



## RESEARCH PAPER

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## Mangrove conservation and utilization in Tacloban City, Leyte, Philippines

Myra A. Abayon\*

*Leyte Normal University, Leyte, Philippines*

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### Abstract

The study investigated the community knowledge and practices of mangroves in Tacloban City, Leyte, Philippines. The study aimed to explore the role of community knowledge and practices in the conservation and management of mangroves while also assessing the sustainable use of these ecosystems. The study used a mixed-methods approach, including surveys and interviews that involved 150 local stakeholders, such as fishers, farmers, and community leaders, living near the area. They were selected using a simple random sampling procedure to identify the community knowledge and practices as well as potential ways to enhance the sustainable use of mangroves in the area. Results revealed that the majority of respondents were knowledgeable about the existence and services of mangroves, except for their medicinal uses. However, many respondents had limited knowledge about the different species of mangroves. The study also found that the mangrove ecosystem was primarily utilized as a food source by most respondents, with few using it for other purposes such as fuel wood, medicine, dyeing agent, and construction materials. Further, results of the study will help in the attainment of Sustainable Development Goals (SDGs), specifically importance of mangroves in achieving SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 14 (Life Below Water). The findings underscore the need to raise awareness of the different services provided by mangroves, promote sustainable utilization practices, and improve community knowledge for the conservation and management of these vital ecosystems.

\* **Corresponding Author:** Myra A Abayon ✉ [myra.abayon@lnu.edu.ph](mailto:myra.abayon@lnu.edu.ph)

## Introduction

Mangroves are a diverse group of plants comprising numerous species (Tomlinson 1986; Primavera 2009; Spalding *et al.*, 2010; Duke 2011; Leбата-Ramos 2013) with a remarkable ecological tolerance, enabling them to thrive in extreme conditions like hypersalinity and high solar radiation (Adame *et al.*, 2021). Mangroves are globally renowned for their exceptional productivity, linking marine and terrestrial ecosystems (Sreelekshmi *et al.*, 2021). They are essential in preserving marine biodiversity in tropical and subtropical regions, and they play a crucial role in global biogeochemical processes and mitigating climate change (Wang and Gu 2021). These characteristics have been thoroughly investigated through multiple studies, highlighting the significance of mangroves in maintaining a sustainable ecosystem.

Furthermore, mangroves are recognized for their impact on human well-being (Hsieh *et al.*, 2015; Akanni *et al.*, 2018), providing various ecosystem services, including provisioning, regulating, supporting, and cultural services (Primavera *et al.*, 2018; Kadaverugu *et al.*, 2021). These services extend to the provision of food and livelihood to local residents (Sawairnathan and Halimoon 2017; Barua and Rahman 2019; Gevaña *et al.*, 2019; Quevedo *et al.*, 2019). For instance, residents sell fish, fuelwood, and logs in the market to earn a livelihood, sustain their needs and improve their economic status (Nfotabong-Athuell *et al.*, 2009; Shah and Datta, 2010). The mangrove ecosystem also serves as a source of raw materials for charcoal production and construction (Nfotabong-Athuell *et al.*, 2009; Sinfuego and Buot 2014; Gonzales *et al.*, 2017). Additionally, mangroves offer medicinal benefits, such as *Rhizophora* spp. being used to treat external hemorrhage and tooth decay (Nfotabong-Athuell *et al.*, 2011), and *Avicennia marina* used for sunburn (Arbiastutie *et al.*, 2021).

Although mangroves provide numerous ecological and economic benefits, there are still knowledge deficits about the ecosystem and its services, as highlighted by Dencer-Brown *et al.* (2018).

Furthermore, local populations often have limited understanding of mangrove species and their benefits, as reported by Satyanarayana *et al.* (2012). Even fishers, who rely heavily on mangroves for their livelihoods, may lack the scientific knowledge necessary to fully utilize these resources (Darkwa and Smardon, 2010). Moreover, community dependence on mangrove-based activities like charcoal making (Kusmana and Sukwika, 2018; Ritabulan *et al.*, 2019) often leads to destructive anthropogenic threats, such as firewood overharvesting, house construction, timber production, agriculture, and aquaculture activities (Nfotabong-Athuell *et al.*, 2011; Warren-Rhodes *et al.*, 2011; Jones *et al.*, 2015; Gonzales *et al.*, 2017; Marican *et al.*, 2018). Recently, ecotourism (Ramli *et al.*, 2018; Mahmood *et al.*, 2021) and urban expansion (Moschetto *et al.*, 2021) have also emerged as new threats to mangrove conservation.

The inadequate knowledge and unsustainable human activities present significant challenges to the conservation and restoration of mangroves (Biswas *et al.*, 2009). Although there have been efforts to address these issues, there are still gaps in understanding how stakeholders, such as community members, can translate initiatives into sustainable development actions (Garcia *et al.*, 2014). To effectively manage and conserve mangroves, it is necessary to have an understanding of their ecosystem services (Friess *et al.*, 2016). However, there is a lack of research on local knowledge and perspectives on mangroves and their use in the Philippines, with only a few studies conducted (Quevedo *et al.*, 2019; Tejada and Cauilan, 2019; Ballad and Mangabat, 2021). In Davao Gulf, research has primarily focused on assessing mangrove species diversity (Jumawan *et al.*, 2015; Pototan *et al.*, 2017, 2021; Cardillo and Novero, 2018) and, more recently, aboveground biomass and carbon stock (Alimbon and Manseguiao, 2021).

Mangroves are an incredibly important and diverse group of plants that are able to thrive in extreme environmental conditions, making them crucial in maintaining a sustainable ecosystem. These plants play a crucial role in preserving marine biodiversity,

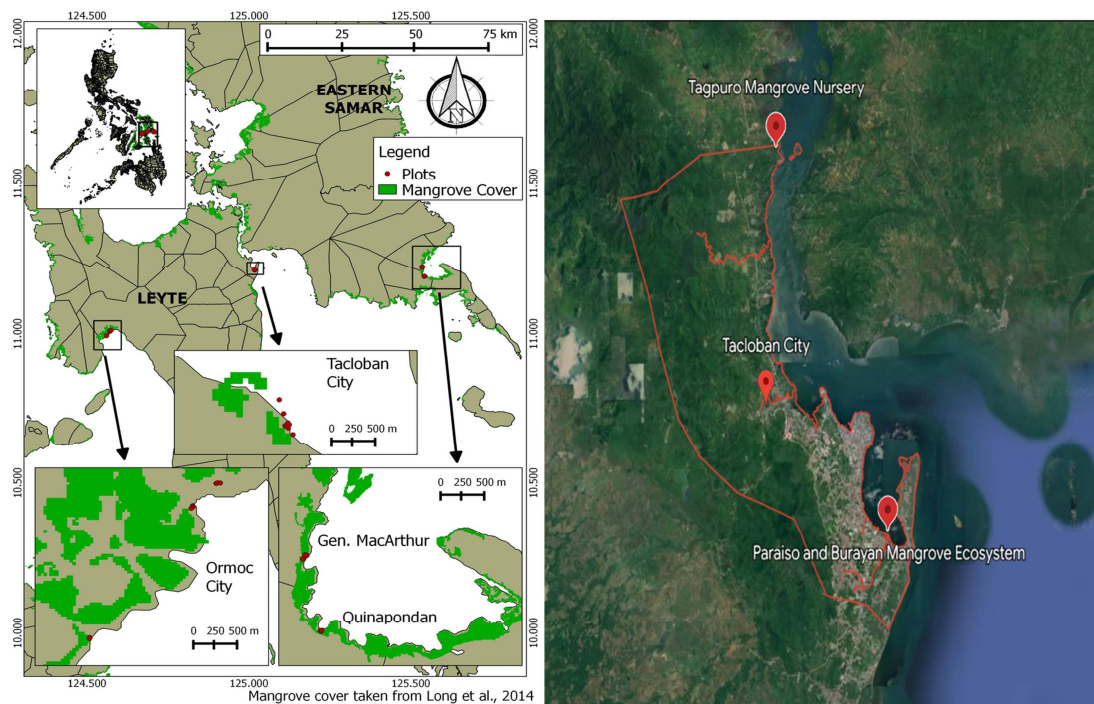
linking marine and terrestrial ecosystems, and mitigating climate change. Additionally, mangroves provide various ecosystem services that impact human well-being, including food and livelihood provision, medicinal benefits, and raw materials for charcoal production and construction. Despite their significant ecological and economic benefits, there are still knowledge deficits regarding mangroves and their services, particularly among local populations. Unsustainable human activities, such as overharvesting and urban expansion, also pose a significant threat to mangrove conservation. To effectively manage and conserve mangroves, it is necessary to have an understanding of their ecosystem services and local knowledge and perspectives on their use. Therefore, this study aims to evaluate the community's knowledge and use of mangroves in Tacloban City, Leyte, Philippines, providing baseline information for authorities to make informed decisions regarding

mangrove management and conservation efforts. By addressing these knowledge gaps and promoting sustainable use, we can work towards protecting and preserving these critical ecosystems for generations to come.

## Materials and methods

### Study Sites

The study was conducted in 9 selected sites in 3 mangrove forests within the different barangays in Tacloban City (Fig. 1). The study sites are located in Tagpuro, Old Kawayan, Cabalawan, Bagacay, Anibong and San Jose. The study was conducted last April-June, 2022. Based on the study of Patindol and Casas of 2019, these mangrove communities house several mangrove species, including *Acanthus ebracteatus* (*lagiuliw*), *Rhizophora apiculate* (Bakuan lalaki), *Rhizophora mucronata* (Bakuan babae), *Acrostichum speciosum* (Palaypay), *Nypa fruticans* (Nipa), and *Ceriops decandra* (Malatangal).



**Fig. 1.** Location of Paraiso Mangrove Eco Learning Park, Marine and Wildlife Sanctuary and Tagpuro Mangrove Nursery (Google Earth, 2023).

### Research design

This is a quantitative type of research employing a survey research design (Creswell 2012) to assess the community knowledge and utilization of mangroves

in selected mangrove forests in Tacloban City, Leyte, Philippines. This study utilizes a quantitative research approach in order to thoroughly examine and understand the community's knowledge, practices

and utilization patterns related to mangroves in Tacloban City. By employing a meticulously designed survey research methodology, following the principles elucidated by Creswell (2012), this investigation aims to gather data and insights about the community's knowledge, awareness levels, and practices concerning the mangrove ecosystems found in their locality.

#### Research Participants

The respondents of this study were the residents inhabiting near or adjacent to the mangrove communities. This study only included those living within the 500-m radius from the boundary of the mangrove parks. To ensure a representative sample, a total of 150 respondents were randomly selected using a rigorous random sampling technique. The utilization of random sampling helped minimize bias and enhance the generalizability of the findings to the larger population of interest. The sample size of 150 was determined using Slovin's formula:  $n = N/(1+Ne^2)$ , which mathematically estimates the appropriate sample size needed to achieve a desired level of precision. In this case, the margin of error was set at 0.05, denoted by the variable 'e', and the population size, denoted by 'N', was taken into account.

#### Research instrument

This study employed a structured questionnaire that was specifically designed to achieve three objectives: (1) gather demographic information about the respondents, (2) assess the level of community knowledge, and (3) determine the extent of community utilization of mangroves. To ensure that the questionnaire was easily comprehensible, it was translated into the local dialect of Tacloban City, Leyte, Philippines. The measurement of community knowledge and utilization of mangroves was conducted using a 4-point Likert scale. To enhance the validity of the instrument, content validation was performed by experts in the field. Additionally, to ensure reliability, the questionnaire was pilot tested among community members who were not part of the study but resided near a mangrove area. Any inconsistencies identified during the reliability checks were promptly addressed and corrected prior to the commencement of data collection.

#### Data analysis

Data on the demographic profile of residents, levels of community knowledge, and the extent of utilization were tabulated and analyzed using frequency and percentages.

#### Result and discussion

Table 1 presents the characteristics of the individuals participating in the study. The largest age group among the respondents is 21 to 30 years old, accounting for 24.0% of the total. Males make up the majority at 51.30%, and 66.2% of the respondents are married.

**Table 1.** Demographic profile of the respondents.

Demographic variables		n	%
Sex	Male	74	49.3
	Female	76	50.7
Marital Status	Single	44	30.0
	Married	99	66.0
	Widowed	5	3.3
	Others (e.g., live-in)	1	0.7
	Did not provide information	1	0.7
Age	20 and below	35	23.3
	21 to 30	40	27.0
	31 to 40	30	20.0
	41 to 50	20	13.3
	51 to 60	16	10.7
	61 and above	6	4.0
	Did not provide information	3	2.0
Education	No formal education	5	3.33
	Elementary	36	24.0
	Secondary	87	58.0
	College	15	10
	Graduate/Post-graduate	2	1.3
	Did not provide information	5	3.3
Number of years in the area	5 and below	49	32.7
	6 to 10	27	18.0
	11 to 15	25	17.0
	16 to 20	12	8.0
	21 or more	33	22.0
	Did not provide Information	4	2.7
Occupation	Fisherman	12	8.0
	Farmer	2	1.3
	Housewife	34	22.7
	Student	30	20.0
	Businessman	18	12.0
	Government employee	4	2.7
	Private employee	5	3.3
Monthly income	Others (i.e., skilled workers)	45	30.0
	PhP 10,000.00 and below	120	80.0
	PhP 10,001.00 – PhP20,000.00	20	14.9
	PhP 20,001.00 – PhP 30,000.00	10	1.3

Note: US\$ 1.00 ≈ PhP 52.00

Regarding education, the majority (55.8%) have completed or reached secondary education, while a small percentage (2.60%) has not received any formal education.

In terms of occupation, only 5.8% of the respondents are involved in fishing, indicating that most are not employed in fishery or coastal resource utilization. The occupations of the respondents include housewives (27.3%), skilled workers (26.6%), students (22.1%), businessmen (11.7%), private employees (3.3%), government employees (2.6%), and farmers (0.7%). Approximately 31.2% of the respondents reported residing in the area for five years or less, indicating recent migration to the area. It is important to monitor this influx of residents, as an increase in the coastal population could lead to mangrove degradation, as noted by Chong (2006). In terms of income, a significant proportion (83.8%) of the respondents earn Php 11,000.00 or less (equivalent to  $\leq$  USD 200), which is below the average monthly poverty threshold of Php 11,825.00 (approximately USD 215) for a family of five (PSA, 2020). This indicates that the monthly income of

many families in the area is insufficient to meet their basic food and non-food needs.

#### *Level of community knowledge*

This study aimed to evaluate the local community's awareness and understanding of the existence and ecosystem services provided by mangroves in the study area (Table 2). The findings revealed a high level of knowledge among the respondents, with a significant majority (81.1%) demonstrating a deep understanding of the presence of mangroves. It is worth noting that a small percentage (6.5%) reported having limited knowledge, while an even smaller fraction (3.9%) had no knowledge at all. This lower awareness could potentially be attributed to the recent arrival of some respondents to the area, as a substantial portion of the participants stated that they had been living there for only five years or less.

**Table 2.** Level of community knowledge of mangroves in Tacloban City, Leyte, Philippines.

Community knowledge	Very knowledgeable		Moderately knowledgeable		Less knowledgeable		No at all knowledgeable	
	n	%	n	%	n	%	n	%
Mangroves exist near my area	125	81.1	13	8.4	10	6.5	6	3.9
Mangroves have different species	32	20.8	26	16.9	48	31.2	48	31.2
Mangroves serve as habitat for other organisms	109	70.8	12	7.8	15	9.7	18	11.7
Mangroves serve as a nursery ground for fish, mollusks, crabs, and shrimp	110	71.4	17	11.0	14	9.1	13	8.4
Mangroves offer protection from coastal erosion and intense wind and waves during storms	114	74.0	12	7.8	13	8.4	15	9.7
Mangroves serve as a food source	92	59.7	18	11.7	23	14.9	21	13.6
Mangroves provide fuel resources (e.g., firewood, charcoal)	80	51.9	18	11.7	18	11.7	38	24.7
Mangroves provide construction and fishing materials (e.g., timber, fishing stakes, and fishing boats)	69	44.8	25	16.2	17	11.0	43	27.9
Mangroves have medicinal use	16	10.4	8	5.2	13	8.4	117	76.0
Mangroves release oxygen and absorb carbon dioxide	59	38.3	26	16.9	26	16.9	43	27.9

Despite the widespread awareness of the existence of mangroves among the surveyed residents, the results indicate a limited understanding of the different species of mangroves, with a significant percentage (31.2%) having minimal to no knowledge. It is worth noting that during the survey, respondents could only provide generic local names for *Ceriops*, *Sonneratia*, and *Rhizophora* species, while only a few respondents were able to provide specific local terms for *R.*

*apiculata* and *R. mucronate* (Table 3). This finding aligns with previous research by Nfotabong-Athuell *et al.* (2011), which similarly showed that residents living near mangrove forests typically have familiarity with only one to four species. Another study by Longépée *et al.* (2021) also discovered a lack of local ecological knowledge among their respondents regarding the number of mangrove species and their respective names.

**Table 3.** Mangrove Composition in Tacloban City, Leyte, 2020.

Family	Scientific Name	Common Name
Acanthaceae	<i>Acanthus ebracteatus</i>	Lagiwliw
Acanthaceae	<i>Avicennia marina</i>	Bungalon
Acanthaceae	<i>Avicennia officinalis</i>	Api-api
Acanthaceae	<i>Avicennia rumpiana</i>	Miapi
Arecaceae	<i>Nypa fruticans</i>	Nipa
Bombacaceae	<i>Camptostemon philippinensis</i>	Gapas-gapas
Combretaceae	<i>Lumnitzera littorea</i>	Tabao
Euphorbiaceae	<i>Excoecaria aga/Jocha</i>	Lipata
Meliaceae	<i>Xylocarpus granatum</i>	Tabigi
Meliaceae	<i>Xylocarpus moluccensis</i>	Piag-ao
Myrsinaceae	<i>Aegiceras corniculatum</i>	Saging-saging
Myrsinaceae	<i>Aegiceras floridum</i>	Tinduk-tindukan
Myrtaceae	<i>Osbornia octodonta</i>	Tawalis
Pteridaceae	<i>Acrostichum speciosum</i>	Palaypay
Rhizophoraceae	<i>Bruguiera gymnorhiza</i>	Busain
Rhizophoraceae	<i>Bruguiera cylindrica</i>	Pototan
Rhizophoraceae	<i>Ceriops decandra</i>	Malatangal
Rhizophoraceae	<i>Ceriops tagal</i>	Tangal
Rhizophoraceae	<i>Rhizophora apiculata</i>	Bakauan lalaki
Rhizophoraceae	<i>Rhizophora mucronata</i>	Bakauan babae
Rhizophoraceae	<i>Rhizophora stylosa</i>	Bakauan bato
Someratiaceae	<i>Sonneratia alba</i>	Pagatpat
Sterculiaceae	<i>Heritiera littoralis</i>	Dungon late

In this study, the community's understanding of the services provided by mangroves was also assessed. Many participants reported having extensive knowledge about specific services, such as the availability of food (59.7%), fuel resources (51.9%), and materials for construction and fishing (44.8%). Several studies (e.g., Dencer-Brown *et al.*, 2019; Quevedo *et al.*, 2019; Setiyaningrum 2019; Wahyuni *et al.*, 2021) have documented the awareness among individuals that mangroves offer one or more of these benefits. The local population largely recognizes these advantages due to their perceived importance and direct contribution to human livelihood (Nyangoko *et al.*,

2021). Interestingly, a significant portion of surveyed residents lacked knowledge regarding mangroves as a source of firewood and charcoal (24.7%), as well as construction and fishing materials (27.9%). Moreover, the community's understanding of the medicinal uses of mangroves appears to be limited, with 76.0% of respondents claiming to be unaware of this particular benefit. Similar findings have been reported in studies where participants demonstrated a doubtful comprehension of the medicinal benefits associated with mangroves (Sulaiman *et al.*, 2019; Wahyuni *et al.*, 2021). Nyangoko *et al.* (2021) even discovered that local inhabitants consider this benefit to be less important compared to other provisioning services.

Furthermore, an assessment was conducted to determine the level of knowledge regarding the supporting and regulating services provided by mangroves. A majority of the surveyed participants demonstrated awareness that mangroves serve as habitats for other organisms, with 70.8% acknowledging this role, while 71.4% recognized their significance as nurseries or spawning grounds. Additionally, a notable 74.0% of the local population had a strong understanding of the mangrove community's ability to protect coastlines from erosion and withstand the impact of storms, including intense winds and waves. However, only 38.3% of the residents exhibited substantial knowledge about the role of mangroves in oxygen release and carbon sequestration. The residents' level of knowledge in these areas may be influenced by their educational attainment, as education is considered a crucial factor in enhancing individuals' comprehension of the mangrove ecosystem (Abd Rahman and Asmawi 2016; Sawairnathan and Halimoon 2017). As indicated in Table 1, 58.83% of the respondents had completed secondary education (high school), which provides them with a basic understanding of mangroves (Abd Rahman and Asmawi 2016). This significant level of knowledge among the local population supports the findings of several studies (Nfotabong-Athuell *et al.*, 2011; Warren-Rhodes *et al.*, 2011; Ferichani and Prasetya 2012; Da Silva 2015; Sawairnathan and Halimoon 2017; Tejada and Cauilan 2019), which have highlighted the residents'

awareness of the benefits and ecological services derived from the mangrove ecosystem.

#### *The extent of community utilization*

The utilization of mangroves by the community was also examined, as shown in Table 4. A significant number of respondents (71.4%) reported that they rely on mangroves as a source of food, with varying frequencies ranging from occasional to frequent consumption. The commonly collected food items from the area were fish and shellfish. However, 28.6% of the surveyed locals never accessed the mangrove site for obtaining food. Despite existing studies (e.g., Dahdouh-Guebas *et al.*, 2000;

Nfotabong-Athuell *et al.*, 2011; Da Silva 2015; Gonzales *et al.*, 2017; Numbere 2019) documenting various uses of mangroves by local inhabitants, such as firewood, charcoal, fodder, construction materials, fishing apparatus, medicine, dyeing agents, household furniture, and other items, only a few respondents claimed to have benefited from these uses in the study area. Furthermore, when it comes to generating income, only 16.2% reported deriving economic benefits from mangrove-related activities. These income-generating activities included selling caught fish and shellfish as well as participating in initiatives initiated by the local government unit.

**Table 4.** The extent of community utilization of mangroves in Tacloban City, Leyte, Philippines.

Community utilization	Always		Sometimes		Rarely		Never	
	n	%	n	%	n	%	n	%
I use mangroves as a food source	26	16.9	29	18.8	55	35.7	44	28.6
I use mangroves as construction materials for houses	4	2.6	6	3.9	7	4.5	137	89.0
I use mangroves as fishing materials (e.g., poles for fish traps, rafts, boats)	6	3.9	5	3.2	10	6.5	133	86.4
I use mangroves as medicine	3	1.9	4	2.6	12	7.8	135	87.7
I use mangroves as firewood	7	4.5	6	3.9	7	4.5	134	87.0
I use mangroves as charcoal	5	3.2	2	1.3	5	3.2	142	92.2
I use mangroves as house furniture (e.g., chairs, tables) and household items (e.g., baskets, mortar, tool handles)	7	4.5	6	3.9	9	5.8	132	85.7
I use mangroves in agriculture (e.g., fence, fencing posts, fodder)	8	5.2	4	2.6	10	6.5	132	85.7
I use mangroves as a dyeing agent	4	2.6	1	0.6	5	3.2	144	93.5
I use mangroves as a source of income	4	2.6	5	3.2	16	10.4	129	83.3

The limited use of mangroves can be attributed to the fact that the majority of residents have occupations unrelated to fisheries and other activities associated with mangroves. Only a small percentage of respondents (5.84%) identified themselves as fishermen. Additionally, this could be due to the residents' extensive knowledge of laws and policies concerning the conservation, protection, utilization, and development of mangroves, as highlighted by Sulistyowati and Astuti in 2018.

In the Philippines, the cutting of any mangrove species is prohibited under the Revised Forestry Code. Moreover, the conversion of mangroves for fishponds or any other purpose is deemed illegal according to Republic Act No. 10654. At the study site, a prominently displayed poster serves as a reminder to the public not to engage in tree cutting or construct any structures within the mangrove forest.

Contrary to findings in several African countries, where a significant percentage of households residing near mangrove forests continue to rely on these resources for their subsistence and economic needs (Nfotabong-Athuell *et al.*, 2009; Da Silva, 2015; Warui *et al.*, 2020), the results of this study indicate a different scenario. Furthermore, Gonzales *et al.* (2017) discovered that in Rio Tuba, Palawan, Philippines, the local community still engages in the harvesting of mangrove trees for house construction and charcoal production. However, Satyanarayana *et al.* (2012) have observed a decline in the utilization of mangrove resources as a prevailing trend.

In conclusion, the community demonstrates awareness of the presence of mangroves in the area, although a significant number of respondents in the survey were unaware of the different species of mangroves.

The majority of respondents possess knowledge about the various ecosystem services provided by mangroves, with the exception of their medicinal uses. In terms of utilization, except for being a food source, the utilization of mangroves can be considered limited. Many respondents reported obtaining food, such as fish and shellfish, from the area at varying frequencies. The non-extensive utilization of mangroves, particularly the avoidance of highly destructive practices like fuelwood and charcoal production, by most residents could be attributed to their occupation and awareness of existing laws that prohibit such activities.

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