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Land Cover and Water Ecosystem Services: Assessment of Bigbiga Protected Landscape (BPL)

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ABSTRACT: This study assessed the profile of respondents, the level of implementation of water ecosystem services, and the relationships between these factors within the Bigbiga Protected Landscape (BPL). It also examined land cover changes from 2010 to 2024 and their correlation with water ecosystem services implementation. Additionally, the study aimed to identify problems in implementing water ecosystem services and propose policies to enhance these services.

A descriptive correlational research design was employed, utilizing survey questionnaires to gather data on respondents' profiles and perceptions of water ecosystem services implementation. The Pearson correlation coefficient was used to explore relationships between profile of respondents and water ecosystem services implementation. Remote sensing and GIS techniques facilitated the analysis of land cover changes, while a t-test evaluated the relationship between these changes and water ecosystem services implementation.

The study found that the BPL community's diverse demographic profile reflects a strong connection to the environment. Notably, watershed protection, biodiversity conservation, flood control and disaster risk, community awareness and education, policy development and integrated resource management are strongly implemented. However, perceptions of service implementation varied significantly with age, length of residency, and household size. The land cover analysis revealed a substantial increase in open forest areas between 2010 and 2024, although these changes did not significantly affect the implementation of water ecosystem services. A key issue identified was the inadequacy of water quality and quantity management.

To address these challenges, a comprehensive policy is proposed, focusing on improving water management through enhanced monitoring, public participation, enforcement of standards, and adaptive policy mechanisms.

The study concludes that implementing customized educational programs, establishing a dedicated task force and local water management committees, and enhancing outreach efforts designed for different demographic groups are essential for the effective management of the BPL's natural resources. Strengthening enforcement mechanisms, improving water system infrastructure, and promoting community involvement in forest protection and water management are recommended to ensure the sustainable use and conservation of water resources in the BPL.

KEYWORDS: Land cover, Water ecosystem services, Bigbiga Protected Landscape, biodiversity conservation, land cover changes, Water Management Policy

1. INTRODUCTION

Background of the Study

The Sustainable Development Goals (SDGs), often called the Global Goals, were set by the United Nations in 2015. This aim to end poverty, take care of our planet, and make sure everyone has a chance to live in peace and thrive by 2030. Among these, SDG 6 focuses on ensuring the availability and sustainable management of water and sanitation, while SDG 15 aims to sustainably manage forests, combat desertification, halt and reverse land degradation, and curb biodiversity loss (United Nations, n.d.). The connection between these goals becomes clear when examining how land cover affects water services. This study explores how land cover within the Bigbiga Protected Landscape (BPL) influences water quality and availability, highlighting the importance of integrating efforts to achieve SDG 6 and SDG 15 for more sustainable and effective outcomes.

Situated in a biodiversity-rich region, the BPL is vital for both conservation and sustainable resource management. The landscape

encompasses diverse land cover types, including forests, wetlands, and grasslands, each contributing significantly to ecological balance and the provision of essential ecosystem services. These land cover types play a crucial role in water regulation, purification, and supply—key aspects of SDG 6. For example, forests within the BPL act as natural water filters, trapping pollutants and sediments to maintain water quality. Wetlands serve as buffers against floods and aid in groundwater recharge, while grasslands contribute to soil health and water retention.

However, the integrity of these ecosystems is increasingly threatened by deforestation, agricultural expansion, and other forms of land degradation, jeopardizing the water ecosystem services they provide. Deforestation, for instance, diminishes the land's capacity to filter pollutants, leading to a decline in water quality. Similarly, the loss of wetlands reduces their ability to regulate floods and recharge groundwater supplies. Given that the BPL is a critical water source for the Narvacan Water District and surrounding areas, maintaining and restoring its land cover is essential for sustaining clean water resources and achieving the targets of SDG 6 (United Nations, n.d.).

SDG 15 underscores the need for sustainable land and ecosystem management, emphasizing the importance of combating land degradation, restoring degraded lands, and protecting biodiversity (United Nations, n.d.). The BPL serves as a prime example of how effective land management can contribute to this goal. By preserving diverse land cover types, the BPL supports a wide range of plant and animal species while maintaining vital ecological processes. Nevertheless, human activities such as logging, mining, and unsustainable agriculture continue to threaten the landscape's ecological integrity and its capacity to provide essential water ecosystem services.

The integration of SDG 6 and SDG 15 is crucial for addressing the complex interactions between land cover and water ecosystem services in the BPL. Effective land cover management directly impacts water quality and availability, just as sustainable water management practices influence land conservation efforts. For instance, preserving forested areas and wetlands not only supports biodiversity but also enhances water filtration and flood regulation, advancing the objectives of SDG 6. Conversely, maintaining healthy water bodies prevents soil erosion and supports vegetation growth, which in turn helps combat land degradation, aligning with SDG 15 (United Nations, n.d.).

Despite these synergies, significant challenges persist, particularly in balancing conservation efforts with the needs of local communities who depend on natural resources for their livelihoods. Addressing these challenges requires conservation strategies that are inclusive and equitable. Opportunities for enhancing the integration of SDG 6 and SDG 15 include leveraging technological innovations such as remote sensing and geographic information systems (GIS) to monitor land cover changes and their impacts on water resources. Engaging local communities in conservation and water management efforts can also lead to improved outcomes, ensuring that solutions are grounded in local knowledge and needs.

The Bigbiga Protected Landscape exemplifies the critical linkages between SDG 6 and SDG 15. The land cover within this area plays a pivotal role in providing water ecosystem services that are essential for clean water and sanitation. By maintaining and restoring diverse land cover types, the BPL supports both water quality and biodiversity, contributing to the achievement of these interconnected SDGs. The insights gained from managing the BPL can inform broader strategies for achieving the SDGs and ensuring a sustainable future for both people and the environment (United Nations, n.d.).

Framework of the Study

Figure 1. Research Paradigm of the Study

INPUT		**PROCESS**		**OUTPUT**
Profiles of the Respondents: a. Age b. Gender c. Educational Attainment d. Number of years e. Trainings attended f. Source of Livelihood g. Income level per month h. Number of household member i. Benefits derived Water Ecosystem Services: a. Water Quality Management		Analysis of Significant Relationship: a. Relationship Between Respondent Profile and Implementation Level Land Cover Change Analysis Using GIS: a. Observable Patterns in Land Cover Changes (2010-2023) Analysis of Significant Relationship: a. Relationship Between Land Cover Change and Implementation Level Identification of Problems:		Formulated Policies to Improve Water Ecosystem Services

b. Watershed Protection and Management c. Biodiversity Conservation d. Flood Control and Disaster Risk Reduction e. Community Awareness and Education f. Policy Development and Enforcement g. Integrated Resource Management		a. Problems in Implementation of Water Ecosystem Services		

In the context of protected areas like the Bigbiga Protected Landscape (BPL), the theory underlying the relationship between land cover and water ecosystem services can be informed by the findings of Karki et al. (2018). This theory suggests that changes in land cover, such as deforestation, agricultural expansion, or urbanization, directly affect the availability, quality, and sustainability of water-related ecosystem services.

Figure 1 presents the research paradigm of the study which includes the Input-Process-Output (IPO) Model to systematically evaluate the implementation of water ecosystem services within the Bigbiga Protected Landscape (BPL). In the Input phase, comprehensive data is collected on the profiles of respondents and the implementation level of water ecosystem services. The profiles of respondents cover details like age, gender, education, how long they've lived in the area, any training they've attended, their sources of livelihood, income levels, household size, and the benefits they get from the BPL.

The Process phase includes investigating the relationship between the profiles of respondents and the level of implementation of water ecosystem services. Furthermore, land cover change analysis using GIS is conducted to observe patterns and trends from 2010 to 2024. Another part of the analysis includes the relationship between land cover change and water ecosystem services. This phase also focuses on identifying any problems with how these services are being carried out in the BPL. The Output phase results in the formulation of policy recommendations aimed to improve the water ecosystem services in the BPL.

Statement of the Problem

The study aimed to assess the land cover change and implementation of water ecosystem services within the Bigbiga Protected Landscape. It also aimed to understand the current status of these services, identify the main problem, and formulate policies to ensure the sustainable management of water ecosystem services. Specifically, it aims to answer the following questions:

1. What is the profile of the respondents at Bigbiga Protected Landscape in terms of:
a. Age
b. Gender
c. Educational Attainment
d. Number of years you have lived in the Barangays adjacent to Bigbiga Protected Landscape
e. Trainings attended
f. Source of Livelihood
g. Income level per month
h. Number of household member
i. Benefits derived from the Bigbiga protected Landscape
2. What is the level of implementation of the water ecosystem services at Bigbiga Protected Landscape in terms of:
a. Water Quality and Quantity Management;
b. Watershed Protection and Management;
c. Biodiversity Conservation;
d. Flood Control and Disaster Risk Reduction
e. Community Awareness and Education
f. Policy Development and Enforcement, and
g. Integrated Resource Management.
3. Is there a significant relationship between the profile of the respondents and the level of implementation of the water ecosystem services?

4. What are the observable patterns in land cover changes within the BPL from 2010 to 2024?
5. Is there a significant relationship between land cover change and implementation of water ecosystem services?
6. What are the problems in the implementation of water ecosystem services?
7. What policy can be forwarded/ formulated to improve the water ecosystem services in Bigbiga Protected Landscape.

Hypotheses

- There is a significant relationship between the socio-demographic profile of respondents and the level of implementation of water ecosystem services in the Bigbiga Protected Landscape.
- There is no significant relationship between the land cover change and the level of implementation of water ecosystem services in the Bigbiga Protected Landscape.

Scope and Limitations of the Study

The study focused on the assessment of land cover and water ecosystem services in Bigbiga Protected Landscape covering 2 barangays of the municipality of Narvacan namely; Marozo and Cadacad. Data were collected through floating of questionnaire to respondents such as barangay officials, stakeholders, and local residents, map shapefiles from NAMRIA to generate 2010, 2015 and 2020 using GIS software and drone technology to capture the present status of the land cover to generate also the updated land cover map 2024. The study was conducted from April 2024 to July 2024. The results of the study will apply only to the above-mentioned municipality and barangays located therein.

Importance of the Study

This study serves as guide for various stakeholders involved in the management and conservation of the Bigbiga Protected Landscape (BPL), particularly in the context of assessing land cover changes and water ecosystem services:

- **For Local Community and Stakeholders:** This study provides insights into how land cover changes and the profile of respondents influence the implementation of water ecosystem services in the BPL.
- **For Community Department of Environment and Natural Resources Office (CENRO):** The results of this research will be instrumental in supporting policies and management actions to address land cover changes and water resource management within the BPL.
- **For Development Planners and Environmental Agencies:** The results of this research will be helpful to development planners and environmental agencies involved in land use planning and sustainable development.
- **For Academic Community and Future Researchers:** The result of this research will contribute to the knowledge and understanding of land cover changes and water ecosystem services in protected areas like the BPL.

Review of Literature

Land cover plays a crucial role in influencing the provision of ecosystem services, including water quality and quantity. Studies have shown that changes in land use and land cover significantly impact these services. For example, Karki et al. (2018) explore how land use changes in Myanmar affect water-related services, while Melese (2016) examines the effects of land cover changes on forest resources in Ethiopia. These findings underscore the importance of effective land management in sustaining ecosystem services. Remote sensing, as highlighted by Avtar et al. (2017), provides valuable data for monitoring land cover and its impact on ecosystems, which is essential for managing both forest and urban environments. Additionally, Loucks et al. (2017) discuss various methods for planning and managing water resources, emphasizing the need for robust monitoring systems to support effective management practices.

Managing water quality and quantity presents significant challenges, particularly in protected areas. Berney and Hosking (2016) delve into the difficulties faced in the Murray-Darling Basin, stressing the need for effective water management reforms to address these challenges. This issue is pertinent to the Bigbiga Protected Landscape (BPL), where water management has received a lower rating, indicating room for improvement. Tanner-McAllister et al. (2017) propose an adaptive management framework for protected areas in the context of climate change, which could be beneficial for addressing emerging challenges at BPL. Furthermore, Martín-de Castro et al. (2016) highlight the role of stakeholder engagement in enhancing environmental policies, supporting the necessity for regular policy reviews and updates.

Effective policy implementation is crucial for managing water resources and ecosystem services. Resende et al. (2021) emphasize the importance of protected areas and Indigenous lands in securing ecosystem services and biodiversity, which is highly relevant for BPL. Orr (2013) provides insights into integrating stakeholder input into environmental policy, demonstrating the importance of collaboration for successful policy implementation. This perspective reinforces the need for a coordinated approach to water management at BPL.

Education also plays a vital role in promoting environmental awareness and conservation practices. Stern et al. (2014) review environmental education programs and their effectiveness in encouraging conservation behaviors. Enhancing community awareness about water conservation is an essential objective for BPL. Collaboration among stakeholders is critical for effective environmental policymaking. Orr (2013) discusses stakeholder collaboration in environmental policy, emphasizing the significance of effective communication and collaborative practices. This underscores the necessity of a unified approach to water management and conservation efforts in the BPL.

2. METHODOLOGY

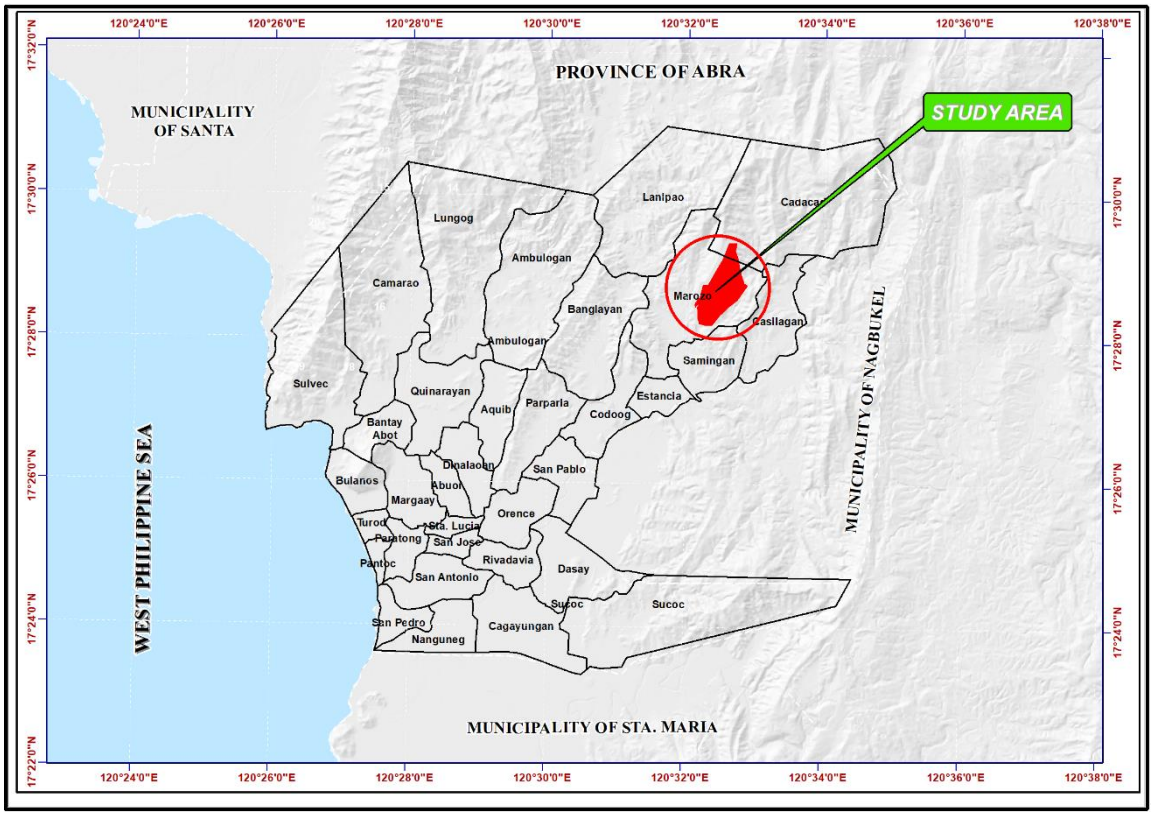
Research Design

This descriptive-correlational design was used in this study to examine the relationships between respondent profiles and the implementation of water ecosystem services in the Bigbiga Protected Landscape (BPL). The correlational analysis investigates how variables such as age, gender, length of residency, training attended, sources of livelihood, income level, household size, and benefits derived affect the effectiveness of water ecosystem services.

Additionally, a documentary analysis is conducted to assess land cover changes in the BPL from 2010 to 2024. This analysis uses shapefiles from NAMRIA, updated Google Earth images, and drone data to track and assess changing land cover patterns and to generate land cover maps. It was also used to explore the relationship between these land cover changes and the water ecosystem services. This aimed to understand how shifts in land cover influence essential services like water quality and quantity management, watershed protection, biodiversity conservation, flood control, community awareness, policy development, and integrated resource management. This comprehensive approach provides insights into how land cover dynamics are connected to the sustainability of water ecosystems in the BPL.

Population and local of the Study

Figure 2. Map of the Study Area



The research was conducted in the Bigbiga Protected Landscape (BPL) in Ilocos Sur, specifically focusing on Barangays Cadacad and Marozo in Narvacan. A purposive sampling method was used to select 320 participants, including barangay officials, stakeholders, and local residents who are familiar with the protected area and its water ecosystem services. Stratified sampling ensured representation across different strata, with 220 respondents from Barangay Marozo and 100 from Barangay Cadacad.

Table 1. Distribution of Respondents by Barangay

Barangay	Population	Sample
Marozo	1427	220
Cadacad	749	100
Total	2176	320

Research Instrument

Questionnaires:

- Questionnaire Development: A structured questionnaire was developed based on the research objectives and a comprehensive literature review. The questionnaire included items designed to gather and measure the profile of the respondents' and level of water ecosystem services.
- Validity Testing: The questionnaire underwent content validity testing by selected DENR personnel to ensure the items adequately measured.
- Pilot Testing: The questionnaire was pilot-tested in the Northern Luzon Heroes Hill National Park located in Magsaysay, Santa, Ilocos Sur, to identify any ambiguities, comprehension issues, or other problems with the instrument. Feedback from pilot testing was used to refine the questionnaire before full-scale data collection.
- Reliability Testing: The reliability of the questionnaire was assessed using Cronbach's alpha coefficient on the pilot test results. The coefficient was 0.97, indicating excellent reliability.
- Data Collection: The finalized questionnaire was administered to residents living within the vicinity of the BPL, specifically within the barangays of Cadacad and Marozo. The survey was carried out through the floating of questionnaires, depending on what was most practical and preferred by the respondents.

GIS and Remote Sensing: Geographic Information Systems (GIS) played a pivotal role in this study by providing a comprehensive framework for spatial analysis and visualization of land cover changes and water ecosystem services within the Bigbiga Protected Landscape (BPL). The following integrated approaches were implemented to apply GIS effectively:

- Landcover Mapping: GIS was utilized to generate thematic maps that illustrate the land cover types within the Bigbiga Protected Landscape (BPL) for the years 2010, 2015, and 2020. These maps provide a visual representation of spatial patterns and changes over time, highlighting areas of land cover transformations. The use of GIS in this context allows for a detailed analysis of how land cover has evolved, aiding in the identification of trends and the impacts on water ecosystem services.
- Drone Technology: Drones were used to capture high-resolution imagery of the study area to update the land cover map for 2024. This current data enabled accurate comparison with land cover maps from previous years (2010, 2015, 2020).
- Data Sources: Geospatial data from reputable agencies (NAMRIA) supplemented the study. This data contributed to creating comprehensive thematic maps and enhancing the accuracy of spatial analysis.
- Temporal Analysis: Comparisons between land cover maps from 2010, 2015, 2020, and the newly generated map for 2024 were conducted. This analysis highlighted temporal changes in land cover types and their implications for ecosystem dynamics.

Data Gathering Procedure

This study employed a systematic approach to collect data on the implementation of water ecosystem services within the Bigbiga Protected Landscape (BPL).

The data gathering process began with a comprehensive review of existing literature to establish a theoretical foundation for the study. Based on this review, a structured questionnaire was developed to capture residents' perceptions and attitudes toward water ecosystem services in the BPL. The questionnaire was validated by DENR officials at the CENRO Bantay, and a pilot test was conducted at the Northern Luzon Heroes Hill National Park to identify and rectify any issues. The final version of the questionnaire was deemed reliable, following content validity testing and confirmation of internal consistency through Cronbach's alpha.

Primary data collection involved administering the questionnaire to residents of Barangays Cadacad and Marozo. A total of 220 respondents from Barangay Marozo and 100 respondents from Barangay Cadacad participated in the survey. The questionnaires were distributed using a floating method, supplemented by face-to-face interviews to ensure comprehensive data collection.

Secondary data were gathered using Geographic Information Systems (GIS) and remote sensing technologies to analyze land cover changes within the BPL. High-resolution drone imagery was utilized to update the 2024 land cover map, which was then compared with historical maps from 2010, 2015, and 2020, provided by NAMRIA. This comparison enabled the identification of temporal changes in land cover types.

Statistical Treatment Data

The Statistical Treatment of Data in this study involved a comprehensive approach to ensure accurate data analysis. Descriptive statistics, including frequency counts, percentages, and measures of central tendency, were utilized to summarize the demographic profiles of the respondents. To examine the relationships between these respondent profiles and the implementation levels of water ecosystem services, Pearson's correlation coefficient was applied, with statistical significance assessed at the 0.05 and 0.01 levels. Furthermore, GIS-based spatial analysis was employed to monitor land cover changes within the Bigbiga Protected Landscape (BPL) from 2010 to 2024. Additionally, a t-test was used to explore how changes in land cover might influence the implementation of water ecosystem services.

Data Categorization

Scale points for rating	Statistical Limit	Descriptive Equivalent	Rating
5	4.21 – 5.00	Very Highly Implemented	VHI
4	3.41 – 4.20	Highly Implemented	HI
3	2.61 – 3.40	Moderately Implemented	MI
2	1.81 – 2.60	Slightly Implemented	SI
1	1.00 – 1.80	Not Implemented	NI

The implementation level of water ecosystem services was categorized using a five-point Likert scale. The categorization helped to assess respondents' perceptions across various aspects, including water quality and quantity management, watershed protection, biodiversity conservation, flood control, community awareness, policy development, and integrated resource management:
The following were the descriptive that was used as basis for the ratings:

Very Highly Implemented (VHI) [100%]: The indicator or activity is fully and comprehensively implemented, meeting all specified criteria and expectations. Every necessary action has been completed, demonstrating thorough and consistent execution.

Highly Implemented (HI) [75%]: Implementation occurs regularly and consistently, although occasional gaps or deviations from ideal standards may be present. The majority of required actions are performed on a regular basis.

Moderately Implemented (MI) [50%]: Implementation is partially complete, occurring inconsistently. Significant gaps or irregularities are evident in fulfilling the required actions or standards.

Slightly Implemented (SI) [25%]: Implementation is infrequent and lacks consistency, with minimal effort exerted. There are notable deficiencies in meeting the required actions or standards.

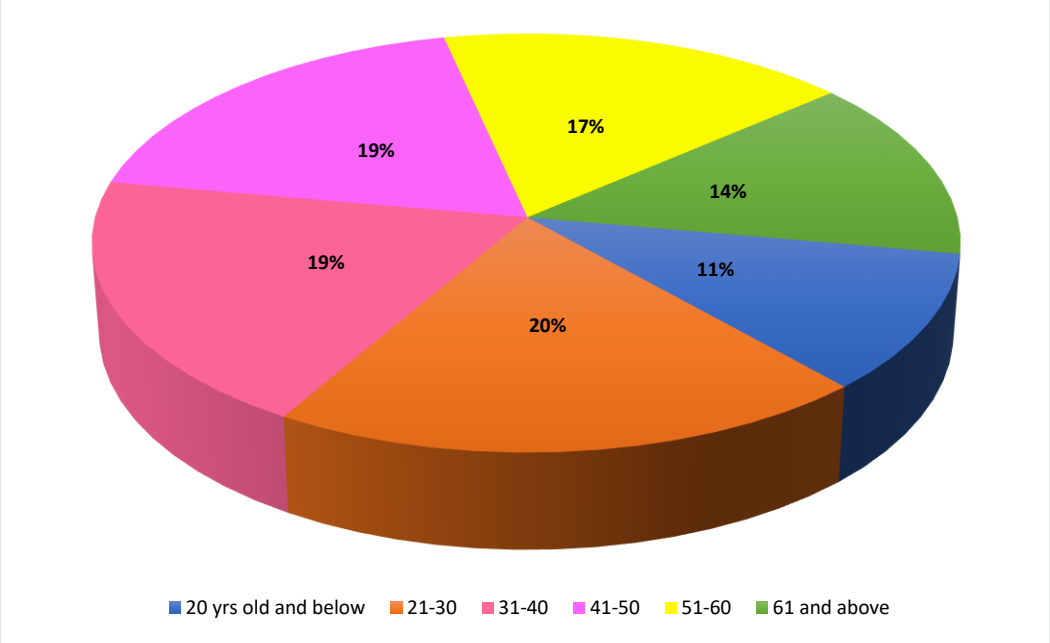
Not Implemented (NI) [0%]: No implementation has occurred. There is no effort or action taken towards fulfilling the required actions or standards.

Indicators with a mean score below 3.5 were identified as areas of problem, signaling aspects of water ecosystem services that are not consistently or adequately implemented. These areas were flagged for further attention and were integral in guiding the development of proposed policy can be forwarded/formulated to improve the management and sustainability of water ecosystem services within the Bigbiga Protected Landscape.

3. FINDINGS

Profile of Respondents

Figure 3. Distribution of Age

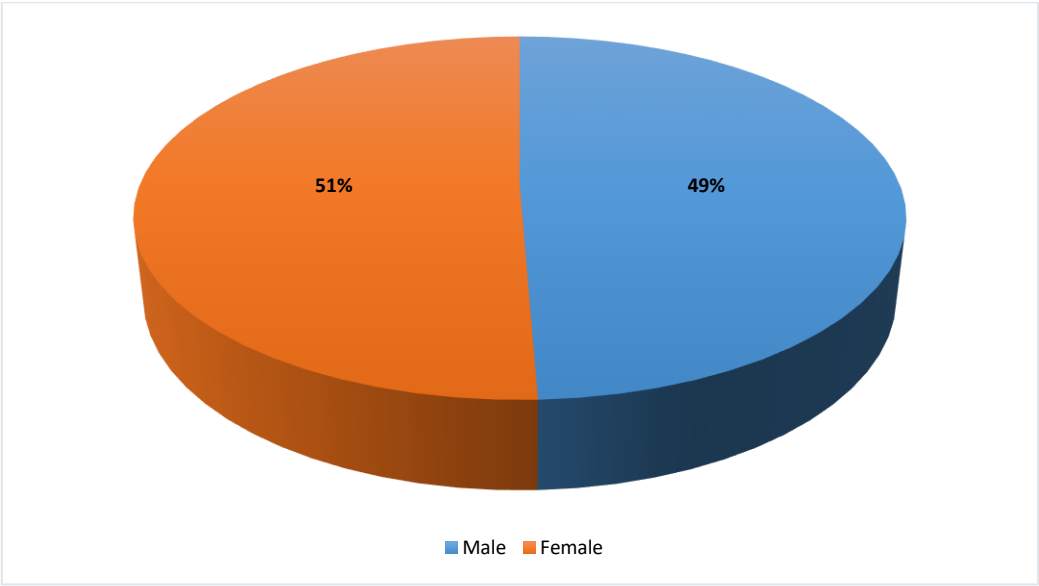


Age. Figure 3 shows that most respondents are between 21 and 50 years old, making this group the most active and economically involved. Their significance highlights their crucial role in promoting and implementing sustainable practices within the Bigbiga Protected Landscape (BPL). In contrast, the smallest group consists of individuals aged 60 years and above. While fewer in number, this older demographic brings invaluable experience and traditional knowledge that can inform culturally sensitive and historically grounded conservation strategies.

This age distribution has important implications for community engagement. Targeting the 21 to 50-year age group can tap into their active participation in economic and community activities, making them key drivers of environmental efforts in the BPL. Meanwhile, even though the 60 and older group is smaller, they can offer valuable knowledge about traditional practices and past environmental conditions, which are important for creating comprehensive conservation strategies.

This observation aligns with Lloyd et al. (2014), who noted that individuals in their middle adulthood stage, particularly those between 30 to 50 years old, are often well-experienced and actively contribute to both community and professional settings. The large number of people in this age group suggests they could have a big influence on local decisions and conservation efforts.

Figure 4. Distribution of Gender

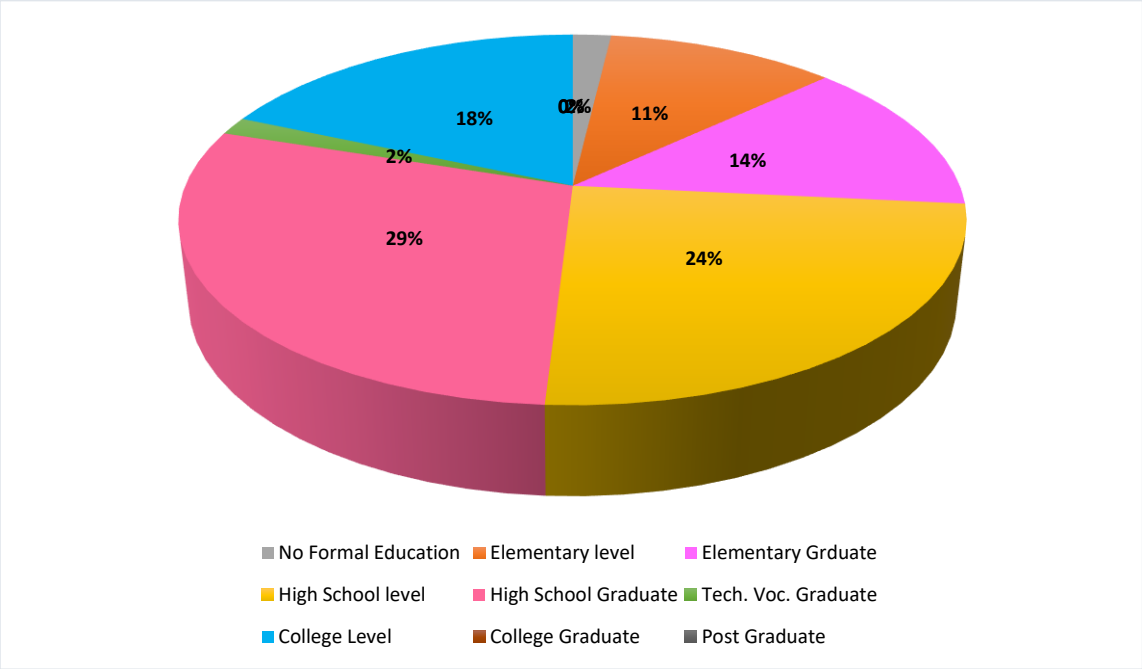


Gender. The Figure 4 shows that there is a nearly equal distribution between males and females in the surveyed population, indicating a balanced representation within the community. This gender balance is crucial for understanding diverse perspectives, roles in natural resource management, and socio-economic impacts within the Bigbiga Protected Landscape (BPL).

The nearly equal number of men and women in the survey indicates that both genders are actively involved in the community's socio-economic and environmental activities. This balance is key for creating fair and inclusive environmental strategies that consider everyone's needs and contributions.

Research by Njuki (2023) shows that having both men and women participate equally in resource management and food systems leads to better and more sustainable results. Their findings highlight that when both genders are involved, conservation and socio-economic efforts are more effective. The balanced gender representation in this survey supports these conclusions and suggests a strong opportunity for working together and making inclusive decisions within the BPL.

Figure 5. Distribution of Educational Attainment

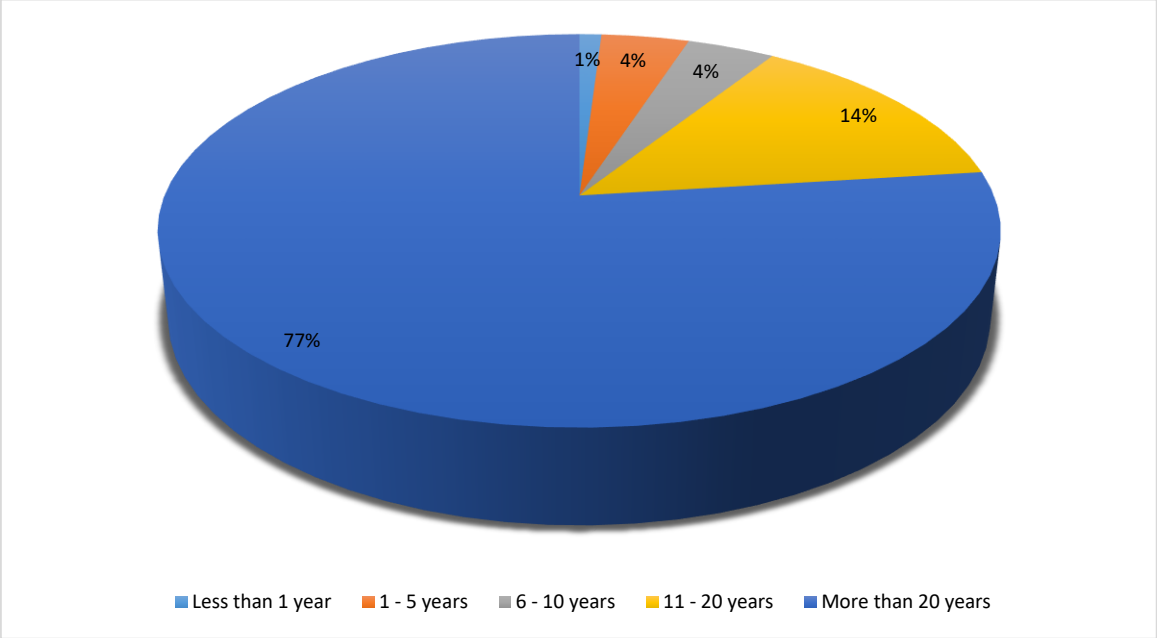


Educational Attainment. Figure 5 shows that the educational levels among the surveyed population provide valuable insights into the community's capacity to engage with and support environmental management and conservation efforts within the Bigbiga Protected Landscape (BPL). A significant portion of respondents have completed at least some high school education, with 29% having graduated. This suggests that the community has a solid foundation in basic education, which is beneficial for understanding and participating in environmental initiatives.

The implication of this educational profile is twofold. First, a community with a high school education level is better equipped to grasp fundamental environmental concepts, supporting the implementation of effective conservation strategies. However, the lack of higher education degrees might indicate limitations in specialized knowledge and skills necessary for addressing more complex environmental challenges. This highlights the need for targeted educational programs or training initiatives to bridge this gap, providing the community with the expertise needed for sustainable management of the BPL.

Research by Adams et al. (2016) shows how important education is for boosting community involvement in managing natural resources. People with more education usually have a clearer understanding of conservation issues and are more likely to get involved in sustainable practices. Given that many survey respondents have at least a high school diploma, there's a strong foundation for effective community participation in environmental management within the BPL.

Figure 6. Distribution of Number of years lived adjacent to BPL

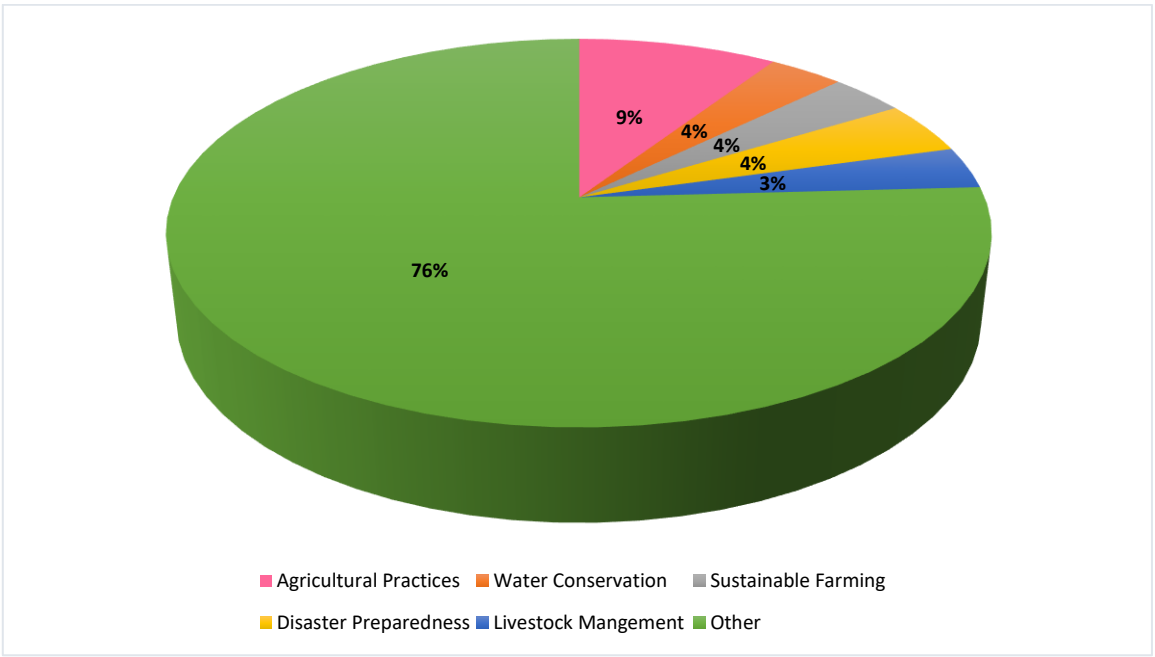


Number of years lived in the barangays adjacent to BPL. Figure 6 shows that a significant majority of respondents (77%) have lived in the barangays near the Bigbiga Protected Landscape (BPL) for more than 20 years, indicating a strong historical connection to the area. This long-term residency provides the community with extensive local knowledge and insights into the area's ecological changes and historical land use. Conversely, only 1% of respondents have lived in the barangays for less than one year, signifying a small but present group of new arrivals. This dynamic mix of long-term residents and newcomers suggests a community that could benefit from targeted educational and integration programs to align new residents with established conservation goals.

The high number of long-term residents highlights how valuable their deep local knowledge is for managing and conserving the BPL. Their long-term presence allows them to understand how the environment and land use have evolved, which is crucial for making conservation plans that fit the local ecosystem.

Corroborating this, Díaz et al. (2015) emphasize that integrating local knowledge with scientific approaches enhances environmental management. Their research reveals that the insights of long-term residents can significantly support effective conservation strategies, aligning with our survey results that suggest their involvement is crucial for the successful management and conservation of the BPL.

Figure 7. Distribution of Trainings Attended

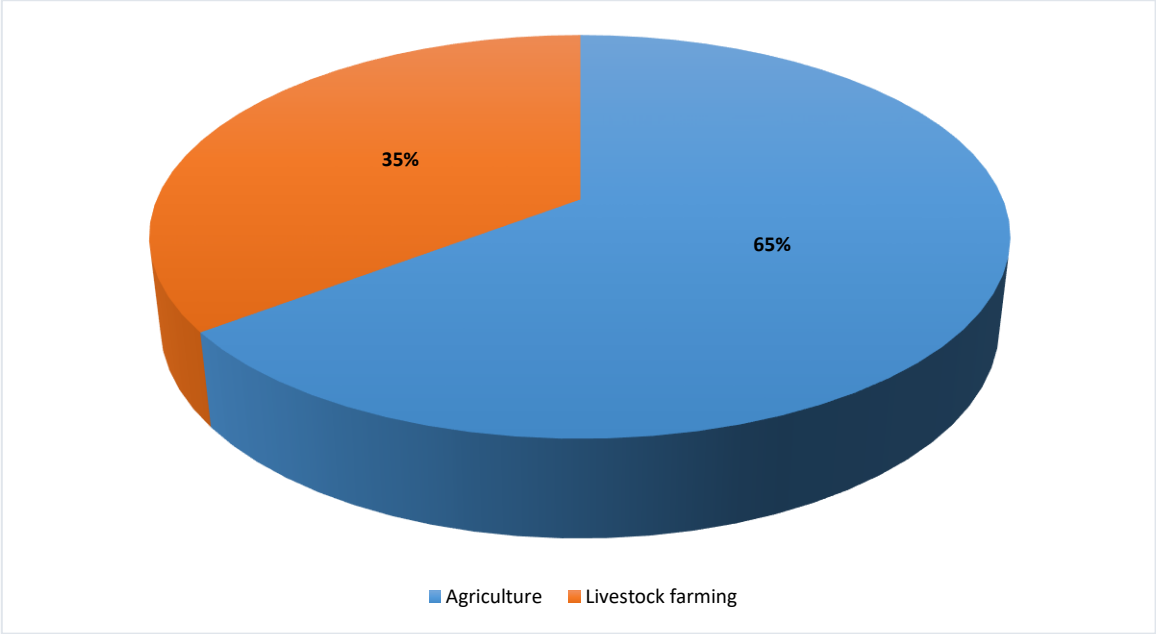


Trainings attended. Figure 7 shows that a significant majority of respondents (76%) have attended 'Other' trainings, reflecting a wide range of specialized programs such as nursing, engineering, and education. This high percentage indicates a broad and diverse skillset within the community, which can contribute significantly to various aspects of sustainable development within the Bigbiga Protected Landscape (BPL). Conversely, only 3% of respondents have attended livestock management training, which represents the lowest attendance among the training categories. This low percentage suggests a more limited focus on optimizing animal husbandry practices compared to other areas of skill development.

The implication is that while the community has a strong foundation in a diverse range of specialized skills, there is a relatively lower emphasis on livestock management training. This indicates that integrating more targeted livestock management programs could be beneficial for enhancing agricultural and animal husbandry practices within the BPL.

Corroborating this, Sumberg and Okali (2014) highlight the importance of targeted training programs in agriculture to address specific gaps and improve overall practices. Their research emphasizes that while a broad range of skills is valuable, focused training in areas such as livestock management can significantly contribute to agricultural productivity and community adaptability. This alignment suggests that addressing the gap in livestock management training could further strengthen the community's capacity for sustainable development within the BPL.

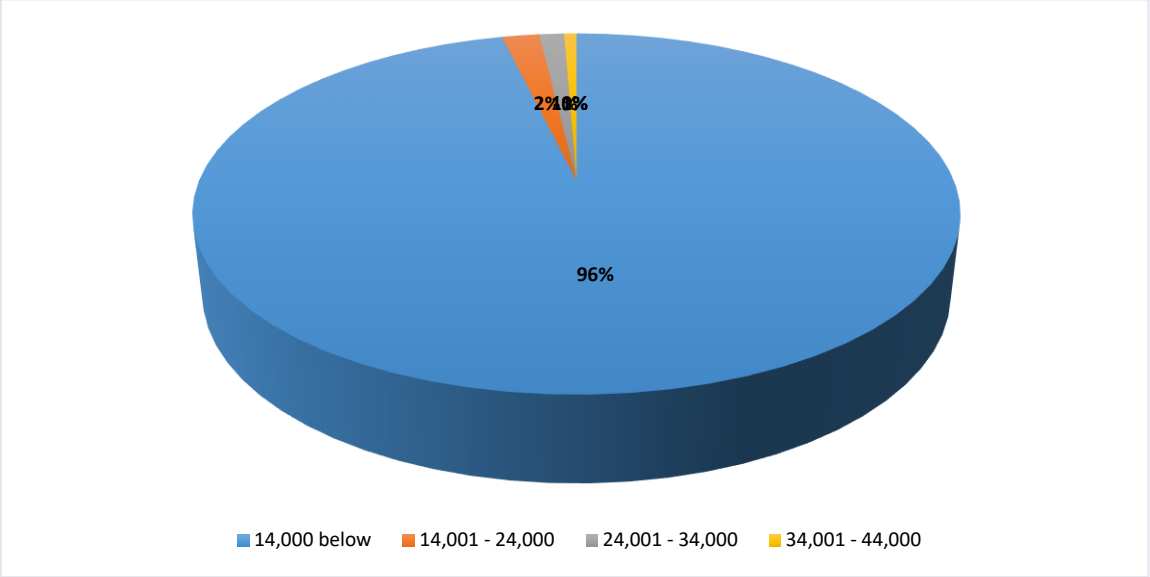
Figure 8. Distribution of Source of Livelihood



Source of livelihood. The high engagement in agriculture underscores its central role in the community's livelihood, indicating a strong dependency on farming for economic stability. The relatively lower involvement in livestock farming suggests that while it contributes to the local economy, its impact is less compared to agriculture. Understanding this balance is crucial for designing effective strategies for resource management and conservation. Emphasizing sustainable farming practices and integrating livestock management into broader agricultural strategies can help ensure that both sectors support long-term economic and environmental goals.

Corroborating this, a study by Sumberg and Okali (2014) highlights how diverse agricultural and livestock practices are vital for rural livelihoods and economic resilience. Their research supports the notion that while agriculture often dominates as the primary livelihood source, integrating and optimizing other practices like livestock farming can enhance overall community well-being and sustainability.

Figure 9. Distribution of income level per month

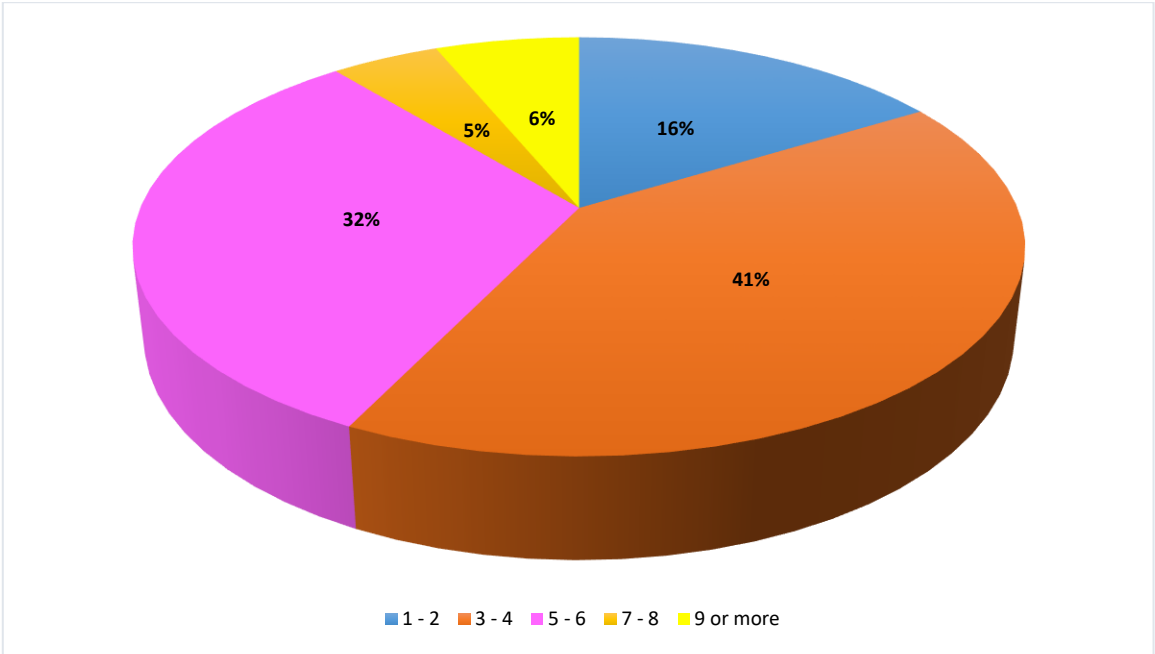


Income level per month. Figure 9 shows that a significant majority of respondents (96%) earn 14,000 pesos or below per month, indicating widespread low income within the community. This high proportion reflects substantial economic challenges, which can limit their ability to engage in sustainable practices and environmental protection effectively. The low income levels underscore the necessity for targeted financial support to enhance the community's economic stability and encourage more active involvement in conservation efforts.

The implication of these income levels is that economic constraints are likely to hinder the community's capacity to adopt and maintain sustainable practices. Addressing these financial challenges is crucial for improving community engagement in conservation activities and enhancing overall well-being. By providing financial assistance and support, the community can better contribute to environmental stewardship while also improving their economic conditions.

Corroborating this, Avtar (2017) highlights that financial limitations in rural areas often restrict effective environmental management and sustainable development. Their research emphasizes that economic support and stability are essential for empowering communities to participate actively in conservation initiatives and achieve sustainable development goals. This alignment suggests that addressing the community's economic challenges is vital for fostering greater involvement in conservation and enhancing overall quality of life.

Figure 10. Distribution of Number of household members

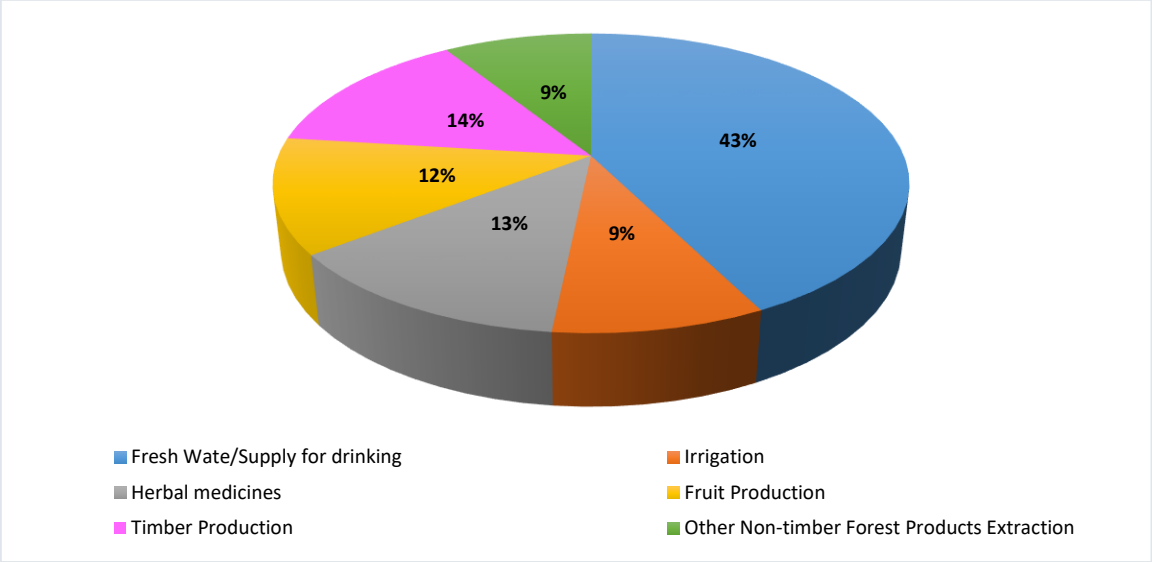


Number of household members. Figure 10 shows that most respondents (41%) live in households with 3-4 members, while only 5% are in households with 7-8 members. This suggests that smaller households are more common in the community, which can impact how resources are managed and how families handle changes in the environment and economy.

The implication is that smaller households might use resources more efficiently and have a lower environmental impact per person. On the other hand, larger households, though less common, might struggle more with managing resources and adapting to changes due to their higher needs. This means that managing resources and conservation needs to be flexible enough to suit both small and large households.

Sumberg and Okali (2014) discuss how household size and structure affect resource management and farming practices. They emphasize that understanding these dynamics is important for creating effective development plans that meet the needs of various household sizes. Their research supports the idea that policies should be tailored to help both small and large households manage resources sustainably.

Figure 11. Distribution of Benefits derived



Benefits derived. Figure 11 highlights the critical role of the Bigbiga Protected Landscape (BPL) in supporting local communities by providing essential resources like fresh water, timber, and non-timber forest products. Fresh water/supply for drinking is the most significant benefit, with 43% of respondents relying on it. In contrast, only 9% of respondents are involved in extracting other non-timber forest products. The variety of resources from the BPL shows how essential it is for farming, health, and food security. It's important to daily life and for the local economy.

The implication is that the community's deep reliance on these resources necessitates a careful balance between resource use and conservation. Effective management plans must ensure that resource extraction does not compromise the BPL's ability to support current and future needs, highlighting the importance of sustainable practices.

Corroborating this, Kremen and Merenlender (2018) emphasize how landscapes that integrate both biodiversity and human needs can support resilience and sustainability. Their research suggests that managing landscapes to benefit both people and ecosystems can enhance community well-being and ecological balance. This aligns what the study shows and emphasizes how important it is to manage resources well in the BPL to keep both the environment and the local economy healthy.

Level of Implementation of Water Ecosystem Services

Table 3. Water Quality and Quantity Management

Indicator	**Mean**
1. Communicates information about water quality and quantity management initiatives to the public.	3.44
2. Monitors programs to the public and accurate data on water quality and quantity.	3.28
3. Collaborates with local communities and stakeholders in water quality and quantity management initiatives.	3.26

4. Effectively responds to emerging challenges and threats to water quality and quantity.	3.33
Total	**3.33**

Water Quality and Quantity Management. Conversely, the lowest mean score of 3.26 is recorded for the indicator Collaborates with local communities and stakeholders in water quality and quantity management initiatives. This indicates that collaboration with local communities and stakeholders is less consistently implemented compared to other aspects of water management.

The overall mean score for Water Quality and Quantity Management stands at 3.33, categorizing it as 'Moderately Implemented' based on the five-point Likert scale. This suggests that although there are efforts to manage water quality and quantity, they're not always consistent and have some major gaps. The 'Moderately Implemented' status points to a need for improved communication and teamwork. To make the program work better, it's important to keep the community updated and engaged. Building stronger connections with local people and groups will ensure everyone has a voice in managing water.

These findings align with similar studies, such as those by Orr (2013), which highlight the significance of stakeholder collaboration and communication in environmental policymaking. Orr's research underscores the importance of integrating stakeholder input and improving collaboration practices to enhance the effectiveness of environmental management strategies. Addressing these areas can help BPL move toward a more comprehensive and effective water management strategy.

Table 4. Watershed Protection and Management

Indicator	**Mean**
1. Implements initiatives for watershed protection to maintain or improve water quality and quantity.	3.66
2. Addresses the conservation of natural resources and biodiversity within the watershed area.	3.57
3. Coordinates with local communities and stakeholders in implementing watershed protection measures.	3.57
4. Integrates watershed protection initiatives with boarder environmental conservation goals, such as maintaining ecological balance and sustaining ecosystem services.	3.62
Total	**3.60**

Watershed Protection and Management. The survey results for Watershed Protection and Management in the Bigbiga Protected Landscape (BPL), as presented in Table 4, that the highest mean score of 3.66 corresponds to the indicator "Implements initiatives for watershed protection to maintain or improve water quality and quantity." This falls into the "Highly Implemented" category (3.41 – 4.20 on the Likert scale), indicating that efforts to protect watersheds and ensure water sustainability are regularly and consistently carried out.

In contrast, the lowest mean scores of 3.57 are reported for the indicators "Addresses the conservation of natural resources and biodiversity within the watershed area" and "Coordinates with local communities and stakeholders in implementing watershed protection measures." These scores are also within the "Highly Implemented" range but slightly lower, suggesting that while these initiatives are implemented regularly, there are occasional gaps or inconsistencies in their execution.

The overall mean score for Water Protection and Management is 3.60, placing it in the "Highly Implemented" category. This suggests that, on average, the initiatives related to water protection and management are consistently carried out. There's definitely room for improvement, especially in conserving natural resources and working more closely with local communities and stakeholders.

These findings match Loucks' (2024) research, which highlights the need to blend environmental conservation with community involvement in managing water resources. Loucks stresses that taking a well-rounded approach, which combines strong watershed protection with broader environmental goals, is key. By focusing on these areas, BPL can improve its efforts in water protection and management, ensuring its water resources remain sustainable and resilient.

Table 5. Biodiversity Conservation

Indicator	**Mean**
1. Implements biodiversity conservation to positively impact water quality and ecosystem health.	3.87
2. Communicated and raises awareness about the importance of biodiversity conservation within water ecosystems.	3.88
3. Ensures collaborative and sustainable practices.	3.79
4. Aligns environmental goals and strategies contributing to the health and resilience of the ecosystem.	3.77
Total	**3.82**

Biodiversity Conservation. The survey results for Biodiversity Conservation in the Bigbiga Protected Landscape (BPL), as shown in Table 5, that the highest mean score of 3.88 corresponds to the indicator 'Communicates and raises awareness about the importance of biodiversity conservation within water ecosystems.' This falls into the 'Highly Implemented' category (3.41 – 4.20 on the Likert scale), indicating that efforts to educate and inform the public about biodiversity conservation are regularly and consistently carried out.

The lowest mean score of 3.77 is for the indicator 'Aligns environmental goals and strategies contributing to the health and resilience of the ecosystem.' This score, also within the 'Highly Implemented' range, suggests that while alignment of environmental goals with broader strategies is regularly practiced, it is slightly less consistent compared to other aspects of biodiversity conservation. Ensuring that conservation efforts are well-aligned with environmental goals is essential for maintaining ecosystem health and resilience.

The overall mean score for Biodiversity Conservation is 3.82, which falls into the 'Highly Implemented' category. This shows that the initiatives are generally effective, reflecting a strong commitment to protecting biodiversity and keeping ecosystems healthy.

Research by Orr (2013) highlights how important it is to communicate and collaborate effectively for successful biodiversity conservation. Orr's findings emphasize that sustained efforts in public engagement and strategic alignment are essential for effective biodiversity conservation. By continuing to focus on these areas, BPL can further strengthen its biodiversity conservation initiatives, ensuring long-term ecosystem health and resilience.

Table 6. Flood Control and Disaster Risk Management

Indicator	**Mean**
1. Implements efforts in flood control and disaster risk reduction to effectively safeguard water quality and mitigate potential environmental hazards.	3.70
2. Coordinates with other relevant agencies and local communities in implementing flood control measures and disaster risk reduction strategies.	3.66
3. Ensures the protection of water quality and ecosystem integrity.	3.71
4. Aligns flood control and disaster risk reduction initiatives with broader environmental goals.	3.60
Total	**3.67**

Flood Control and Disaster Risk Management. The survey results for Flood Control and Disaster Risk Management in the Bigbiga Protected Landscape (BPL), as shown in Table 6, that the highest mean score of 3.71 is for the indicator "Ensures the protection of water quality and ecosystem integrity." This score falls into the "Highly Implemented" category (3.41 – 4.20 on the Likert scale), suggesting that efforts to protect water quality and maintain ecosystem integrity are regularly and consistently carried out.

The lowest mean score of 3.60 is for the indicator "Aligns flood control and disaster risk reduction initiatives with broader environmental goals." Although this score also falls within the "Highly Implemented" range, it indicates that aligning these initiatives with broader environmental goals is slightly less consistent compared to other aspects of flood control and disaster risk management.

The overall mean score for Flood Control and Disaster Risk Management is 3.67, which places it in the "Highly Implemented" category. This reflects a strong commitment to safeguarding water quality and mitigating potential environmental hazards through consistent flood control and disaster risk management efforts.

While specific previous research on this topic is limited, studies such as those by Nkwunonwo (2016) emphasize the importance of integrated flood risk management and stakeholder involvement in effective disaster risk reduction. Nkwunonwo's research shows that it's crucial to blend technical solutions with active involvement from both agencies and local communities. By keeping this approach in mind, BPL can improve its flood control and disaster risk management efforts.

Table 7. Community Awareness and Education

Indicator	**Mean**
1. Engages in community awareness programs regarding water quality and conservation practices.	3.77
2. Promotes understanding and participation in water conservation efforts.	3.73
3. Collaborates with local communities and stakeholders in implementing community-based initiatives for water quality awareness and conservation.	3.72
4. Communicates strategies to convey important information about water quality and conservation practices to diverse community groups.	3.65
Total	**3.72**

Community Awareness and Education. The survey results for Community Awareness and Education in the Bigbiga Protected Landscape (BPL), as presented in Table 7 that the highest mean score of 3.77 is for the indicator 'Engages in community awareness programs regarding water quality and conservation practices.' This score falls into the 'Highly Implemented' category (3.41 – 4.20 on the Likert scale), indicating that efforts to raise awareness about water quality and conservation are regularly and consistently executed.

The lowest mean score of 3.65 is for the indicator 'Communicates strategies to convey important information about water quality and conservation practices to diverse community groups.' Although this score is still within the 'Highly Implemented' range, it suggests that there is slightly less consistency in effectively communicating these strategies to diverse community groups.

The overall mean score for Community Awareness and Education is 3.72, which also falls into the 'Highly Implemented' category. This reflects a strong commitment to promoting understanding and participation in water conservation efforts among the local community.

Research by Jacobson et al. (2015) underscores the importance of effective conservation education and outreach techniques in enhancing community engagement and promoting sustainable practices. Their work provides valuable guidance on designing and implementing successful education programs, which can help BPL strengthen its community awareness and education initiatives.

Table 8. Policy Development and Enforcement

Indicator	**Mean**
1. Implements policies for water resources management contributing to sustainable water quality and quantity.	3.90
2. Addresses the diverse needs of stakeholders while maintaining ecological balance in water ecosystems.	3.84
3. Enforces regulations to control industrial discharges and pollution in water bodies.	3.82
4. Implements integrated water resources management plans to ensure sustainable water quality and quantity.	3.78
Total	**3.84**

Policy Development and Enforcement. The survey results for Policy Development and Enforcement in the Bigbiga Protected Landscape (BPL), as shown in Table 8, that the highest mean score of 3.90 is for the indicator 'Implements policies for water

resources management contributing to sustainable water quality and quantity.' This score falls into the 'Highly Implemented' category (3.41 – 4.20 on the Likert scale), suggesting that efforts to implement policies for managing water resources to ensure sustainability are conducted regularly and consistently.

The lowest mean score of 3.78 is for the indicator 'Implements integrated water resources management plans to ensure sustainable water quality and quantity.' Although this score is still within the 'Highly Implemented' range, it indicates slightly less consistency in implementing integrated management plans compared to other policy-related efforts.

The overall mean score for Policy Development and Enforcement is 3.84, which falls into the 'Highly Implemented' category. This suggests that, on average, initiatives related to policy development and enforcement are regularly and consistently carried out. It reflects a strong commitment to developing and enforcing policies that address stakeholder needs while maintaining ecological balance in water ecosystems. However, there remains room for improvement, particularly in implementing integrated water resources management plans to enhance overall policy effectiveness.

Research by Loucks et al. emphasizes the importance of comprehensive water resources systems planning and management. This means not just having strong policies but also systematic planning. Loucks' research supports the need for robust and integrated policy approaches to ensure sustainable water management. By continuing to focus on these areas, BPL can further strengthen its policy development and enforcement initiatives, ensuring a more resilient and sustainable approach to managing water resources. This alignment with Loucks et al.'s findings underscores the importance of comprehensive planning and effective policy implementation in achieving long-term water management goals.

Table 9. Integrated Resource Management

Indicator	**Mean**
1. Implements integrated water resources management plans to ensure sustainable water quality, quantity and ecosystem health.	3.92
2. Considers the diverse needs of stakeholders, fostering collaboration for effective water conservation.	3.84
3. Coordinates with various government agencies and local communities in implementing integrated resource management plans for water ecosystems.	3.83
4. Integrates resource management strategies, believing thy contribute to sustainable water quality and environmental resilience.	3.80
Total	**3.84**

Integrated Resource Management. The survey results for Integrated Resource Management in the Bigbiga Protected Landscape (BPL), as shown in Table 9, that the highest mean score, 3.92, is for the indicator "Implements integrated water resources management plans to ensure sustainable water quality, quantity, and ecosystem health." This score falls into the "Highly Implemented" category (3.41 – 4.20 on the Likert scale), indicating that integrated water resources management plans are the most frequently executed aspect of the program.

The lowest mean score, 3.80, is for the indicator "Integrates resource management strategies, believing they contribute to sustainable water quality and environmental resilience." Although this score remains within the "Highly Implemented" range, it suggests that the integration of resource management strategies is slightly less consistent compared to other aspects of integrated resource management.

The overall mean score for Integrated Resource Management is 3.84, which falls into the "Highly Implemented" category. This indicates that, on average, initiatives related to integrated resource management are regularly and consistently carried out. It reflects a strong commitment to fostering collaboration among diverse stakeholders and coordinating efforts with government agencies and local communities.

Teodosiu's research (2009) demonstrates how integrated resource management can effectively enhance environmental resilience and sustainability. His findings stress the importance of combining technical strategies with active collaboration among stakeholders. By focusing on these areas, BPL can strengthen its approach to managing resources, ensuring both resilience and sustainability. Aligning with Teodosiu's insights, this approach highlights the need for thorough and cooperative strategies to achieve lasting success in water management.

Relationship Between Respondent Profiles and Implementation of Water Ecosystem Services

Table 10. Correlation Results Between Profile of the Respondents and Implementation of Water Ecosystem Services

	Water Quality and Quantity Management	Watershed Protection and Management	Biodiversity Conservation	Flood Control and Disaster Risk Reduction	Community Awareness and Education	Policy Development and Enforcement	Integrated Resource Management
Age	** -.154	-.073	-.094	-.087	-.043	*-.122	-.079
Gender	.063	.042	-.009	.033	.021	-.014	-.024
Educational Attainment	-.017	-.075	-.007	-.045	-.096	-.051	-.063
Number of Years	-.079	-.012	-.103	-.102	-.069	* -.114	* -.125
Trainings attended	.090	.055	* .125	.074	.066	* .138	.105
Source of Livelihood	-.078	-.082	* -.132	-.094	-.092	-.074	-.068
Income Level	.004	-.032	-.057	-.021	-.035	-.071	-.072
Household Members	** .176	.101	.052	**.148	** .153	* .121	* .138
Benefits Derived	* -.128	-.092	-.037	.006	-.055	-.012	-.002

The table 10 shows the correlation results between profile of the respondents and the implementation of water ecosystem services. The correlation coefficients (r-values) indicate the strength and direction of the relationship, with asterisks (*) denoting statistical significance. The analysis revealed several significant correlations between profile of the respondents' variables and the implementation of water ecosystem services within the Bigbiga Protected Landscape (BPL). These findings have important implications for understanding how different community attributes influence perceptions and implementation of water ecosystem services.

Water Quality and Quantity Management (Age Correlation): The significant negative correlation (r = -0.154) between age and water quality and quantity management suggests that older respondents perceive lower levels of implementation. This could imply that older residents are either more critical due to their longer experience with the area's environmental changes or perhaps less engaged with newer initiatives. Addressing this perception gap is crucial for ensuring that water management efforts are inclusive and recognized across all age groups. This implies that older residents may have valuable historical perspectives but might also need targeted communication to appreciate newer initiatives. Efforts to involve older residents more actively in current water management practices could enhance their engagement and support.

Research by Krosnick and MacInnis (2019) demonstrates that older adults may have varying levels of support for environmental policies based on their long-term exposure to environmental changes and experiences. This variability in perspective highlights the importance of considering age-related factors when designing and implementing environmental initiatives.

Policy Development and Enforcement (Age Correlation): Similarly, the significant negative correlation (r = -0.122) indicates that older respondents perceive lower levels of policy development and enforcement. This perception might arise from a historical perspective where past policy implementations were less robust. To address this, it is important to enhance communication strategies that clearly demonstrate the effectiveness and progress of current policies. Highlighting advancements and changes in policy enforcement over time can help bridge this perception gap. Engaging more with older residents could lead to better understanding and stronger support for current initiatives. This is in line with what Gillingham and Palmer (2014) found, showing that clear communication and targeted insights are key to bridging gaps in public support and perception. Their research highlights the importance of addressing historical gaps and improving outreach across various age groups to boost overall effectiveness and acceptance.

Policy Development and Enforcement (Number of Years Residing Correlation): The significant negative correlation (r = -0.114) suggests that long-term residents perceive lower levels of policy development and enforcement. This perception might arise from

past inconsistencies or perceived failures in policy implementation. To address this, it is crucial to actively involve long-term residents in current policy-making processes and clearly demonstrate the effectiveness of new enforcement measures. This can help change their views to reflect the current practices. Adger et al. (2013) point out that understanding the historical context and involving communities in the policy process are crucial for improving perceptions and making policies more effective. Their research shows that addressing past problems and engaging with communities can help close perception gaps and build stronger support for today's policies.

Integrated Resource Management (Number of Years Residing Correlation): The significant negative correlation (r = -0.125) indicates that long-term residents perceive lower levels of integrated resource management implementation. This may reflect a historical lack of integrated approaches in the area. Enhancing awareness and involving these residents in integrated management practices can improve their perception and cooperation. This aligns with recent findings by Cook et al. (2021), who observed that long-term residents are often skeptical of new management practices due to past experiences, but that increased engagement and transparent communication can help build trust and improve perceptions of integrated resource management.

Biodiversity Conservation (Training Attended Correlation): The significant positive correlation (r = 0.125) suggests that respondents who attended more training perceive higher levels of biodiversity conservation implementation. This highlights how important educational and training programs are for boosting community awareness and involvement in protecting biodiversity. Expanding these training opportunities could further strengthen local engagement and contribute to more effective conservation outcomes. These findings are consistent with research by Jacobson et al. (2015), which demonstrated that well-designed educational programs significantly improve community perceptions and active participation in biodiversity conservation initiatives.

Policy Development and Enforcement (Training Attended Correlation): Policy Development and Enforcement: A significant positive correlation (r = 0.138) indicates that those who attended more trainings perceive higher levels of policy development and enforcement. This highlights how education is key to helping people better understand and appreciate policy efforts. Boosting training and educational outreach can strengthen community support for these initiatives. Stern et al. (2014), who found that training and education play a crucial role in enhancing community support for environmental policies.

Biodiversity Conservation (Source of Livelihood Correlation): The significant negative correlation (r = -0.132) suggests that respondents with certain livelihood sources perceive lower levels of biodiversity conservation implementation. This might be because their daily activities clash with conservation efforts. By adjusting conservation strategies to better support and fit with local ways of life, it could help change these views and encourage more sustainable practices. These findings are in line with research by Pailler et al. (2015), who found that livelihood sources significantly influence perceptions of conservation efforts, especially when there are perceived conflicts between economic activities and conservation goals.

Water Quality and Quantity Management (Number of Household Members Correlation): The significant positive correlation (r = 0.176) indicates that households with more members perceive higher levels of water quality and quantity management implementation. Larger households might be more aware of and dependent on water resources, thereby perceiving and appreciating management efforts more keenly. This suggests that larger households are more involved in water management because they depend on these resources more. Making sure that water management efforts address the needs of these larger households can boost their support and participation. This aligns with Iosifidi's (2016) findings, which showed that larger households tend to be more aware of and appreciative of resource management due to their higher usage and dependence on resources. By tailoring water management practices to better fit the needs of these households, their involvement and support can be greatly enhanced.

Flood Control and Disaster Risk Management (Number of Household Members Correlation): The significant positive correlation (r = 0.148) suggests that larger households perceive higher levels of flood control and disaster risk management implementation. This could be because larger households experience more significant impacts from disasters, making them more appreciative of management efforts. This indicates that larger households may be more vulnerable to disasters and thus more appreciative of management efforts. Focusing on the needs and concerns of larger households in disaster risk management can improve their perception and support. This aligns with research by Onuma et al. (2017) findings, who showed that the importance of household size in influencing disaster preparedness and perception of risk management efforts.

Community Awareness and Education (Number of Household Members Correlation): The significant positive correlation (r = 0.153) indicates that larger households perceive higher levels of community awareness and education. This may be due to the broader dissemination of information within larger families, where knowledge-sharing and communication are more robust. Larger households often value community involvement more because their combined voice can impact local projects. This means that community awareness and education programs work especially well when they engage these larger households, who can spread information widely within the community. Targeting these households in educational campaigns can boost the overall impact of these efforts. By focusing on larger families, programs can enhance community-wide awareness and involvement, using the natural

networks and communication channels within these bigger family units. This aligns results with research by Onuma et al. (2017) findings, which found that households with more members tend to have a higher level of preparedness and engagement in community initiatives.

Policy Development and Enforcement: Policy Development and Enforcement (Number of Household Members Correlation): The significant positive correlation (r = 0.121) suggests that households with more members perceive higher levels of policy development and enforcement. This might show that larger families have a stronger sense of collective awareness and advocacy. With more shared responsibilities and diverse experiences, they are often more attuned to policy issues. Involving these households in policy discussions can boost community support for enforcement efforts, as their united voice can highlight the need for consistent and effective policy implementation. This aligns with findings from Onuma et al. (2017) findings, who observed that larger households tend to have greater preparedness and risk perception in the context of natural disasters.

Integrated Resource Management (Number of Household Members Correlation): The significant positive correlation (r = 0.138) indicates that larger households perceive higher levels of integrated resource management implementation. This perception may arise from the direct benefits they experience from well-managed resources, such as improved access to clean water and sustainable land use practices. Larger households, often more dependent on local resources, are likely to recognize and value the outcomes of effective management strategies. To further strengthen their support and involvement, it is crucial that integrated resource management efforts continue to address the specific needs of these larger households. This aligns with research by Onuma et al. (2017) findings, which showed that larger households tend to have heightened awareness and preparedness in the context of resource management, reflecting their reliance on and appreciation for well-managed resources.

Water Quality and Quantity Management (Benefits Derived Correlation): The significant negative correlation (r = -0.128) suggests that respondents who derive more direct benefits from water resources perceive lower levels of water quality and quantity management implementation. This could indicate that beneficiaries with substantial stakes may have higher expectations and be more critical of management efforts. They might be more attuned to any perceived inadequacies in management practices. This implies that better engagement and communication with these beneficiaries are crucial. By involving them more in decision-making and clearly showing how management practices benefit them, their views can be more in line with what's actually being done. Improved engagement can lead to more accurate assessments and greater support for these efforts. Martín-de Castro et al. (2016) support this idea, emphasizing that effective stakeholder involvement is key to improving perceptions and policies in environmental management. Their research highlights the need to meet stakeholder expectations and enhance communication to ensure that perceptions match the actual practices.

Patterns of Land Cover Change within the Bigbiga Protected Landscape from 2010 to 2024

The land cover of the Bigbiga Protected Landscape (BPL) has undergone notable transformations from 2010 to 2024, as captured through GIS mapping, NAMRIA land cover maps, Google Earth imagery, and validated drone assessments. This analysis reflects the evolving ecological and conservation dynamics within the protected area.

In the Land Cover 2010 Map provided by NAMRIA, the BPL's landscape was primarily characterized by Annual Crops and Brush/Shrubs. Annual crops covered a modest 2.84 hectares, indicating limited agricultural activity, which aligns with the BPL's primary conservation goals focused on preserving natural vegetation. Brush/Shrubs, covering 140.03 hectares, represented a significant portion of the landscape, highlighting the predominance of semi-natural vegetation essential for ecological health. This extensive brush and shrub cover supports vital functions such as water retention and soil stabilization, crucial for protecting the BPL's water resources.

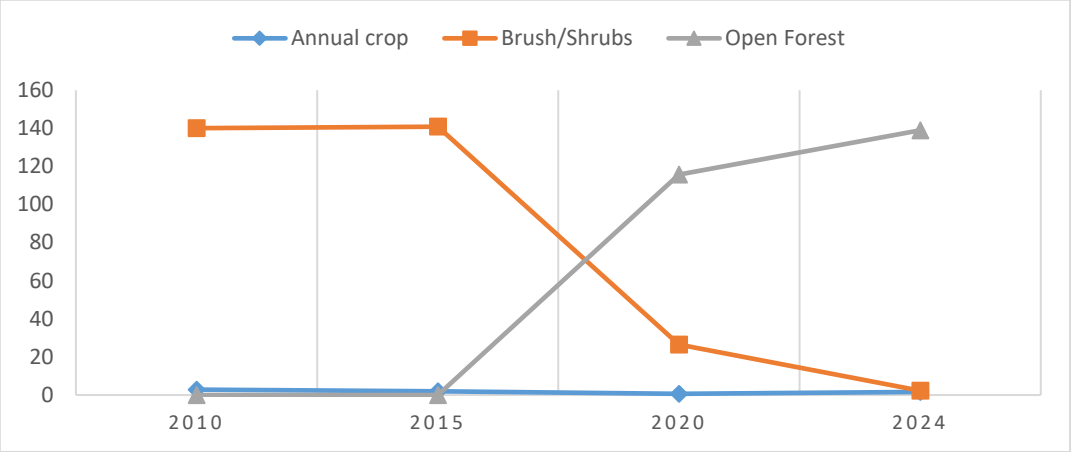
By 2015, as illustrated in the Land Cover 2015 Map from NAMRIA, there were slight but notable changes. The area covered by annual crops decreased to 2.04 hectares, reflecting a continued emphasis on minimizing agricultural impact within the protected area. Conversely, the brush/shrub area increased marginally to 140.83 hectares, suggesting a positive trend toward more semi-natural vegetation, which supports ongoing ecological stability and enhances functions such as water retention.

In the Land Cover 2020 Map from NAMRIA, the BPL showed significant improvements. The area covered by annual crops decreased further to 0.64 hectares, reinforcing the focus on maintaining natural vegetation. A substantial decrease in Brush/Shrubs to 26.49 hectares indicated a shift away from shrub-dominated areas, potentially due to land management activities or natural ecological succession. Most notably, the introduction of 115.74 hectares of Open Forest marked a significant positive transformation. This development underscores successful reforestation efforts and natural regrowth, enhancing ecological functions like water regulation and habitat provision.

For the 2024 land cover map, recent Google Earth imagery was cross-verified with drone footage to ensure accuracy. The findings revealed further progress, with annual crops slightly increasing to 1.66 hectares and brush/shrubs drastically reducing to 2.28

hectares. The most remarkable development was the growth of open forests to 138.93 hectares. This expansion aligns with the BPL's conservation objectives, enhancing water regulation, habitat quality, and overall ecological health.

Figure 12. Land Cover Trend



The decrease in brush/shrub cover from 140.03 hectares in 2010 to 2.28 hectares in 2024 represents a shift towards more effective land management and ecological health. However, it's essential to watch these changes closely to ensure they don't affect water availability, especially during dry periods. Effective reforestation and conservation efforts are key to making sure that the new open forest areas can still manage water well and make up for any loss in water-regulating capacity.

The fluctuations in annual crop areas, particularly the reduction to 0.64 hectares in 2020 followed by an increase to 1.66 hectares in 2024, reflect dynamic land use patterns. While the limited extent of agricultural land is generally favorable for conserving natural vegetation, which is crucial for maintaining water quality and quantity, any expansion in crop areas must be carefully managed to prevent adverse effects on water resources.

Overall, the increase in open forest areas is a positive development for water services in the BPL. Nonetheless, it's crucial to address potential concerns about water availability, particularly during dry seasons. Regularly checking how land cover changes and adjusting management practices are key to keeping the BPL's water resources and the ecosystem healthy. This study highlights why it's crucial to continue conservation efforts to keep the area in good condition and ensure it keeps providing essential water services to nearby communities. Karki et al. (2018) back this up, showing how important land cover is for ecosystem services, especially in places undergoing big changes from both natural and human activities. Their work stresses that smart land management, like reforestation, is key to maintaining ecosystem functions like water regulation, which is exactly what's needed in the BPL.

Relationship of Land Cover Changes and Implementation of Water Ecosystem Services

Table 11. Correlation Results Between Land cover change and Implementation of Water Ecosystem Services

Scale points for rating	Water Ecosystem Services	Land Cover Change
Mean	3.84921875	0
Variance	0.993455501	19139
Observations	320	3
Hypothesized Mean Difference	0	
Df	2	
T Stat	0.048191838	
P(T<=t) one-tail	0.482971496	
t Critical one-tail	2.91998558	
P(T<=t) two-tail	0.965942992	
t Critical two-tail	4.30265273	

The analysis of Table 11 indicates that there is no significant relationship between land cover change and the level of implementation of water ecosystem services in the Bigbiga Protected Landscape. The computed t-value of 0.048 is significantly

lower than the critical t-value of 2.92, suggesting that land cover change does not have a statistically significant effect on the implementation of these services. This finding implies that the factors driving the success of water ecosystem services might be more closely related to human activities, policies, and management practices rather than just changes in land cover.

Corroborating this result, recent research by Melese (2016) on land use and land cover changes in Ethiopia highlights that while changes in land cover can affect ecosystem services, the extent of this impact often depends on the specific context and the type of ecosystem services being considered. Sometimes, with the right management practices, it's possible to reduce the negative effects of changes in land cover. This helps keep ecosystem services functioning well, even as the environment evolves. This matches what other research has found: the link between land cover and ecosystem services can be complicated and isn't always straightforward.

Problems in the Implementation of Water Ecosystem Services

Based on the results of the survey assessing the implementation of water ecosystem services in the Bigbiga Protected Landscape (BPL), the primary issue identified is related to water quality and quantity management. This area received a mean score below 3.5, indicating a notable concern among respondents.

The survey results indicate that people think the current water quality and quantity management efforts are not sufficient. This suggests that the existing measures might not be effectively providing clean and adequate water. Given how important good water quality and supply are for both the environment and the community, it's crucial to address these shortcomings. Improving water management will be key to keeping the area healthy and sustainable for the long term

Fixing the issues with water quality and quantity management is essential for the BPL. It's important to create and put in place stronger management practices that can meet community needs while protecting the area's natural balance. Improving this aspect of water services will help the BPL better support the environment and the resources that local communities rely on.

Karki et al. (2018) point out how important it is to manage water properly to support both the environment and local communities, especially in areas facing land use changes. They reveal that poor water management can seriously harm the environment and affect people's lives. This aligns with the BPL survey results, highlighting the need for better strategies to manage water quality and supply in the protected area.

Proposed Policy for Water Management Policy in the Bigbiga Protected Landscape (BPL)

To enhance water quality and quantity management within the Bigbiga Protected Landscape (BPL), the following proposed policy framework can be developed and implemented;

Policy Statement: This policy establishes a comprehensive framework for the protection and sustainable management of water resources within the Bigbiga Protected Landscape (BPL). It aims to preserve water quality and regulate water quantity to support ecological integrity, biodiversity conservation, and community needs.

Scope: This policy applies to all stakeholders within the Bigbiga Protected Landscape (BPL), including government agencies, local communities, NGOs, and private entities. It covers activities affecting water resources, such as water use, management, conservation efforts, and emergency response within the BPL.

Rationale: The findings of the study on the water ecosystem services in the Bigbiga Protected Landscape (BPL) reveal that water quality and quantity management received the lowest rating, with a score of 3.60, indicating only moderate implementation. This underscores the need for focused improvement in these areas. The primary objectives of this policy are:

- To enhance monitoring and management practices for water quality and quantity within BPL.
- To promote community collaboration and awareness in water conservation.
- To ensure sustainable water resource use that supports both ecological health and human needs.

The policy aligns with national environmental laws, international agreements, and sustainable development goals, providing a unified approach to water management in the BPL.

Definitions:

- Water Quality: The chemical, physical, and biological characteristics of water, determining its suitability for uses such as human consumption, recreation, and ecological functions.
- Water Quantity: The availability and distribution of water resources, including surface and groundwater within BPL.
- Protected Areas: Legally designated zones managed for conservation purposes and protected from significant human exploitation.

Policy Guidelines (Implementing Rules and Regulations - IRR):

A. Monitoring and Reporting:

- Water Quality Indicators: Establish a robust system to monitor key water quality indicators, such as pH, turbidity, dissolved oxygen, and contaminant levels.

- Data Management: Maintain a centralized database to record and share water quality data, ensuring transparency and accountability.
- Regular Reporting: Generate and disseminate regular reports to inform stakeholders and the public about the state of water resources in BPL.

B. Enforcement of Standards:

- Compliance Monitoring: Conduct regular inspections to enforce water quality standards and extraction limits, applying sanctions for non-compliance.
- Sustainable Usage: Ensure water extraction and usage do not exceed sustainable levels, thereby preserving the integrity of water ecosystems.

C. Public Participation and Education:

- Awareness Programs: Develop and implement educational programs to raise awareness about the importance of water conservation and management.
- Community Engagement: Facilitate active involvement of local communities in monitoring and protecting water resources through engagement initiatives.

D. Emergency Response:

- Contingency Planning: Establish emergency protocols to address water-related incidents, such as contamination or supply disruptions.
- Coordinated Response: Ensure rapid and coordinated responses to minimize impacts on water availability and public health, including plans for alternative water sources and public communication.

E. Policy Review and Adaptation:

- Regular Reviews: Subject the policy to periodic reviews, updating it to incorporate new scientific research, technological advancements, and stakeholder feedback.
- Adaptation to Change: Modify the policy to address changing environmental conditions and emerging challenges, ensuring the ongoing protection and sustainable management of water resources in BPL.

Enforcement and Accountability:

- Responsibility: The Department of Environment and Natural Resources (DENR) and the Protected Area Management Board (PAMB) will be responsible for enforcing this policy within the Bigbiga Protected Landscape (BPL).
- Sanctions: Non-compliance with the policy will result in penalties, including fines, suspension of activities, or other appropriate measures.
- Transparency: Ensure all actions, decisions, and data related to water management are accessible to the public to promote accountability.

Review and Amendment:

- This policy will be reviewed every five years or as needed based on changing environmental conditions or feedback from stakeholders. Amendments will be made to address emerging issues or improve policy effectiveness.

4. CONCLUSIONS

Based from the proceeding results of the study, the following conclusions were made:

1. The diverse demographic profile of respondents underscores the community's deep connection to the environment.
2. The Bigbiga Protected Landscape (BPL) shows strong implementation in watershed protection, biodiversity conservation, flood control and disaster risk, community awareness and education, policy development and integrated resource management.
3. The analysis reveals that age and length of residence negatively influence perceptions of water ecosystem services implementation.
4. The analysis of land cover changes in the Bigbiga Protected Landscape from 2010 to 2024 reveals a substantial increase in open forest areas.
5. The analysis reveals that land cover change does not have a significant relationship with the level of implementation of water ecosystem services in the Bigbiga Protected Landscape.
6. The primary problem in the implementation of water ecosystem services in the Bigbiga Protected Landscape is inadequate water quality and quantity management.
7. To enhance water quality and quantity management in the Bigbiga Protected Landscape, the proposed water management policy includes establishing a comprehensive monitoring and reporting system, enforcing water quality standards and extraction limits, promoting public participation and education, implementing emergency response protocols, and ensuring regular policy review and adaptation to address evolving environmental challenges.

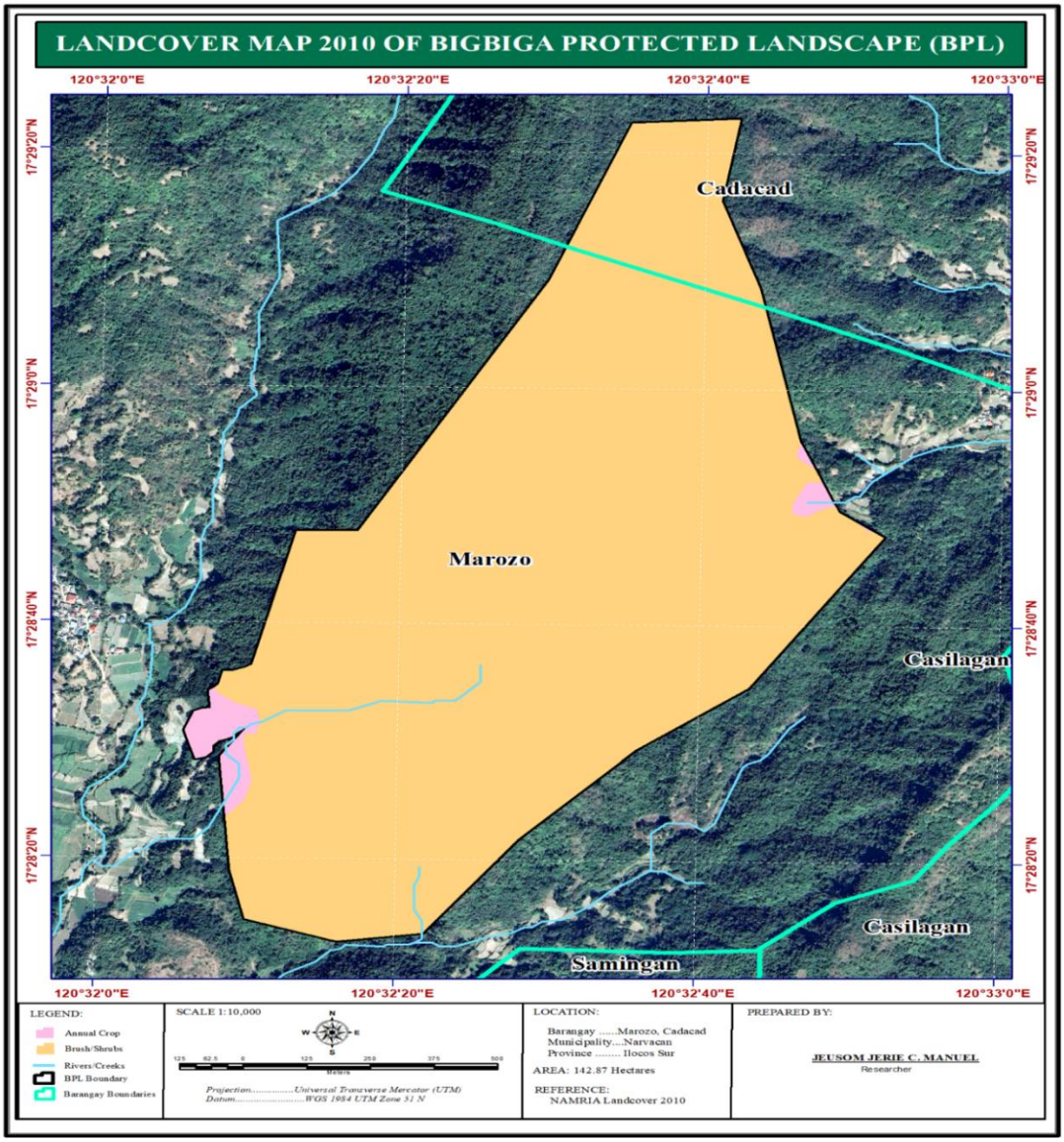
5. RECOMMENDATIONS

The following are the recommendations based on the findings of this study:

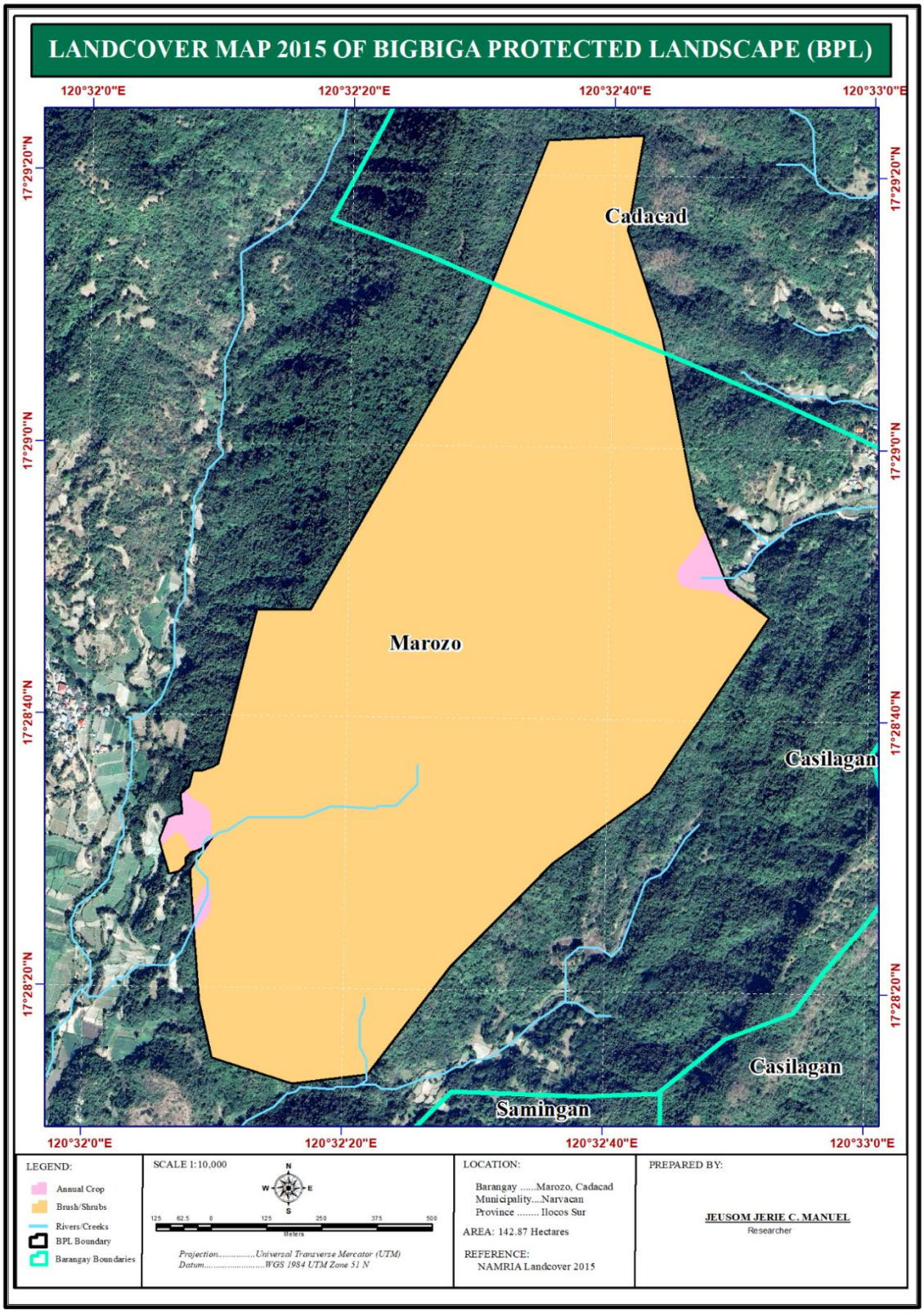
1. Implement customized educational programs and incentives to promote sustainable environmental practices and enhance the community's active role in managing the Bigbiga Protected Landscape's natural resources.
2. Establish a dedicated task force and local water management committees to ensure consistent, efficient, and sustainable management of water ecosystem services.
3. Enhance outreach and engagement programs that address the concerns of older and long-term residents to improve their perception of water ecosystem services and encourage their active participation in current management efforts.
4. Implement sustained monitoring and maintenance of forest areas to prevent degradation, while encouraging active community involvement in forest protection.
5. Reassess and integrate land cover management practices with water ecosystem service initiatives to better align conservation efforts and ensure that both are effectively contributing to environmental sustainability.
6. Strengthen water quality and quantity management by developing integrated water resource management strategies, improving water system infrastructure or implementing water impounding systems, and engaging local communities in sustainable water use practices.
7. Implement the proposed water management policy by prioritizing the development of a comprehensive monitoring and reporting system, strict enforcement of water quality standards and extraction limits, increased public participation and education, establishment of emergency response protocols, and regular policy evaluations to adapt to changing environmental conditions.

6. APPENDIX

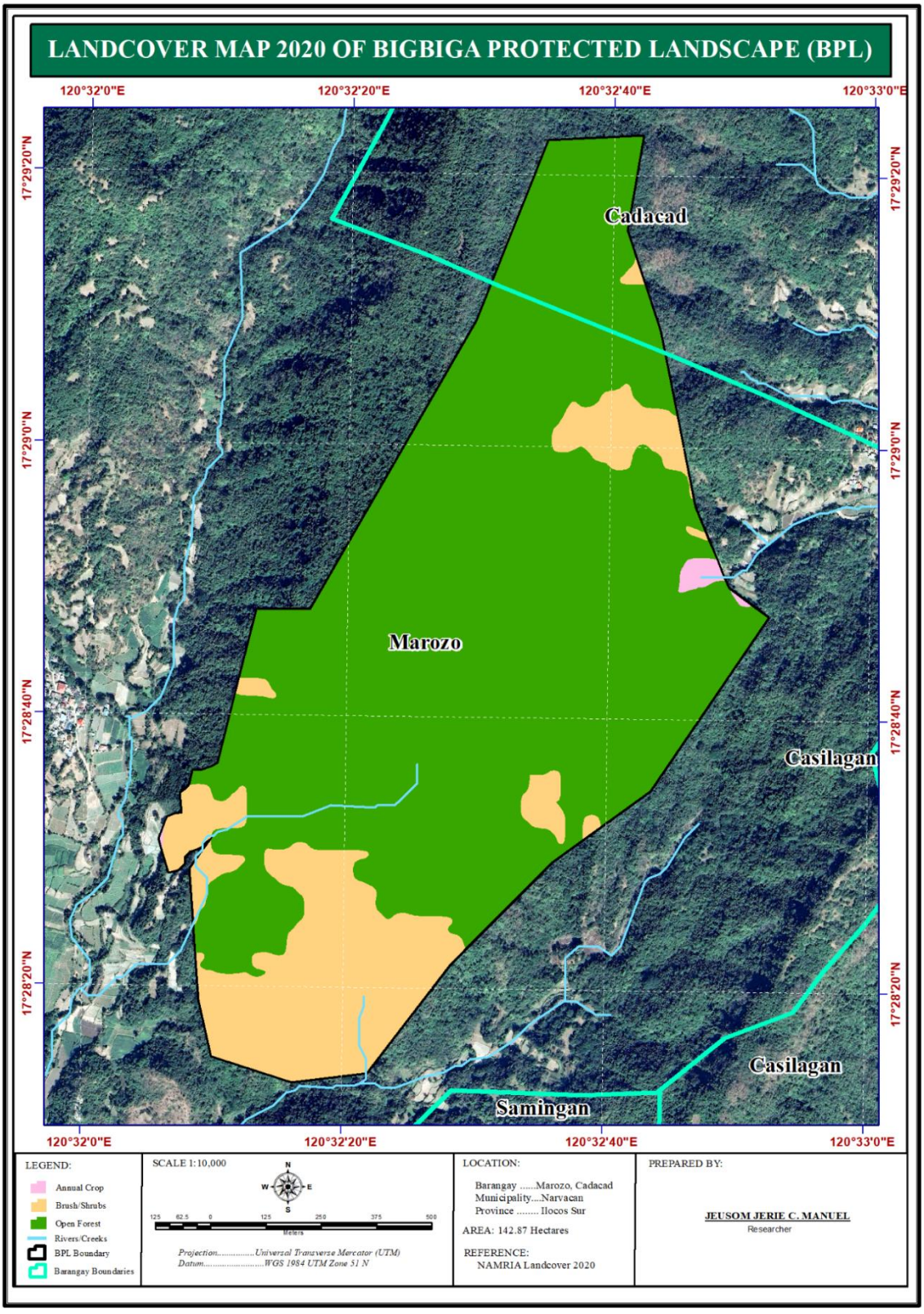
Appendix 1. 2010 Land Cover Map of BPL



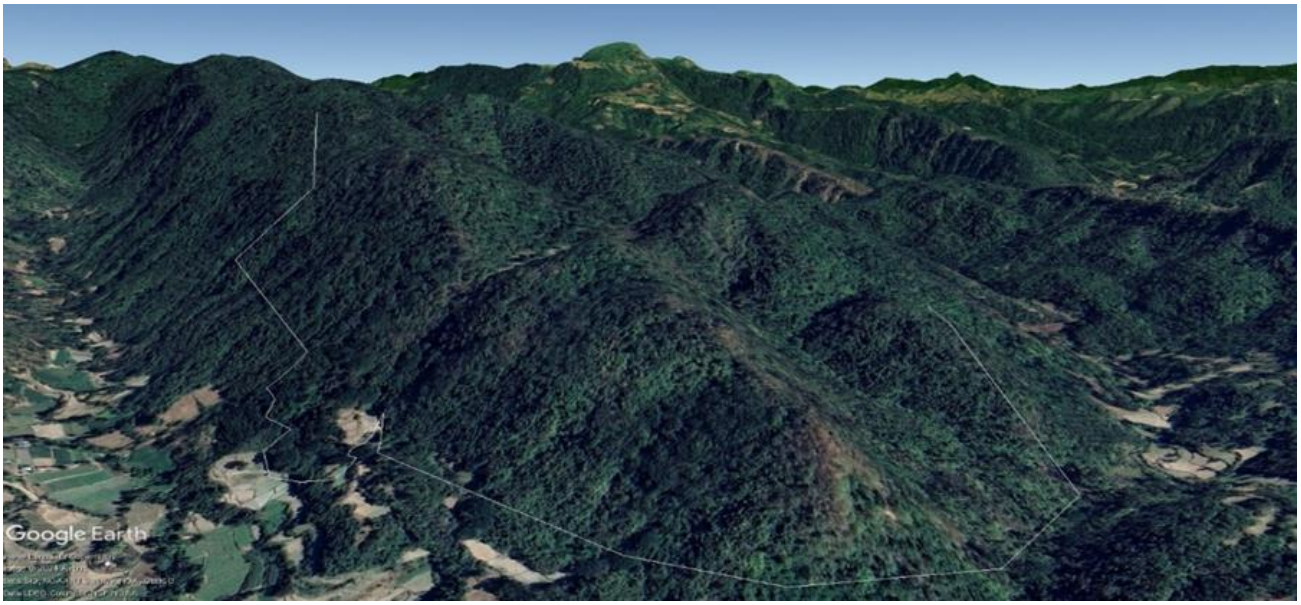
Appendix 2. 2015 Land Cover Map of BPL



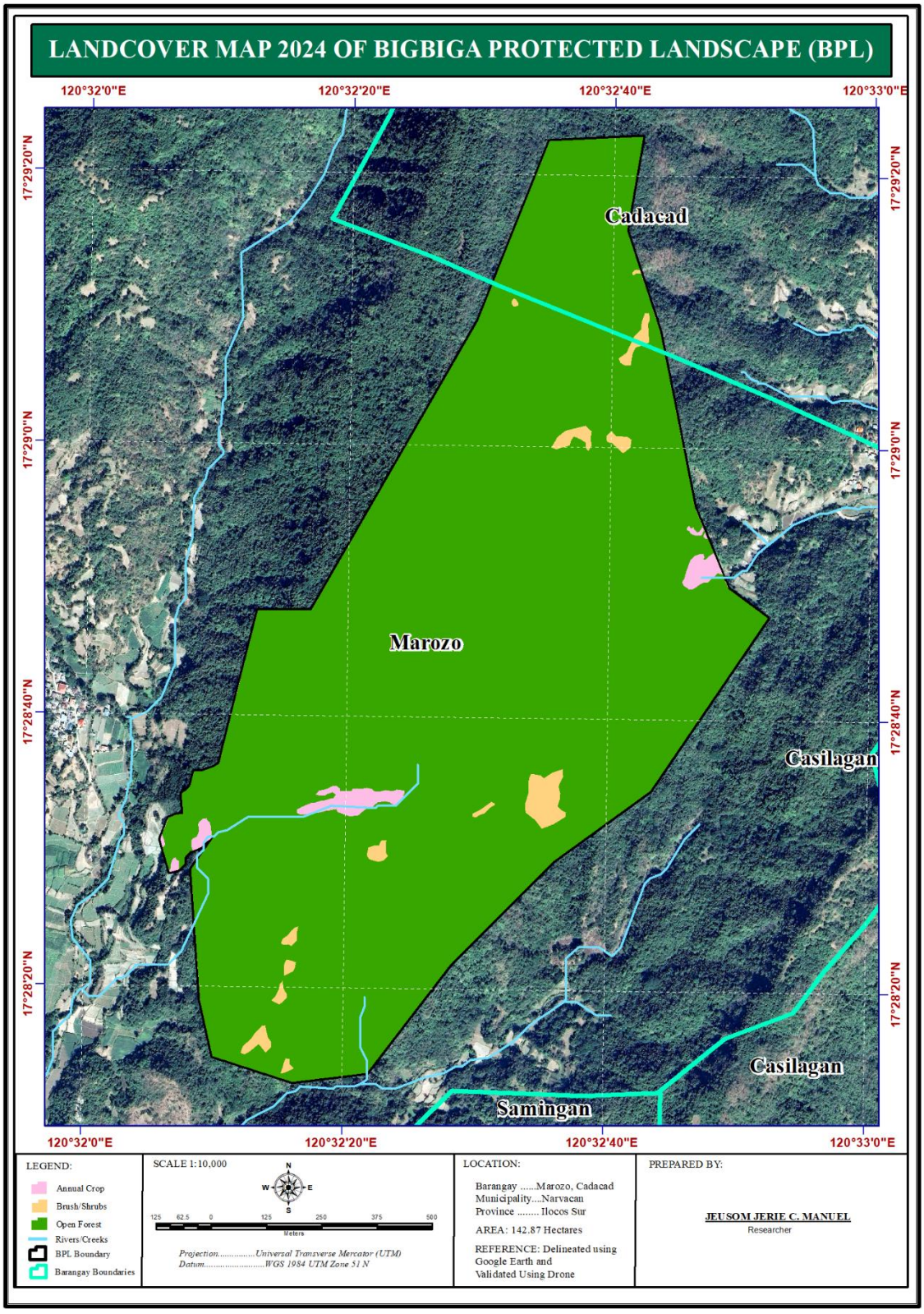
Appendix 3. 2020 Land Cover Map of BPL



Appendix 4. Google Earth Image VS Drone Image



Appendix 5. Generated 2024 Land Cover Map of BPL



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