

Indigenous Watershed Management for Sustainable Framework at Besao, Mountain Province

Mileatte P. Omaney¹, Vicente T. Wacangan², Conrado C. Bao-idang²,
Sano L. Ngiwas²

¹Assistant Professor II, College of Agriculture, Forestry and Environmental Science, Romblon State
University, Agpudlos Campus, San Andres, Romblon, Philippines

²Faculty, Benguet State University, La Trinidad, Benguet, Philippines

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Email of Corresponding Author: rangerstation18@gmail.com

Abstract

This study examined sustainable indigenous watershed management in Besao, Mountain Province, by integrating traditional forest management practices, customary guiding principles, land uses, forest cover, slope conditions, and government policies and programs. Its conceptual framework considered traditional forest management, forest cover, and slope classification alongside land uses, indigenous principles, and government interventions as bases for developing a sustainable watershed management framework. The study employed a qualitative research design involving 140 Applai indigenous household members aged 50 years and above, particularly elders and leaders engaged in traditional watershed management. Data were obtained through focus group discussions, community mapping, field visits, on-site observations, photo documentation, secondary sources, and GIS-based analysis using land cover maps, slope data, and QGIS software. The findings revealed that all 14 barangays implemented forest protection measures, including regular foot patrols, community warning systems, voluntary fire suppression, restricted tree harvesting, and spring protection. Forest maintenance involved assisted natural regeneration, wildling management, cultural practices, and fire-line establishment, while forest development included biodiversity conservation and community-based ecotourism. Community mapping identified 7,545.45 hectares of protection forest, 4,153.30 hectares of production forest or Batangan, and 6,491.89 hectares of multiple-use areas. The results showed that sustainable watershed management was strengthened by customary laws, collective responsibility, cultural beliefs, regulated resource use, and community participation. However, steep terrain, landslide susceptibility, forest fires, timber poaching, encroachment, water scarcity, and inappropriate land use remained important concerns. The study concluded that indigenous forest management effectively supports watershed protection and the responsible use of forest resources. It recommended strengthening partnerships between local government units and communities, formally integrating indigenous knowledge into local policies, rehabilitating degraded forestlands, stabilizing slopes, and clearly demarcating protection, production, and multiple-use areas. The study supports SDG 6, SDG 11, SDG 15, and SDG 17 through water protection, community-based governance, sustainable land and forest management, and institutional partnerships. Its sustainability impact lies in strengthening ecological protection, cultural continuity, community livelihoods, spatial planning, and locally grounded environmental governance.

Keywords: Batangan, Community Participation, Forest Management, Geographic Information System, Indigenous Knowledge, Land Use Planning, Slope Analysis, Sustainable Watershed Management, Watershed Governance

1. Introduction

This study focuses on sustainable indigenous watershed management in the municipality of Besao by examining indigenous forest management practices, traditional land uses, forest cover, slope conditions, and government policies and programs. It emphasizes the need to integrate indigenous knowledge, customary guiding principles, land use planning, and GIS-based slope analysis in developing a sustainable watershed management framework. The study recognizes that watershed sustainability depends not only on physical and ecological conditions but also on community participation, traditional resource governance, and culturally grounded land management practices.

1.1 Watershed Degradation and Indigenous Watershed Management in Besao

A watershed is a topographically delineated land area where rainwater drains as surface runoff through a stream or river system toward a common outlet, such as a dam, irrigation system, municipal water supply point, larger river, lake, or sea (Brooks et al., 1991). Watersheds serve multiple ecological and community functions by providing habitats for plant and animal species, regulating floods and other natural hazards, and supplying water for domestic, agricultural, and industrial needs. Sustainable watershed management therefore involves the proper use and protection of watershed resources to ensure continuous goods and services for present and future generations. Indigenous watershed practices serve as guiding

rules and codes of conduct among stakeholders for preserving and maintaining watershed resources. Brooks et al. (1991) explained that watershed management involves guiding and organizing land and other resource uses within a watershed to provide desired goods and services without damaging soil and water resources. As cited by Camacho et al. (2016), indigenous forestry knowledge systems include local technologies, innovations, skills, practices, beliefs, and cultural values that unite communities in conserving forest resources. Wacangan (2000) also found that indigenous technologies such as tuping, banak, and akan, together with traditional beliefs such as abig and boyon, enhanced watershed sustainability in Sagada. Watersheds are increasingly affected by severe soil erosion, erratic stream flow, diminishing groundwater resources, and declining land productivity due to human activities such as mining, deforestation, and overgrazing. FAO (1993) reported that the annual deforestation rate in Southeast Asian countries such as Brunei, Indonesia, Malaysia, the Philippines, and Singapore was estimated at 1.926 hectares in 1981-1990. These conditions highlight the need for appropriate land use planning and watershed management practices that balance environmental protection, forest production, and community needs.

1.2 Indigenous Practices, Land Use Planning, and Watershed Sustainability

Land use planning is essential to the sustainability of forests and natural resources (Cruz, 1999). FAO (1993) emphasized that land-use planning tools and methods should help diverse and competing land users select management options that improve productivity, support sustainable agriculture and food systems, promote governance over land and water resources, and meet societal needs. Ziadat et al. (2017) described land use planning as a systematic assessment of land potential and alternatives for optimal land uses and improved economic and social conditions through participatory, multispectral, multi stakeholder, and scale-dependent processes. Land use planning includes identifying and comparing present and potential land uses, deciding on appropriate land use types, and implementing development programs based on these decisions (SDMS-IEMSD, 1997). In sustainable watershed development, planning must be supported by timely and reliable information, modern land assessment technologies, and scientific knowledge for decision support. Sloping lands are especially vulnerable to erosion and watershed degradation, making slope analysis important in mapping land attributes and informing decisions at watershed and community scales. The literature also emphasizes the role of indigenous knowledge in sustainable resource management. Dixon (2002) stated that recognizing, empowering, and incorporating indigenous knowledge in participatory rural development projects supports socially, environmentally, and economically sustainable natural resource management. Beshah et al. (2016) further explained that advanced technologies and new approaches become more valuable when blended with traditional knowledge from target communities. These insights support the integration of scientific assessment, land use planning, and indigenous practices in sustainable watershed management.

1.3 Local, National, and Global Contexts of Indigenous Watershed Governance

In the local context, Besao's watershed management is grounded in traditional forest management practices and customary laws. The Batangan system is a traditional forest management practice affirmed under DENR-NCIP JAO 2008-01, which provides guidelines and procedures for recognizing, documenting, registering, and confirming Sustainable Traditional and Indigenous Forest Resources Management Systems and Practices of Indigenous Cultural Communities or Indigenous Peoples in Ancestral Domain/Land. In this system, forest development and protection are community mandates, and people have inherent rights to the resources they produce and manage as woodlots. At the national level, the Philippines has approximately 30 million hectares of land, of which 15.8 million hectares are forest land and 14.2 million hectares are alienable and disposable land (NAMRIA, 2009). This land base requires careful allocation for housing, food, water, employment, agriculture, industry, and environmental protection. Traditional land ownership systems, such as those observed among the Ifugao, are shaped by customary policies and practices (Camacho et al., 2016). In Besao, traditional land uses include farm grounds, pasture lands, burial grounds, water sources and watersheds, woodlots or forest lands, and developed areas, all of which are governed by customary practices and recognized regulations. In the broader global context, indigenous and local knowledge systems contribute to natural resource conservation and sustainable development. Indigenous forestry knowledge systems have developed through long-term direct human interaction with the environment (Armstrong et al., 2006). Indigenous peoples also observe customary laws that support justice, unity, and peace within their tribes (Lim et al., 2012). The United Nations Conference on Sustainable Development in 2012, entitled "The Future We Want", also stressed the need for coherent and integrated planning and decision-making at national and local levels, as well as stronger institutions and multi stakeholder bodies for sustainable development.

1.4 Conceptual Basis of Sustainable Indigenous Watershed Management in Besao

The conceptual basis of the study is anchored on the integration of indigenous practices, land use systems, forest cover, slope analysis, and government policies in developing a sustainable indigenous watershed management framework. Documented indigenous practices and policies serve as guiding principles for a holistic and balanced approach to sustainable watershed management. These practices have been recognized as effective in mitigating erosion on sloping lands, stabilizing landscapes, and maintaining clean water. Calanog (1995) stated that "indigenous knowledge and practices are important in biodiversity conservation". Mukwada (2012) also cited that indigenous knowledge systems are important in natural resource conservation because they create mutual co-existence and balance between people and the local

environment. The study considers traditional practices of forest management, forest cover type, and slope map as independent variables. These variables provide data for identifying sustainable alternative land uses that are accepted by the community, reduce damage from natural and man-made hazards, and reflect watershed conditions. The comparison of suitable land uses based on biophysical conditions, the identification of the most appropriate land uses, and the allocation of land according to this process are generally considered land use planning (FAO, 1993). The intervening variables include land uses in the municipality, government policies and programs on watershed sustainability, and indigenous guiding principles of the community. The dependent variable is the development of sustainable indigenous watershed management through the analysis of the relationship between land uses and forest cover, as well as the relationship between slope and land uses. This framework recognizes that sustainable watershed management depends on both physical land characteristics and the cultural, institutional, and policy systems that shape resource use.

1.5 Research Gaps on Land Uses, Forest Cover, Slope, and Indigenous Practices

The study addresses the need to connect indigenous watershed management practices with technical land assessment methods, particularly GIS and Digital Elevation Models. Existing discussions emphasize the importance of indigenous knowledge, land use planning, and watershed conservation, but the study highlights the need to analyze how traditional practices, forest cover, land uses, and slope conditions can be integrated into a sustainable local framework. This is important because sloping lands are vulnerable to erosion and degradation, which reduce the ecological services and economic benefits of watersheds. Traditional watershed management in Besao reflects the community's view of the forest as a source of life and a foundation of cultural identity. The relationship between local culture and forests makes forest management less costly and more effective because conservation practices are embedded in everyday life (Saway, 2011). As cited by Magar (2008), indigenous knowledge systems are developed and practiced in every community as part of adaptation to the environment. In Besao, the community participates in the protection, maintenance, and utilization of resources. The study also recognizes customary guiding principles as a basis for sustainable watershed management. Customary laws reflect traditions and beliefs that guide watershed conservation and support the balanced co-existence of people and forests (Wacangan, 2000). Inayan serves as a customary standard of caution for self-reflection before committing unacceptable acts, while Lawa refers to forbidden acts (Profile of the Kankana-ey "Batangan", 2011). Galatis refers to free service or labor provided by the community for watershed protection, development, and maintenance, as well as mutual assistance through financial help or labor exchange. Traditional practices further show how conservation is embedded in everyday resource use. Serrano and Cadaweng (2005) cited that in Ifugao, dead branches may be gathered as fuel wood from other muyongs even without permission, but this privilege is reciprocated by cleaning and tending the muyong. If a tree is harvested, it should be replaced with two seedlings. Lim et al. (2012) also noted that in Dong communities in Guizhou Province, Southwest China, parents plant fir trees when a baby boy is born, and these trees may later be used when the child reaches adulthood and marries. These examples show how customary systems can reinforce conservation, responsibility, and long-term resource planning. Slope analysis provides the technical basis for identifying suitable land uses. Slope describes the shape and relief of the land and is measured by calculating the difference in elevation between points divided by the lateral distance between them (Von Englen, 1961). The municipality is characterized by steep slopes, ravines, narrow valleys, top ridges, and limited patches of gentle slopes. Geographic Information System methods help analyze slope maps and other parameters to examine watershed and landform relationships (Palaka & Sankar, 2008). Daipan (2015) found that slightly vulnerable landslide areas in a watershed include inland waters such as creeks, rivers, streams, or lakes, with slope ranges from 0 to 8% and mountain soil classification. (Anbalagan & Singh, 2001) also cited that land use indirectly indicates slope stability, while sparse vegetation increases weathering and erosion.

1.6 SDG Alignment of Sustainable Indigenous Watershed Management

The study aligns with SDG 6 - Clean Water and Sanitation because it focuses on watershed protection, water sources, stream flow, groundwater resources, and the maintenance of clean water through sustainable watershed management. It also supports SDG 11 - Sustainable Cities and Communities because the study emphasizes community-based resource governance, locally accepted land uses, customary guiding principles, and the protection of areas that support settlement, livelihood, and community needs. The study is also relevant to SDG 15 - Life on Land because it addresses forest conservation, biodiversity, land degradation, erosion, forest cover, and sustainable land use. Since the study integrates indigenous knowledge, government policies, community participation, and land use planning, it further supports SDG 17 - Partnerships for the Goals, particularly in relation to multi stakeholder participation, local institutions, and coordinated planning for sustainable development.

1.7 Multidisciplinary Sustainability Contributions of the Besao Watershed Study

The study contributes to environmental and ecological sustainability by emphasizing forest conservation, watershed protection, erosion control, slope-based land suitability, and the preservation of land and water resources. By recognizing indigenous forest management practices and customary laws, the study also supports cultural sustainability because it values traditional knowledge, beliefs, and practices that have guided community survival and resource protection over time. The study contributes to socio-economic and community sustainability by identifying land uses that support livelihoods, agriculture, water access, settlement, and community resource needs while safeguarding watershed functions. It also

supports policy and governance sustainability by linking indigenous guiding principles with government policies and programs, thereby strengthening local decision-making for sustainable watershed management. Finally, the use of GIS and Digital Elevation Models contributes to technological and institutional sustainability by providing spatial information that can help decision makers evaluate land suitability, reduce risks from natural and man-made hazards, and develop a sustainable indigenous watershed management framework for the municipality.

2. Material and methods

2.1 Research Design

The study used a qualitative research approach to examine indigenous watershed management practices and their relationship with land uses, forest cover, and slope classification in the municipality. This approach was appropriate because the study involved understanding community-based practices, traditional knowledge, and local perspectives. Qualitative research is defined as “an inquiry process of understanding a social or human problem, based on building a complex, holistic picture formed with words, reporting detailed views of informants, and conducted in a natural setting” (Creswell, 2003).

2.2 Locale of the Study

The study was conducted in the municipality of Besao, Mountain Province, which had a population of 7,040 based on the Philippine Statistic Authority (PSA, 2015) and an average household size of four persons per household. The municipality is located in the western part of Mountain Province, with coordinates of 170 05' latitude and 1200 05' longitude as of October 2019. It has an estimated land area of 18, 190 hectares, of which 97% is classified as forest land and 3% as alienable and disposable land. It is bounded by Quirino, Ilocos Sur on the west, Tubo, Abra on the north, Sagada on the east, and Tadian on the south. Besao has 14 barangays, all of which contribute to the Abra River. Its sub-watersheds drain to the Abra River, which traverses Abra and Ilocos Sur, contributes to irrigation supply in these areas, and empties into the West Philippine Sea. Physiographically, the municipality is composed of a single ethnic group referred to as the “applai” in the western part of the province. The barangays are grouped into four management zones. Zone I includes Payeo, Padangaan, and Kin-iway, where established woodlots and indigenous plantation schemes are visible. Zone II includes Soquib, Banguitan, Besao East, and Besao West, which form a major part of the Guinawang tributary headwaters and include pine forest areas and Banao Lake A and B. Zone III includes Agawa, Ambagiw, Gueday, and Lacmaan, where family and clan-claimed traditional forests are maintained. Zone IV includes Catengan, Laylaya, and Tamboan, which form part of the headwaters of the Layugan River, a tributary of the Abra River. The municipality is dominated by steep and very steep slopes, representing 78% and 14% of the municipal land area, respectively. Because of its steep terrain, Besao is prone to landslides. Level to gently rolling lands and rolling to moderately steep slopes account for only about 4% and 3%, respectively (CLUP Besao, 2018).

2.3 Respondents of the Study

The respondents of the study were Applai indigenous peoples of Besao, Mountain Province, particularly elders and leaders involved in traditional watershed management practices. A total of 140 household members aged 50 years old and above participated in the study. Identified indigenous leaders, with at least 10 members per management block, joined the focused group discussion and mapping of existing land uses within their ancestral domain claim.

2.4 Sample and Sampling Procedure

The participants were selected from each barangay based on age, involvement in traditional practices, and willingness to participate in the study. In the first stage, the researcher gathered the names of household heads and population data from the Municipal Health Office and the Municipal Planning and Development Office to determine the sample size. In the second stage, the researcher visited each barangay to identify elders and leaders involved in indigenous practices related to watershed sustainability. The participants were informed of the schedule of activities through letters addressed to the barangay chairmen.

2.5 Research Instrument

The study used primary and secondary sources of data. Secondary data were obtained from references such as past studies and documentation conducted by various agencies, particularly DENR-CAR CENRO Sabangan, and maps from NAMRIA. Primary data were gathered through Focus Group Discussion, mapping, field visits, on-site observations, and photo documentation. Photo documentation was used to record activities within the research area and visually document the watershed conditions in each management zone.

2.6 Data Gathering Procedure

Before conducting the study, the researcher prepared an official letter of request addressed to the Municipal Mayor to explain the purpose of the study and ask permission to conduct data gathering in the municipality. This helped facilitate the data collection process and avoid suspicion among community members. The Focus Group Discussion and mapping

activities were conducted with selected elders and leaders from the management blocks. Discussions focused on identifying indigenous sustainable measures for watershed management, particularly practices that reduce damage caused by natural and man-made hazards and reflect the observed condition of the watershed. The participants also shared their views on alternative land uses acceptable for sustaining forest resources. The mapping activity used GIS maps generated from National Mapping Resource Information Authority maps from 2003, 2010, and 2013, as well as an updated map from 2015. The researcher overlaid land cover maps by year and created data tables to show information and percentage changes from 2003, 2010, 2013, and 2015. The community mapping results on major municipal land uses were merged with land cover data using QGIS. The researcher integrated spatial data sets through clipping and intersection to create new polygons representing specific land cover and land use change types. The slope map derived from Department of Environment and Natural Resources data was then overlaid with the land use results to determine whether actual land uses fit the slope categories. Field visits, direct observation, and photo documentation were conducted to validate the data gathered from the Focus Group Discussion and mapping activities. Additional secondary data were also collected from different offices.

2.7 Data Analysis Techniques

The data gathered from the Focus Group Discussion were reviewed, transcribed, and consolidated with corresponding percentages. This process was used to determine the indigenous sustainable measures on watershed management and the alternative land uses accepted for the sustainability of forest resources. The objectives of the study were further addressed through ground validation and Focus Group Discussion. The gathered maps were analyzed and summarized using QGIS software. The mapping results of different land uses from Google Earth as KML files were converted into shapefiles and result maps. These outputs were used to examine land uses, forest cover, and slope categories as bases for developing a sustainable indigenous watershed management framework.

3. Results and Discussion

3.1 Indigenous Sustainable Measures on Watershed Management

3.1.1 Forest Protection Activities

The data gathered through Focus Group Discussion from selected household members in the four zones of the municipality showed that forest protection activities are one of the major indigenous sustainable measures used to reduce damage caused by natural and man-made hazards. The community practiced traditional protection activities against forest fire, timber poaching, unauthorized occupancy or encroachment, and water scarcity. All 14 barangays practiced regular foot patrol or “menbeyabey,” warning systems such as “mentangguyob,” “menbugaw,” “menwandas,” and ringing of public or church bells, as well as voluntary suppression activities called “galatis.” All 14 barangays also practiced regular patrol and limited tree harvesting to prevent timber poaching, while 11 barangays practiced boundary marking through sod fences, canals, and planting of distinct trees or shrubs to prevent encroachment. For water scarcity, all 14 barangays prohibited activities that pollute springs and practiced “men-apoy,” a ritual conducted when water sources dry up. These findings show that forest protection in Besao is sustained through community awareness, customary enforcement, and collective responsibility. The results agree with Manochon (2010), who found in Bontoc, Mountain Province that people are one with nature and that water resource management is the responsibility of every community member. The results also coincide with Wacangan (2000), who stated that traditional practices such as fencing, firebreak construction, brushing, and patrolling are consciously implemented to minimize damage to plantations. The practice of limiting tree harvesting to three to five trees per family for household construction also supports Wacangan (2000), who found that harvested trees were mainly used for household purposes and firewood through selective cutting with permission from the dap-ay or elder. These practices indicate that customary protection measures remain effective because they are enforced by local officials, guided by elders, and embedded in community responsibility.

3.1.2 Forest Maintenance Activities

The findings showed that forest maintenance activities included assisted natural regeneration, wildling management, cultural activities, and fire line establishment. Nine barangays practiced tree planting or “dedekan” to increase the density of growing trees and establish a closed forest canopy. Six barangays practiced wildling management through clearing at least one meter around seedlings, locally called “mendalus,” especially during the onset of the rainy season. Eight barangays practiced the cultural activity called “dadangtey,” in which elders offer a pig in a sacred place as thanksgiving for water abundance and other blessings. All 14 barangays practiced clearing and cleaning of boundary lines through “menkinkin” or fuel reduction, usually from November to December, to prevent forest fires. These findings indicate that forest maintenance in Besao combines ecological care, cultural practices, and community labor. The practice of wildling management and fuel reduction coincides with Macalling (2005), whose study showed that plantation maintenance and protection, including fuel reduction, were fully implemented and helped sustain watershed management programs. The cultural practice of “dadangtey” supports Cuanso (2014), who stated that the Kankana-ey of Buguias believe that land and resources belong to gods, spirits, and ancestors, and that such beliefs guide the use of resources as part of their life ways and thought ways. The regular practice of “menkinkin” also supports Motes (2018), whose study revealed that fuel

reduction as part of plantation maintenance and protection contributed to the successful implementation of the National Greening Program. These results suggest that forest maintenance is sustained through both practical and cultural systems.

3.1.3 Forest Development Activities

The results showed that traditional forest development activities focused on biodiversity conservation and the promotion of ecotourism attractions. Seven barangays practiced biodiversity conservation by establishing diverse species along boundary lines and within woodlots. Woodlot owners planted species such as coffee seedlings under pine, fire-resistant species such as “maguey,” and nurse trees such as *Alnus maritima* or “alnus” and *Callindra calothyrsus* or “calliandra” before planting coffee. Nine barangays from Zones 2, 3, and 4 practiced the promotion of ecotourism through participatory identification and development of sites and attractions. However, sacred grounds identified by elders were strictly prohibited from ecotourism activity. These findings show that forest development in Besao is guided by community participation, biodiversity protection, and respect for cultural boundaries. The results are connected to Camacho et al. (2016), who stated that indigenous knowledge systems and practices help promote forest sustainability. The practice of planting diverse species also supports Matso-Liyo (2018), who found that Indigenous Forest Management Systems and Practices were effective in sustaining forests through the establishment of diverse species along boundary lines and the inter-planting of short-term crops while maintaining long-term forest resources. The community-based approach to ecotourism further reflects Scheyvans (2002), who stated that ecotourism ventures should be considered successful only when local communities have some control over them and share equitably in the benefits. These results suggest that development activities contribute to watershed sustainability when ecological, cultural, and community interests are balanced.

3.2 Land Uses Accepted for the Sustainability of Forest Resources

3.2.1 Protection Forest

The findings showed that protection forest, or watershed areas, covered the uppermost portions of the municipality, including mossy forests. Based on community mapping, the protection forest covered an estimated 7,545.45 hectares. These areas served as community watersheds with minimal human activities, such as hunting and gathering medicinal plants. Mossy forests, locally called “kallasan or aas,” were found in distant mountain areas of Lacmaan, Agawa, Gueday, Ambagiw, and Tamboan, as well as in communal forest lands in Banguitan and Kinali/Balas-iyon. These forests contained hardwood species such as tikem, gasatan, payen, amiyaw, narra, bitaog, and buuken, along with rattan, bamboo species, and medicinal plants used for wounds, stomach illness, internal diseases, scabies, malaria, kidney trouble, and protection against spells. These results show that protection forests are central to watershed conservation, biodiversity, and cultural resource use in Besao. Their limited use for hunting and medicinal plants indicates that the community recognizes their ecological importance and restricts activities that may damage watershed functions. The presence of hardwood species, rattan, bamboo, and medicinal plants also reflects the role of protection forests in supporting both environmental and community needs. This supports the broader view that indigenous forest management is connected to the forest as a source of life, which agrees with Saway (2011); that the Talaandig people relate to the forest socially, economically, politically, and spiritually.

3.2.2 Production Forest or Batangan

The findings showed that the production forest or Batangan was dominated by Benguet pine (*Pinus kesiya*) and covered an estimated 4,153.30 hectares of the municipality’s land area. These areas were established through mass community tree planting in the 1950s to provide accessible fuel wood. The existing pine forests began from natural pine stands and later expanded through seed dispersal by wind, rain, and other means. Within this category, pasture land was also used as a grazing area for cattle, carabao, and goats. Cattle owners were responsible for fencing designated grazing areas and were accountable for damages caused by their animals to agricultural crops or water sources. These findings indicate that the Batangan functions as a production forest while still operating under customary management. Its development through mass tree planting shows the community’s long-term effort to ensure forest resource availability. The inclusion of pasture land under regulated use also reflects the balance between livelihood needs and watershed protection. The practice of assigning responsibility to cattle owners shows that production activities are managed through accountability and customary regulation, which helps reduce pressure on agricultural areas, water sources, and forest resources.

3.2.3 Multiple-Use Areas

The findings showed that multiple-use areas covered agriculture, cemetery areas, forest vegetation, and settlement areas, with an estimated total area of 6,491.89 hectares. Agricultural lands, including “payeos” or rice fields and “um-as” or vegetable gardens and agroforest areas, covered 2,318.79 hectares. These lands were used mainly for rice production, while some rice fields were also used for sweet potato, peanuts, and vegetables as second crops. Cemetery areas were present in all 14 barangays and covered 9.02 hectares. Forest vegetation near settlements covered 3,816.75 hectares and was used for recreation, tourism activities, social gatherings, barangay fiestas, Christmas parties, and school camping. Settlement areas covered 347.33 hectares and included residential, commercial, institutional, infrastructure, utility, and open spaces. Residential growth was increasingly associated with road networks, although earlier settlements were located near agricultural areas. These findings show that multiple-use areas support the community’s livelihood, cultural, social, and

settlement needs while remaining linked to forest resource management. The presence of cultural sites, ritual grounds, burial grounds, sacred sites, and places believed to be dwelling areas of supernatural beings shows that land use in Besao is shaped not only by economic needs but also by indigenous beliefs and cultural respect for the environment. The mapping results showed that protection areas were larger than multiple-use areas, suggesting that the community has managed resources in harmony with the environment while allowing use of forest-based resources in designated areas. This agrees with Cruz (1999), who stated that the primary concern of watershed management is to organize and guide the use of land and other watershed resources to ensure the sustainability of water, soil, and the flow of watershed goods and services.

3.3 Integrated Findings on Indigenous Watershed Management and Sustainable Land Use

The overall findings showed that indigenous watershed management in Besao is sustained through protection, maintenance, and development activities supported by community participation, elders, local government units, and customary practices. Forest protection was practiced across all barangays through foot patrol, warning systems, limited harvesting, boundary marking, spring protection, and rituals. Forest maintenance was sustained through assisted natural regeneration, wildling management, cultural thanksgiving, and fire line establishment. Forest development was supported through biodiversity conservation and community-based ecotourism. Land use mapping also showed that protection forest occupied 7,545.45 hectares, production forest or Batangan covered 4,153.30 hectares, and multiple-use areas covered 6,491.89 hectares, for a total municipal land area of 18,190.63 hectares. These findings indicate that the sustainability of Besao's watershed is influenced by the integration of customary laws, community responsibility, forest-based livelihoods, cultural beliefs, and land use planning. Indigenous practices remain important because they are collectively observed, locally enforced, and linked to community identity. The findings suggest that sustainable watershed management in the municipality depends on protecting critical watershed areas, regulating production and multiple-use zones, maintaining forest resources, and respecting cultural sites and traditional governance systems.

4. Conclusion & Recommendations

The study concluded that traditional forest management in Besao views forests as a source of life connected to the social, political, economic, and spiritual dimensions of indigenous communities. Indigenous practices such as natural regeneration, community vigilance, forest protection, boundary identification, and collective participation support sustainable forest management and help prevent forest fires, unauthorized tree cutting, encroachment, and clearing activities. The establishment and expansion of Batangan areas on steep slopes, vacant lands, abandoned areas, and open areas became part of the community's customary practices, requiring families, clans, and Dap-ay groups to manage forest areas responsibly for present and future generations.

The study recommended strengthening LGU-community partnerships, collective action, and policy support to mainstream indigenous forest management practices in local governance. It emphasized the need to respect the rights of the Besao community over traditionally established forest resources through equitable access, sustainable utilization, protection, maintenance, and development. The government should formally adopt indigenous knowledge systems and practices as sustainable forest resource management tools, provide full support to ICCs/IPs in rehabilitating degraded and open forestlands, stabilize slopes, maintain ecological balance, and demarcate ancestral domain forestlands for production, protection, or multiple-use purposes under formal management.

Compliance with ethical standards

The study was conducted with due consideration of ethical standards in community-based research. Permission to conduct the study in the municipality was sought through an official letter addressed to the Municipal Mayor, and coordination with barangay officials was made before the conduct of data gathering activities. The study involved Applai indigenous elders and leaders who were knowledgeable about traditional watershed management practices and were willing to participate in the Focus Group Discussion, mapping activities, field visits, observations, and documentation. The research process respected the role of the community, local officials, and indigenous leaders in providing information related to their traditional practices, land uses, and watershed management systems.

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