea*, and *X. granatum* have been categorized as species with decreasing population as recognized by IUCN Red List. There is a conservation policy towards the area, however, conservation measures for these threatened species are not evident.

A total of 115 mangrove individuals were recorded in the three sampling sites (Table 1). *A. corniculatum* had the highest relative abundance of 19.1, followed by *N. fruticans* with 10.4 and *X. granatum* has the least with 0.9. Three species were commonly observed in all three sites—*N. fruticans, A. floridum*, and *B. cylindrica*.

There was a decrease of 79% in the total number of individuals in Timaco Mangrove swamps based on the previous study. Dimalen & Rojo (2018) mentioned that the lower species richness of mangroves in the study site, specifically in Kalanganan I, was due to the aforementioned anthropogenic activities despite the presence of local ordinance. Moreover, it was observed that there were structures such as houses for human settlement. These anthropogenic activities along with land conversion to fishponds contribute significantly to the decline of mangrove forests in the Philippines (Dangan-Galon et al. 2016; Buitre et al. 2019). This decrease will not affect only the biodiversity and ecosystem function

Table 1. An updated list of mangrove species in Timaco Mangrove Swamp.

Family	Species name	Common name	Relative abundance	Conservation status
Lower vascular plant				
Pteridaceae	*Acrostichum aureum* L.	Palaypay	8.7	Least Concern
	Acrostichum speciosum Willd.	Palaypay	6.1	Least Concern
Flowering plant				
Acanthaceae	*Acanthus ebracteatus* Vahl	Lagiwliw	7.8	Least Concern
Arecaceae	*Nypa fruticans* Wurmb	Nipa	10.4	Least Concern
Avicenniaceae	*Avicennia rumphiana* (Hallier f.) Bakh.	Bungalon	7.8	Vulnerable
Combretaceae	*Lumnitzera littorea* (Jack) Voigt.	Tabao, Culasi	4.3	Least Concern
Meliaceae	*Xylocarpus granatum* J. Koenig	Tabigi	0.9	Least Concern
Myrsinaceae	*Aegiceras corniculatum* (L.) Blanco	Saging-saging, Tinduk-tindukan	19.1	Least Concern
	Aegiceras floridum Roem. & Schult.	Saging-saging, Tinduk-tindukan	6.1	Near Threatened
Sonneratiaceae	*Sonneratia alba* Sm.	Pagatpat	4.3	Least Concern
	Sonneratia caseolaris (L.) Engl.	Pedada	3.5	Least Concern
Rhizophoraceae	*Bruguiera cylindrica* (L.) Bl.	Pottan, Busain	9.6	Least Concern
	Ceriops tagal (Perr.) C.B. Rob.	Tungog, Tangal	1.7	Least Concern
	Rhizophora mucronata Lamk	Bakhaw babae	3.5	Least Concern
	Rhizophora stylosa Griff.	Bakhaw bata	6.1	Least Concern

of the mangrove forest but also ecosystem services that generally benefited human population (Cardinale et al. 2012) especially those villagers who are dependent on coastal resources (Primavera 2000). Furthermore, it was observed that mangrove individuals commonly noted as tall with big trunk species have shorter and lesser trunk diameter particularly *A. rumphiana*. According to Patindol & Casas (2019), such a condition has resulted from the long history of cutting mangroves. Individuals of species under the families Avicenniaceae and Sonneratiaceae found in the area were almost multi-stem which must have been restored after heavy cutting in the early years (Image 3). Efforts have been done to rehabilitate the area using propagules of the *Rhizophora* species; however, various factors affect the unsuccessful growth towards maturity of the seedlings planted. During hightide, seedlings were being covered by water hyacinth (abundance of water hyacinth is a perennial problem of the area) which eventually cause the seedlings to die during low tide. In addition, domesticated animals of the community nearby were observed to feed on the growing plant which inhibits the growth of the propagules. Though mangrove forest conservation and rehabilitation have captured the interests of various stakeholders, most efforts were unsuccessful due to the lack of science-based approach guidelines (López-Portillo et al. 2017). Moreover, if rehabilitation strategies employed by other mangrove areas in the southern Philippines will be done in Timaco mangrove swamp such as community involvement and science-based strategy, the rehabilitation endeavor will be successful. In the case of Katunggan Eco Park situated in Lebak Sultan Kudarat, Philippines policy strengthening in mangrove forest conservation and protection is accompanied by community involvement (Mangaoang & Flores 2019). Locals were made part in the management of the said mangrove forest such as involvement in the tree-growing activities and delegated as forest guards.

CONCLUSION AND RECOMMENDATION

The significant decrease of mangroves in Timaco Mangrove Swamp calls for immediate action to conserve this important coastal mangrove forest not only on the presence of two species with conservation concerns but the whole mangrove ecosystem which is facing the effects of the unregulated harvest of timber, the establishment of structures and as well as attempts to secure ownership of the part of the area is on its way. Cotabato City was once hit by an earthquake in the year 1976 and produced tsunami which destroy properties and even lives. If this mangrove forest will be rehabilitated, this will prevent the greater impact of the aforementioned natural calamity. Utilization of the

Image 2. Noteworthy species in Timaco Mangrove Swamp: A—*Aegiceras floridum* | B—*Avicennia rumphiana*. © Authors.

Image 3. Short and multi-stemmed individuals of *Sonneratia alba* and *Avicennia rumphiana*: A—*Sonneratia alba* | B—*Avicennia rumphiana* | C—Sampling area showing short individuals of mangroves. © Authors.

remaining individuals of mangrove species in the area can be utilized as a source of propagules in rehabilitating it. Restoration effort of an almost denuded mangrove forest like of the Timaco Mangrove swamp requires a concerted effort of the government, community, and stakeholders; a sense of ownership must be felt by the community to lessen if not totally eradicated the activities leading to mangrove forest destruction. Furthermore, a more comprehensive study on the mangrove biodiversity of this area must be conducted to strengthen policy decisions for Timaco mangrove swamp restoration, protection, and preservation.

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