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Research Article

Bioresource Rent Value of Mt. Malindang Range Natural Park, Philippines, for Access and Benefit Sharing Scheme

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The Mt. Malindang Range Natural Park (MMRNP) in the Philippines is a vital protected area that harbors a diverse range of flora and fauna with substantial economic significance. Despite the extensive research conducted within MMRNP, the monetary value of its rich biodiversity remains vastly underestimated. This research employs a combination of key informant interviews and focus group discussions with local and indigenous people (IP) communities living near MMRNP. Value chain analysis and resource rent calculation were utilized to determine the economic value of MMNRP's bioresources and ensure their sustainability and equitable management. Through these participatory methods, nine bioresources of significant economic importance have been identified, prioritized, and found to be collected, utilized, and traded by communities. These include five floral species: *Dendrocnide* sp., *Calamus* sp., *Cinnamomum mercadoi, Agathis philippinensis,* and *Gymnostoma sumatranum*, and four faunal species: *Limnonectes sp., Apis* sp., *Apis cerana, and Sus philippensis*. The estimated annual value of these economically important bioresources within MMRNP is PhP 42,708,861.20. Given its potential contribution to the local economy, the establishment of enabling policies to protect bioresources is crucial to mitigate the adverse impacts of natural resource exploitation on both economic growth and the development of local communities residing near MMRNP. It is strongly recommended that joint close monitoring and supervision by relevant agencies such as the Department of Environment and Natural Resources (DENR), local government units (LGUs), and Protected Area Management Boards (PAMB) be implemented. This approach will promote transparency and consensus building, ensuring the sustainable management of these invaluable bioresources for access and benefit of present and future generations.

Keywords: bioresources; focus group discussion; indigenous people; resource rent; value chain analysis

1. Introduction

Biodiversity provides the ecological structures and processes that sustain ecosystems and their capacity to deliver ecosystem services [1]. It also serves as the foundation for economic growth, food and livelihood security, good health, and climate regulation, as they all depend on the state of biodiversity. Despite its importance, biodiversity loss is one of the main issues facing the world today. Moreover, bioresources are typically undervalued despite their contribution to the local, regional, and national economy. Due to large budget gaps in public finance, it is challenging to implement biodiversity policies and targets [2]. The conservation of biological resources has received considerable attention globally and nationally in recent decades [3, 4]. Alongside the growing dialog on biodiversity conservation, there is also an increasing recognition of the role of traditional and indigenous knowledge in solving biodiversity crisis [5].

Historically, biological resources have been managed and sustainably used by the world's indigenous communities for their survival, sustenance, and livelihood [6]. Their contribution in protecting and restoring ecosystems has been documented as they were able to protect critical ecosystems in many parts of the world [7]. In adherence to Article 15.7 of the Convention on Biological Diversity (CBD), user countries should take legal, administrative, and policy steps to ensure that value creation in the bioeconomy can contribute to the conservation and sustainable use of biological diversity [8]. The NP to CBD on ABS is a new international treaty on ABS, adopted in October 2010 to support the implementation of the third objective of CBD, namely, the fair and equitable sharing of benefits arising from the utilization of genetic resources. It is based on the twin principles of prior informed consent (PIC) and mutually agreed terms (MAT) enshrined in the CBD. This Protocol on ABS entered into force on 9 October 2014, prompting the Parties to CBD to prepare for its implementation by taking appropriate policy, legislative, and administrative measures [9]. They are based on diverse national and regional laws and regulations, which mostly result from the implementation of the United Nations CBD and its supplementary agreement, the NP [10]. The rapidly expanding field of ABS is influenced by the national implementation of the parties as they interpret the ABS goals and integrate them into their regulatory mechanisms [11]. ABS is a framework that refers to a relatively recent type of legal requirement for access to and use of genetic resources, emphasizing sustainability and equitable benefit-sharing [12]. Governance systems for access to genetic resources and sharing of benefits (ABS) arising from their commercial utilization may be seen from several positions such as perspectives of the primary stakeholders, provisions of the national regulatory framework, and the country's legally binding obligations under international treaties to which it is a Contracting Party [13].

The Philippines has biological resources of about 52,000 endemic species, both flora and fauna [14]. The 2022 Philippine Biodiversity Conservation Prioritization Project (PBCPP) estimated the annual economic value of the country's biodiversity at approximately US $1.2 billion [15]. The study highlighted the potential of ABS in achieving both economic growth and poverty reduction among upland occupants [16]. Under this approach, the value of the bioresources must be equitably shared with the communities responsible for their protection [17]. This principle is enshrined in the NP as it emphasizes the fair and equitable distribution of benefits and income arising from genetic resources and associated traditional knowledge [18].

In the Philippines, the Republic Act 10055 enacted the Philippine National Access and Benefit Sharing Framework that provides essential guidelines for the fair, equal, and equitable sharing of genetic resources from the park and associated traditional knowledge. Thus, valuing bioresources for ABS is crucial in the conservation and sustainable use of biodiversity in the Philippines.

This study focuses on Mt. Malindang Range Natural Park (MMRNP), one of the protected areas, Key Biodiversity Areas, and an ASEAN Heritage Park in the Philippines [19–21]. It is home to unique, rare, and threatened species of flora and fauna that sustain its ecosystem services, specifically the provisioning services, for the surrounding communities of the province of Misamis Occidental and the adjacent provinces of Zamboanga del Norte and Zamboanga del Sur in Region 9 [22]. These provisioning services include various benefits such as food, water, energy, and other natural resources [23]. The well-being of households, particularly those in upland areas, depends on these resources for survival and additional income [24]. Therefore, understanding the connection between bioresources and household well-being is crucial in designing policies and interventions that support sustainable development and poverty reduction in the remote areas of MMRNP.

This study aims to determine the estimated value and economic significance of selected bioresources of MMRNP for access benefit sharing and policy options for effectively and efficiently managing these resources. Furthermore, understanding the economic value of bioresources is crucial for MMRNP sustainable management and conservation efforts.

2. Materials and Methods

2.1. Study Area. The MMRNP is geographically located in the province of Misamis Occidental, Region X, Mindanao Island, Philippines (Figure 1). It connects the eastern part of the Zamboanga Peninsula. It is within geographic coordinates 123°31′45″ to 123°55′30″ East longitudes and 8°30′30″ to 8°45′55″ North latitudes. It has a total area of 53,062 ha encompassing the municipalities of Don Victorino, Bonifacio, Clarin, Tudela, Sinaban, Jimenez, Panaon, Aloran, Lopez Jaena, Calamba, and Concepcion and three cities of Tangub, Ozamiz, and Oroquieta. It is bounded on the north by the town of Concepcion; on the

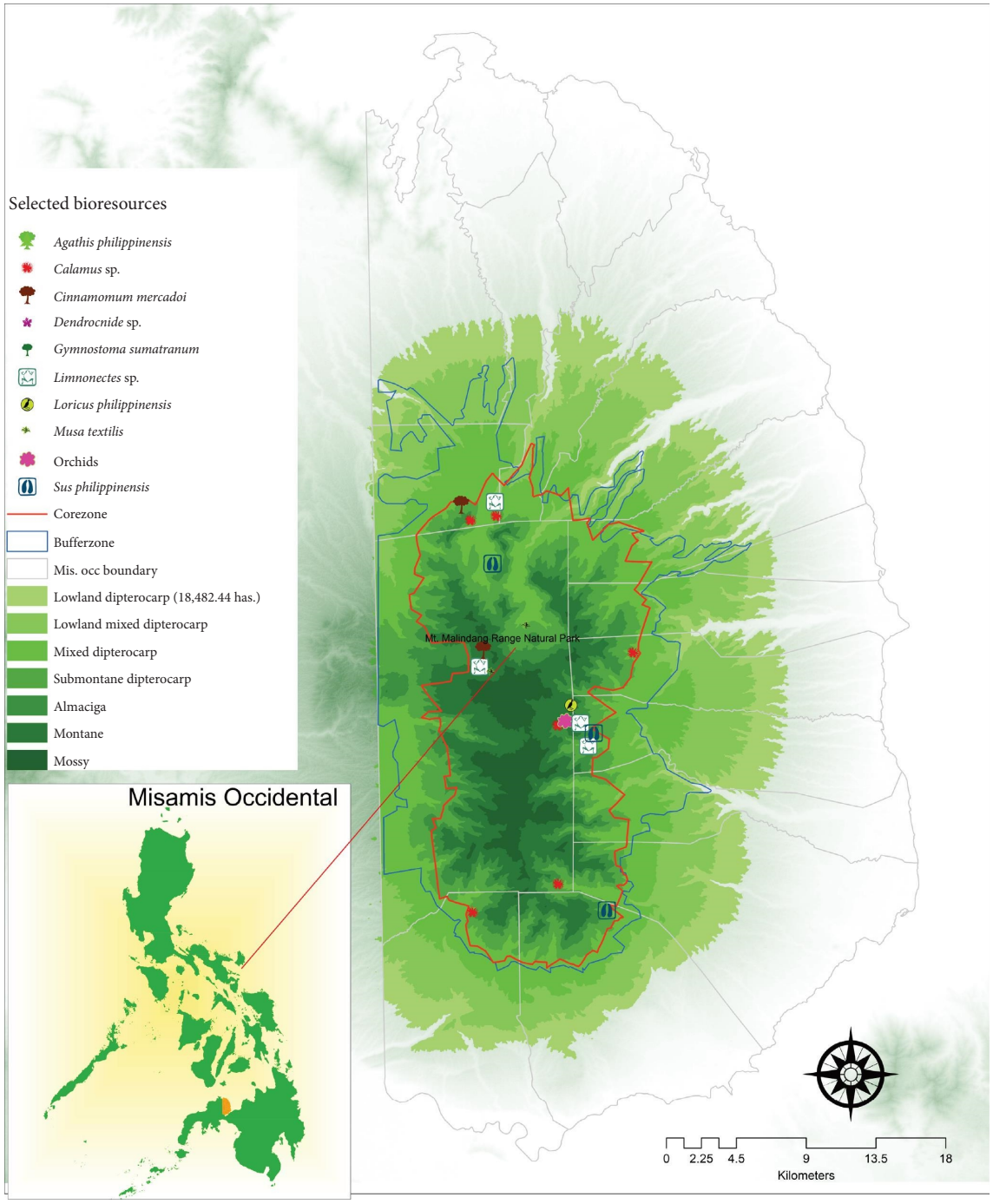

Figure 1: Map of the location of the study area and the prioritized bioresources in Mt. Malindang, Misamis Occidental, Philippines.

east by the towns of Aloran, Jimenez, and Sinacaban; on the west by the province of Zamboanga del Sur and Norte; and on the south by the town of Bonifacio. The MMRNP, due to its immense importance, was a recognized Key Biodiversity Area, Important Bird Area, ASEAN Heritage Park, and the Alliance of Zero Extinction Site. Most of the Subanen indigenous peoples' (IP) population is concentrated in the park's core zone, which is about 90%. In 2020 population census by the Philippine Statistics Authority (PSA), a total IP population of 42,392, or 6.8% of the province's total population of the province of Misamis Occidental, was recorded.

2.2. Data Gathering and Analysis. In the identification of bioresources in MMRNP, the focus group discussions (FGDs), key informant interviews (KIIs), and participatory

mapping were conducted in collaboration with the Department of Environment and Natural Resources (DENR) representatives, selected Protected Area Management Board (PAMB) members, Armed Forces of the Philippines (AFP), National Commission on Indigenous Peoples (NCIP), representative of selected City/Municipal local government units (LGUs), PAMB local community members, and representatives from the Subanen indigenous cultural communities. The FGDs and KIIs were conducted from November 8, 2022, to March 8, 2023.

Since the MMRNP hosts numerous bioresources, the selected bioresources with the identified criteria were prioritized and processed using pairwise ranking to give appropriate weights for each criterion. Pairwise frequency scores were used to rank each criterion to determine the percentage weights (Table 1). KIIs were held in areas identified during the FGDs to investigate further the utilization of the bioresource, its market price, and its collection and trade locations. Selected bioresources satisfy the following criteria, as agreed by the FGD participants, namely, economic value, medicinal benefits, and availability and accessibility. The identified criteria were ranked using pairwise ranking; the frequency score from pairwise was used to assign weights by percentage for each criterion. Then, a multicriteria analysis was conducted to prioritize the identified bioresources during the FGDs and KIIs conducted in the upland communities. The collection and trade locations of the bioresources were also identified during the FGDs.

The method used in this study for marketed bioresources [25] suggests using value chain analysis to value bioresources for ABS. Through value chain analysis, the equity of the distribution of revenues can be analyzed across the value chain from the main source to the end markets. The value chain analysis procedures are summarized below (Nelliyat and Pisupati, n.d.).

1. Understand the status of the bioresources and biodiversity data through its potential and purpose from the lens of local communities, traders, research organizations, government agencies, and industries.
2. Trace the leveraging and circulation of data in the community (e.g., exporters and custom department).
3. Research on the promising uses of bioresources based on value addition cost of bioresources the from forest gate to company gate.
4. Identify the major production steps.
5. Identify the different factors of production and its cost/remuneration.

The assumption of Lasmarias [26] that the scarcity rent and information rent are already included in the total cost of production was followed. Thus, the resource rent (RR) computation is as follows:

$$\text{RR} = \text{TR} - \text{TC} - \text{Normal return on capital}, \quad (1)$$

where TR is the total revenue and TC is the total cost. The standard expected return on capital is approximately 15% of the total production cost. In cases where it is challenging to determine the costs associated with bioresources, the price at the initial point of sale is utilized as an indicator of their economic value. This approach is considered as one of the most accurate estimations of ecosystem service value [27].

3. Results

The findings of the FGDs and KIIs revealed that bioresources are socioeconomically important in MMRNP. The key informants and FGD participants identified 9 priority species, comprising five floral species and four faunal species. As shown in Table 2, the priority floral species include *Dendrocnide* sp., *Calamus* sp., *Cinnamomum mercadoi, Gymnostoma sumatranum*, and *Agathis philippinensis*, while priority fauna species include *Limnonectes* sp., *Apis* sp., *Apis cerana,* and *Sus philippensis.* These priority bioresources play a major role in the ecological balance and the health of MMRNP, emphasizing the need for targeted conservation efforts and sustainable management practices to ensure their preservation. These bioresources are typically harvested manually in the barangays within MMRNP in the province of Misamis Occidental. They are commonly used for medicine, basket-making, strips, firewood, and food.

As outlined in Table 3, rattan, wild pigs (meat), and honey have the highest RR values, emphasizing their economic importance and contribution to the local economy in the area. The result provides valuable insights into the potential benefits of different bioresources in MMRNP. The identified values associated with each bioresource offer a basis for resource conservation and management decision making among the PAMB as the governing body of the park. Understanding the economic contributions of these resources, stakeholders and policymakers can design strategies that balance economic development with environmental conservation. The range of RR values, from the highest (rattan, wild pigs, and honey) to the lowest (Alingatong products), reflects the varying degrees of economic significance among the bioresources. This information can guide prioritization in conservation efforts and resource allocation, ensuring that the most economically valuable resources receive adequate attention and protection.

As outlined in Table 3, the result provides valuable insights into the potential benefits of these natural resources in MMRNP. Determining the RR value, the study highlighted the significance of these various bioresources to the park occupants in MMRNP. Among these bioresources, rattan, wild pigs (meat), and honey emerged as the top contributors to RR values, emphasizing their economic importance and contribution to the local economy in the area.

The emphasis on sustainable management practices is crucial for the long-term availability of these bioresources. Recognizing the economic value of biodiversity, the study aligns with broader research trends that highlight the interconnectedness of ecological health and economic prosperity [28]. The experiences from similar studies, such as

Table 1: Criteria in selecting priority bioresources in Mt. Malindang Range Natural Park, Misamis Occidental.

Criteria	Frequency score	Ranking	Assigned weights (%)
Economic value	1	3	50
Traditional value	3	1	17
Accessibility and availability	2	2	33

those conducted in Palawan Island in the Philippines, underscore the importance of understanding how indigenous communities interact with and contribute to the economic value of bioresources [29].

Similarly, the IPs should be the principal protectors of the ecosystem and are essential to preserving biodiversity in protected areas. Protected areas like in the case of Mount Apo Natural Park, the populations of endemic brown deer (*Rusa marianna*) within the ancestral domains are widely protected by IP, suggesting the importance of IP in the preservation of biodiversity. The IP of Mount Apo Natural Park considered that wildlife and forests are sacred [30].

Table 4 presents the aggregated value of bioresources within MMRNP amounting to PhP 42,708,861.20. This aggregated value represents the value of the priority bioresources that the local and IPs collected, extracted, and utilized. This value will become an input to policies to promote the sustainability of these bioresources in MMRNP.

Despite the legal implications consistent with existing laws and regulations of gathering and hunting wildlife in contravention of the existing laws against collection and trading, the community still revealed information. Since the research team had already engaged in multiple previous projects in MMRNP, they were known to the community, hence their confidence in sharing the information as input for this study.

4. Discussion

This section provides a detailed description, uses, and RR value of the nine priority bioresources identified and prioritized by local and IP communities in MMRNP.

4.1. Floral Species

4.1.1. Dendrocnide sp. (Alingatong). *Dendrocnide* sp., commonly known as "Alingatong," is a plant species found in the Philippines. It belongs to the family Annonaceae, which is known for its many medicinal and economic uses. The bark of the tree contains alkaloids and other compounds that are used in traditional medicine. *Dendrocnide* sp. has a long history of traditional use in Philippine folk medicine. The bark of the tree is traditionally used to treat fever, diarrhea, and other gastrointestinal problems. The leaves are also used as a poultice for wounds and skin infections. In addition, the fruit of the tree is edible and is used in some local dishes [31].

In MMRNP, some of the locals collected the roots of Dendrocnide sp., specifically in Barangay New Liboron, Hoyohoy, Lake Duminagat, Mialen, and Singalat, and sold them to market by the bundle at PhP 100/bundle. Based on the KIIs and FGDs, they collect *Dendrocnide* sp. roots depending on the demand in the market. During the pandemic, "Alingatong" was in high demand in the market, specifically in Ozamiz City, because it was believed that it could cure many diseases such as kidney infections, arthritis, and COVID-related infections. Some Subanens believed that boiling Alingatong and drinking it while it is warm could prevent them from COVID-19 infections. But this perceived belief has yet to be confirmed by scientific studies.

The RR of *Dendrocnide* sp. (Alingatong) roots is Php 735.25/batch and Php 49.02/bundle. The conservation status of *Dendrocnide* sp. is currently unknown, as there is limited information available about its population size and distribution. Like many other plant species in the Philippines, *Dendrocnide* sp. is threatened by habitat loss due to deforestation, logging, and agricultural expansion.

4.1.2. Calamus sp. (Rattan). Rattan is a palm belonging to the genus *Calamus*. In MMRNP, the species known to local/IP residents as identified include Palasan (*Calamus merrilli).* Based on the Biodiversity Monitoring System (BMS) report of the DENR, there are different varieties of *Calamus* sp. that can be found in the forest areas of the MMNRP. The locations identified by the respondents of KIIs and FGDs are in the forest Mt. Balabag in the municipality of Concepcion, Municipality of Tudela, Sinacaban, Jimenez, Bonifacio, and Tangub City. Some households gathered rattan poles from the protected area and marketed them as "bukag" on an order basis and as strips ("tagkos") to the local market.

Rattan product valuation has been a challenge for the industry, especially in the Philippines. Due to the necessity for proper grading and quality standards, rattan products are typically underestimated [32]. To boost the value of rattan products, recent efforts have been made to establish a rattan grading and certification system in the country [33]. In the Philippines, rattan gathering and production are key economic activities. Alam and Salahuddin (2016) discovered that rattan offers collectors with an average annual income of Php 24,625 to Php 32,855. It also indicated that the average annual collection per collector is 1.157 kilos. Unfortunately, the availability of rattan has reduced over time due to over harvesting. As a result, rattan production has decreased and local populations' income has decreased. Rattan valuation is an important part of the rattan industry. Rattan valuation has been a big issue in the Philippines due to the absence of consistent price procedures. The absence of regular pricing procedures has led to price swings and a lack of market stability in the rattan industry. Hence, the study advised establishing a pricing structure that takes into account other aspects, such as rattan quality and market demand [34].

The valuation of rattan products in the Philippines is influenced by a variety of factors, including the quality of the raw materials, the skill of the craftsmen, and the

Table 2: Priority bioresources of Mt. Malindang Range Natural Park, Misamis Occidental, Philippines.

Bioresources	Methods of Collection	Location in MMRNP	Frequency of Gathering	Uses in the community
Dendrocnide sp. (Alingatong)	Manual using bolo	Barangays Liboron, Hoyohoy, Lake Duminagat, Mialen, and Singalat	Four times/year	Medicine roots and barks
Calamus sp. (rattan)	Manual using bolo	Small Potongan, Carmen, Sebucal, Lalud, Namut, Hoyohoy, and Mapurog,	Four times/year	Basket
	Manual using bolo	Small Potongan, Carmen, Sebucal, Lalud, Namut, Hoyohoy, and Mapurog,	Four times/year	Strips for tying
Cinnamomum mercadoi (Kalingag)	Manual using bolo	Lake Duminagat, Gandawan, Liboron, Namut, Hoyohoy, and Small Potongan	Depends on the needs	Bark for medicine—consumption only
Gymnostoma sumatranum (Maribuhok)	Manual	Barangay Small Potongan	Once a month	Wood for firewood
Agathis philippinensis (Almaciga)	Manual	Liboron, Sebucal, Lake Dumiangat, Hoyohoy, Namut	Depends on the need	Resin—used for lightning and incense Used to treat wounds, headache, overfatigue
Limnonectes sp. (Bakbak)	Manual	Hoyohoy, Namut, Small Potongan, and Carmen	Once a month	Meat—food consumption
Apis sp. (Putyukan)	Manual	Namut, Hoyohoy, Small Potongan, and San Lorenzo	Twice a year	Honey—food
Apis cerana (Ligwan)	Manual	Hoyohoy, Namut, Small Potongan, and Carmen	Once a year	Honey—food
Sus philippensis (wild pig)	Trap	Lake Duminagat, Gandawan, Sebucal, San Lorenzo Ruiz, New Liboron, and Small Potongan	Once a year	Food—meat

Table 3: Summary of bioresources collected in Mt. Malindang Range Natural Park, Misamis Occidental.

Bioresources	Product	Market price (Php)	Resource rent (Php)	Data sources
Dendrocnide sp. (Alingatong)	Roots	100.00	49.02	FGDs
Calamus sp. (rattan)	Basket	400.00–500.00	274.30	KKIs/FGDs
Rattan strips	Strips	350.00	275.25	KIIs/FGDs
Gymnostoma sumatranum (Maribuhok)	Wood (firewood)	70.00	48.53	FGD
Cinnamomum mercadoi (Kalingag)	Bark			KIIs
Agathis philippinensis (Almaciga)	Resin			KIIs
Apis sp. (Putyukan)	Honey	250.00	215.00	FGDs
Apis cerana (Ligwan)	Honey	250.00	136.73	FGDs, KIIs
Limnonectes magnus (Bakbak)	Meat	250.00	170.94	FGDs
Sus philippensis (wild pig)	Meat	250.00	227.77	KIIs,

Table 4: Bioresource value of MMRNP.

Bioresource (measure)	Value per unit (Php)	Estimated volume (annual)	Current aggregated value (Php)
Alingatong resource rent (root bundle)	49.02	72,000	3,529,440.00
Rattan resource rent (basket)	309.53	960	297,140.00
	173.50	8000	1,388,000.000
	320.79	5400	1,732,266.00
Rattan resource rent (strips)	275.25	48,000	13,212,200.00
Maribuhok resource rent (bundle)	48.53	36,000	1,747,080.00
Bakbak resource rent (kg)	170.94	6000	1,025,640.00
Honey resource rent—Putyukan (per bottle)	217.78	3380	736,096.40
	212.24	1500	318,360.00
Honey resource rent—Ligwan (per bottle)	136.73	2000	273,460.00
Wild pig resource rent (per kg)	227.77	81,000	18,449,370.00
Total bioresource value (current)			**Php42,708,861.20**

Note: The significance of the bold values is to highlight the total economic value of bioresources.

demand for the items on the local and worldwide markets. It was discovered that the design and quality of rattan items have a significant impact on their worth in the Philippines [35]. The study concluded that the demand for rattan products in the Philippines is influenced by a variety of factors, including the availability of replacements and the intensity of market rivalry. The Philippines' rattan business has a long history and has been an important source of income for numerous rural people. Rattan is gathered from the wild, and there are no rattan plantations on a big scale in the Philippines. Moreover, the collection of rattan in the Philippines is primarily carried out by small-scale gatherers who rely on the material for their livelihood [36].

In the study site, 36 to 40 households were involved in gathering rattan within the multiple-use zone (MUZ) and buffer zone (BZ) of MMRNP. Accordingly, those who collected rattan will only harvest if they received orders from ambulant bread vendors, neighbors, or the local market. The participants also shared that those who collected charged Php300.00 to Php500.00 for each "bukag" and Php100.00 for each "Mano" bundle (each bundle consists of 100 pieces of 1-meter strips of rattan stem). The calculated revenue from rattan declared in the FGDs and KIIs was Php1,200.00 per household per year. They collect rattan inside the forest to supplement their livelihood, particularly in locations near the protected area. Most participants in the FGD disclosed that the money these households earned from selling rattan products was used to buy food (rice) and other household expenditures, and even pay tuition for their children. *Calamus* sp. was also used by the Subanen IP during the conduct of rituals as tie, while the edible parts were eaten, and the fruits were fermented and used as substitute for vinegar. However, the *Calamus* sp. population is declining in some areas of the park due to continual collection, and measures are being implemented to enhance its numbers.

In the municipalities of Jimenez, Concepcion, and Tudela in MMRNP, communities have cultivated *Calamus* sp. for their own consumption rather than collecting it from the forest. They cultivate rattan on their properties because of the many risks and that the forest is far from their homes. Additional reasons include the area's insurgency issues and the restrictions in accordance to DENR and LGU policies. Although the DENR-Protected Area Management Office strictly prohibits the collection of rattan inside MMRNP's core zone, the KII interviews revealed that certain households still gather rattan inside the area.

In barangay Hoyohoy, rattan collectors typically stay at least two to three days in Sitio Kalinuban, their collection site, and when they returned home, they brought the finished product, i.e., basket, with them. It was revealed that they gathered rattan four times in a year.

The results of the KIIs conducted in Namut, Tudela, and San Lorenzo Ruiz, Sinacaban, revealed that the Subanen community in these barangays is actively collecting rattan for baskets. The basket price was Php500.00 per basket, which was higher compared to other locations in the province where rattan baskets were collected. This may indicate that there is a demand for rattan baskets produced by the community. The computed resource rent value for each basket in Barangay Namut was Php 320.79.

The price range of Php300.00–500.00/basket in the province of Misamis Occidental can be used as a reference for other areas that produce rattan baskets. However, the collection of rattan inside Mt. Malindang was strictly prohibited. This prohibition of the collection of rattan indicated that there is a need for sustainable management practices to ensure the continued availability of this bioresource for future generations. The involvement of some households in gathering rattan inside the park shows that rattan basket production can provide livelihood opportunities for indigenous communities who are allowed to collect bioresources in the MUZ and buffer zones of the park. The existing demand for rattan baskets produced by the local community in Mt. Malindang suggests that there is potential for a sustainable rattan industry in the area. The computed RR can be used to determine the economic value of the resources used in producing rattan baskets and can help in sustainable management practices to ensure the continued availability of resources for future generations.

4.1.3. Cinnamomum mercadoi (Kalingag). Cinnamomum mercadoi, also known as Mercado's cinnamon or Philippine cinnamon, is a tree species endemic to the Philippines. It belongs to the family Lauraceae and is one of the few cinnamon species native to the country. *Cinnamomum mercadoi* has several uses in the Philippines, including medicinal, culinary, and cultural. Traditional medicine is a remedy for various ailments, such as diarrhea, fever, colds, coughs, headaches, and rheumatism.

Its bark and leaves contain essential oils with antifungal, antibacterial, and anti-inflammatory properties. In the culinary industry, *Cinnamomum mercadoi* is a popular spice used in Filipino cuisine. Its bark has a sweet and aromatic flavor that is commonly used to flavor desserts, such as rice cakes, pastries, and puddings. It is also used in savory dishes, such as stews and soups, to add a warm and spicy flavor [37]. Despite its economic and cultural significance, *Cinnamomum mercadoi* is currently endangered. The main threats to the species include habitat loss due to deforestation, illegal logging, and the conversion of forests into agricultural lands. In addition, the species is also threatened by the overharvesting of its bark. Various conservation measures have been put in place to address these threats. These include establishing protected areas, such as the Mounts Iglit-Baco National Park in Mindoro Island, home to a population of *C. mercadoi*. The DENR has also implemented programs to promote reforestation and sustainable forest management practices.

Accordingly, the Kalingag tree dies due to constant debarking and they use it for firewood. They collected it for household consumption only. *Cinnamomum mercadoi* is listed as "Endangered" on the IUCN Red List of Threatened Species [38].

The FGDs revealed that some households collected only the bark of *C. mercadoi* for medicinal uses. Some locals and Subanen use *C. mercadoi* to treat illnesses for headaches and overfatigue. The bark is scraped and put on the side of the head to relieve the headache. Others use the bark of *C. mercadoi* in cooking as a flavoring. Accordingly, when a Kalingag tree dies due to constant debarking, the locals then cut it down and use it as fuelwood.

On the other hand, the study of Olandag [39] revealed various flora with ethnomedicinal values from the Subanen tribe of Calamba, Misamis Occidental, suggesting the important role of IP in conveying knowledge of biodiversity.

4.1.4. Agathis philippinensis (Almaciga). Almaciga, also known as the Philippine resin tree, is a tall evergreen tree native to Southeast Asia, including the Philippines. It belongs to the family Araucariaceae. The tree is known for its valuable resin, which has been traditionally used for a variety of purposes, including incense, varnish, and medicine. The Almaciga resin is a white sap coming from the Almaciga tree. The resin of Almaciga has been used in traditional medicine in the Philippines and other countries in the region. It has been used as a treatment for a variety of ailments, including coughs, colds, and digestive disorders. In modern times, researchers have investigated the potential of Almaciga resin as a source of natural compounds with therapeutic properties. Studies have found that the resin contains a variety of bioactive compounds, including flavonoids, terpenes, and phenolic acids, which may have antioxidant, anti-inflammatory, and antimicrobial properties [40].

In MMRNP, the Almaciga tree is being tapped by a "bolo" so that the sap will come out and harden. It is used by the Subanen and some locals as an igniter when cooking and as light at night. The bark is used as "talimughat" wherein the locals boil the bark and drink it. Extraction of resin ("salong") from the Almaciga tree is for household consumption only. However, the extraction of Almaciga resin in some areas has become a contentious issue in recent years. The tree has been heavily exploited for its resin, leading to the depletion of the species in many areas. In response, the Philippine government has implemented regulations to limit the extraction of Almaciga resin and protect the species from overexploitation [41].

4.1.5. Gymnostoma sumatranum (Maribuhok). Gymnostoma sumatranum, often known as "Maribuhok," is a member of the Casuarinaceae family. It can reach 40 m in height and has a straight trunk and a dense crown of branches. The bark is fissured and grayish-brown, and the leaves are grouped in whorls around the stem. It is utilized for construction, furniture, and pulp. In traditional medicine, it is used to cure a variety of conditions, including fever, diarrhea, and dysentery.

According to FGDs and KIIs, "Maribuhok" bark is traditionally utilized by the Subanen and even locals for

"talimughat," as a remedy for "bughat" or overfatigue. The bark is boiled in water and consumed on a regular basis until the condition is cured. In some parts of the MMRNP, specifically in Barangays Small Potungan and Upper Potungan of Municipality of Concepcion, Maribuhok trees were reportedly harvested for firewood and sold for Php70.00/bundle. Once a month, the head of the household gathers firewood. It has a RR of Php48.00/bundle. The income derived from the sale of "Maribuhok" helps them in their household expenses, accordingly.

4.2. Faunal Species

4.2.1. Limnonectes sp. (Bakbak). The locally known "Bakbak," a frog species, is one of the vertebrate faunal species collected by locals who are residents of the park. These frogs were collected and used as viand of the household. The locals collect "Bakbak" especially during the rainy season because it is abundant and easily captured due of its distinct sound when it is raining. Some gatherers used flashlights to catch "Bakbak"; the light from the flashlights would stop the "Bakbak" from moving. Other materials used in the gathering of "Bakbak" include sacks, which served as a container, and "sulo," a torch made of coconut leaves. The locals collect "Bakbak" in streams and rivers and then sell it to their neighbors for Php250.00/kilo. The locals believed that the frog has therapeutic effects, but it has not been proven by scientific studies.

4.2.2. Apis sp. (Putyukan). *Apis* sp., often known locally as "Putyukan," is a species of honeybee native to the Philippines. It is a subspecies of the Western honeybee, *Apis mellifera*, but stands out for its smaller size, aggressive temperament, and distinctive honey flavor. About 8–10 mm in length, "Putyukan" bees are minute insects. They are brownish-yellow with darker stripes on their abdomen. Their demeanor is very aggressive, and their sting is very painful.

Currently, the conservation status of Pukyutan bees is uncertain. Yet they face the same risks as other bee species, including habitat loss, pesticide use, and climate change. Consumers highly value the distinctive flavor and high quality of Putyukan bees' honey. Honey has medicinal characteristics and is used in traditional medicine to cure coughs, wounds, and other diseases in addition to its culinary uses [42]. *Apis* sp. beekeeping is a significant source of income for many local communities in the Philippines, especially rural regions with limited economic possibilities.

*Api*s species are significant pollinators of numerous plant species, including fruits and vegetables. Pollination services offered by bees are crucial for sustaining biodiversity and ensuring food security in MMRNP and surrounding areas in Misamis Occidental.

In MMRNP, honey is gathered from the tree where beehives are constructed. Local collectors used torch "sulo" as the main device to extract honey from the tree's crown. The torch, "sulo," is made of rolled coconut leaves and lit with fire. Initially, the honey collectors prepare dried leaves to create smoke, which causes the bees to leave the hive. Afterward, the collector will slowly climb the tree with a sharp "bolo" and a pail to gather the honey. The collected honey will then be packaged in a 350 mL bottle and sold for Php300.00/bottle. Honeys are harvested twice a year. In Barangay Namut, 10 to 15 households collect honey in the forest, but because the DENR and the military have restricted access to the forest, only five homes rely on this resource for livelihood.

Apis sp. are significant pollinators of numerous plant species, including fruits and vegetables. Pollination services offered by bees are crucial for sustaining biodiversity and ensuring food security in MMRNP and surrounding areas in Misamis Occidental. In another community in Mt. Malindang, they collected honey and sold it raw for Php250.00/bottle. They sold it to their neighbors on an order basis. The price value of the honey from Barangay Namut is cheaper than in Small Potungan, Concepcion. Thus, their RR is also different, which is Php212.24/bottle (Table 3).

4.2.3. Apis cerana (Ligwan). *Apis cerana* is native to Southern and Southeast Asia, including the Philippines. Locals have gathered the wild honey from the forest. They collect honey by burning coconut leaves to make smoke to dissuade *Apis cerana* species. After the honeybees left their hive, a local collector then sliced open the honey compartment. The honey was packaged in 350 mL bottles and sold at a local market for Php100.00/bottle. Interviews with key informants suggested that 10 to 15 homes participated in the harvesting of wild honey. The RR value is Php1,367.00 per batch and Php136.73 per bottle.

Apis cerana is an important honeybee species that helps keep the biodiversity of different habitats through pollinating crops. With its beneficial honey used in traditional medicine, this species of bees is in grave danger due to habitat loss, pesticide use, and climate change. *Apis cerana* and the many benefits they provide can only be sustained if their homes are protected, pesticide use is cut down, and the effects of climate change are lessened.

4.2.4. Sus philippensis (Wild Pig). *Sus philippensis* is a small pig, standing only 50–60 cm tall at the shoulder. It is characterized by its unique appearance, which includes a coat of dark hair with a distinctive pattern of white stripes on its face and white spots on its body [43].

The Philippine warty pig has cultural and ecological significance in the Philippines. In some areas, the species is hunted for food, and its meat is considered a delicacy. However, the species is revered as a sacred animal in other areas, and hunting is prohibited. The species also play an important ecological role as a seed disperser, contributing to forest regeneration and ecosystem health [43].

The results of the FGDs and KIIs suggest that *S. philippensis* "Baboy Sulop" is abundant in MMRNP. It can be found in the barangays of Lake Duminagat, Gandawan, Sebucal, San Lorenzo Ruiz, New Liboron, Hoyohoy, and Small Potungan. The barangays are located within the protected area where *S. philippensis* is sighted in barangays in Lake Duminagat, Gandawan, Sebucal, Mialen, Mabas,

Mamalad, Singalat, Penacio, and Dalingap. Traps and improvised marble gun were used to hunt and kill *S. philippensis* then the poachers sold their catch to the community (Table 3). Locals only captured *S. philippensis* if found in their garden or established farm. Unlike before, when hunting was not prohibited inside the forestland of MMRNP, locals hunted *S. philippensis* inside the forest for their consumption. At present, *C. philippensis* is considered a pest by the locals in their cultivated areas because it consumes their planted crops which are their main sources of food and family income. Local farmers sometimes intentionally kill the *S. philippensis* when spotted in their farms or gardens. RR per batch amounted to Php6,833.00 and RR per kilo of wild pig is Php227.77.

4.3. Significance of Bioresources in MMRNP. The economic value of bioresources in Mt. Malindang, as outlined in Table 3, provides valuable insights into the potential benefits of these natural assets. By identifying the RR values using KIIs and FGDs, the study has highlighted the significance of various bioresources in the MMRNP. Among these resources, rattan, wild pigs (meat), and honey emerged as the top contributors to RR values, emphasizing their economic importance.

The utilization of such economic data can play a pivotal role in informing sustainable management practices. The identified values associated with each bioresource offer a basis for resource conservation and management decision making. By understanding the economic contributions of these resources, stakeholders and policymakers can design strategies that balance economic development with environmental conservation. The range of RR values, from the highest (rattan, wild pigs, and honey) to the lowest (Alingatong products), reflects the varying degrees of economic significance among the bioresources. This information can guide prioritization in conservation efforts and resource allocation, ensuring that the most economically valuable resources receive adequate attention and protection.

Moreover, the call for sustainable management goes beyond economic considerations. It emphasizes balancing resource utilization with biodiversity conservation and minimizing adverse environmental impacts. Sustainable practices aim to ensure that the harvesting of bioresources does not compromise the integrity of ecosystems, supporting the overall health of the environment. The economic valuation of bioresources in Mt. Malindang provides a foundation for informed decision making in conservation and management. The identified RR values offer a tangible metric for assessing the economic importance of various bioresources, guiding efforts to balance economic development with environmental sustainability. By incorporating these findings into management strategies, the aim is to secure the continued availability of bioresources for future generations while safeguarding biodiversity and minimizing adverse environmental effects.

At present, despite the continuous effort of the concerned agencies, some of the MMRNP residents were not prohibited and/or regulated in doing their economic activities inside the protected area. Found inside the park is the livelihood for subsistence and income for these residents. Although these livelihood activities cannot produce large-scale forest products, they still need to find additional household income from other sources. The forest bioresources have the potential for commercialization if large-scale trading is allowed on resources including rattan, Kalingag, and Alingatong for commercial uses. Also, honey products could be a potential source of income among the park residents.

The bioresources collected in Mt. Malindang were identified through KIIs and FGDs, and their RR values were computed (Table 4). The top three bioresources with the highest RR values were rattan (PhP 275.25), wild pigs (meat) (PhP 227.77), and honey (PhP 215.00), while the lowest was Alingatong products (roots) (PhP 49.02). This information can be used to determine the economic value of these resources and help in sustainable management practices to ensure their continued availability for future generations. Related studies have shown that protecting biodiversity generates economic benefits in terms of direct and indirect values Therefore, it is important to manage the collection of these bioresources sustainably to ensure their continued availability while also protecting biodiversity and minimizing negative impacts on other aspects of the environment.

5. Conclusion and Recommendations

The bioresources within MMRNP play a vital role in the sustenance of livelihood and cultural identity of the Subanen IP and local communities in Misamis Occidental. The study identified 16 bioresources within MMRNP, prioritizing nine of them for RR valuation. The calculated annual aggregated value of these bioresources is Php 42,708,861.20, highlighting their potential for supporting ABS schemes. These bioresources, such as *Calamus* sp. (rattan), *Cinnamomum mercadoi* (Kalingag), *Dendrocnide* sp. (Alingatong), and *Apis* sp. (honey products), hold significant economic and cultural value. The utilization of these resources is allowed, while there is minimal collection due to restrictions of these existing laws which contributes to subsistence and additional income for IPs and local communities. However, unregulated use poses risks to sustainability, making proper management and regulation essential.

Based on the findings of the study, it is recommended that the DENR, PAMB, LGUs, NGOs, and CSOs implement efficient management and regulatory procedures. Community organizing and development, rigorous enforcement of current policies, capacity building, communication, education, and public awareness (CEPA) campaigns, alternative livelihood program implementation, community resource monitoring and research, localized ABS mechanisms, and the promotion of sustainable ecotourism activities within MMRNP should all be considered key initiatives.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Bobby B. Alaman, Jersam C. Calago, and Emmarie F. Mapi-ot conducted the data gathering, analysis, and drafting of the paper. Grace V. Villanueva assisted in providing the technical advice relating to study methods and reviewing of the paper draft. Joan U. Ureta, J. Carl Ureta, Richard B. Parilla, and Gemmalyn M. Trespalacio helped in providing technical help in the study methods, data gathering, analysis, and reviewing of the paper draft. Joseph Glenn Laput also helped in the analysis of data. All contributions from all authors helped to make the research work and paper submission a success.

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