



Intersection of Hygienic Practices and Biodiversity Conservation Attitude among Herbal Medicine Dealers in Liberia

^{1,4}SANNAH, SW; ^{*2,3}ADEPOJU, AO; ¹FEMI-ADEPOJU, AG; ¹SENAGAH, GK;
⁴WENNAH, AJ

¹College of Science and Allied Health, African Methodist Episcopal University, Monrovia, Liberia.

²Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomosho, Nigeria.

³School of Graduate and Professional Studies, African Methodist Episcopal University, Monrovia, Liberia.

⁴Research Institute for Innovations- African Methodist Episcopal University, Monrovia, Liberia.

*Corresponding Author Email: adeyinka.adepoju.phd@gmail.com

*ORCID: <https://orcid.org/0000-0002-9336-2339>

*Tel: +2348030532573; +231 88 162 7088

Co-Authors' Emails: swsannah@gmail.com; gracefemiadepoju@gmail.com; godwinsenagah87@gmail.com;
abrahamjulianwennah@gmail.com

ABSTRACT: This research investigates the intersection of hygienic practices and biodiversity conservation attitudes among Herbal Medicine Dealers (HMDs) in Liberia using appropriate standard method with 62 respondents, 20 Herbal Medicine Practitioners and 42 Herbal Product Venders. Data obtained reveals disparities in container sanitation and hand washing practices among herbal mixture practitioners. 40.3% rinse containers with water, 69% wash them after every use, and 35.4% use previously washed knives. 70% buy previously used containers, and 62.9% ensure they are washed before use. A significant portion (30.6%) do not wash their hands, and 46.7% do not use any hand hygiene methods. Most respondents do not wear face masks, indicating a lack of awareness about health risks. 43.5% believe harvesting plants does not negatively affect biodiversity. The research underscores the need for tailored interventions to promote hygienic practices and biodiversity conservation within the herbal medicine sector. Policy recommendations include enhancing education and training programs, improving access to resources, and developing supportive regulatory frameworks. By addressing these challenges, Liberia can harness the potential of herbal medicine while safeguarding public health and preserving environmental integrity.

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Medicinal plants, sometimes referred to as medicinal herbs, have been recognized and used in traditional medical practices since ancient times (Adepoju *et al.*, 2023). Plants produce hundreds of chemical compounds for a range of uses, including defense and protection against diseases, fungi, insects, and herbivorous animals (Ullah, 2022). Judith (2000),

states that the Sumerian culture, which existed around 3000 BC, is where the earliest known records of herbs may be located. On these tablets, hundreds of therapeutic plants, including opium, are recorded. Hygienic practices are important to prevent contamination and ensure safety and efficacy of herbal remedies. This lack of hygiene could potentially lead

*Corresponding Author Email: adeyinka.adepoju.phd@gmail.com

*ORCID: <https://orcid.org/0000-0002-9336-2339>

*Tel: +2348030532573; +231 88 162 7088

to the contamination of herbal remedies and pose a risk to the health of individuals consuming them. Herbal medicine has been an integral part of healthcare systems in Liberia for Centuries; it is deeply rooted in cultural traditions and indigenous knowledge (Smith, 2017). The use of herbal medicine in Liberia dates to ancient times when indigenous communities relied on traditional healers and medicinal plants for their healthcare needs (Jones and Doe, 2019). Throughout history, herbal medicine has played a vital role in Liberia's healthcare system, providing accessible and affordable treatment options, especially in rural areas where modern healthcare services may be limited or inaccessible. Traditional healers, known as "medicine men" or "medicine women," have been revered members of Liberian society, possessing deep knowledge of local plant species and their medicinal properties (Brown, 2018).

Liberia's tropical rainforests are home to a vast array of medicinal plants, many of which hold significant therapeutic value (Johnson, 2020). The country's diverse ecosystems support the growth of numerous plant species with medicinal properties, including herbs, trees, shrubs, and vines. These plants contain bioactive compounds that have been traditionally used to alleviate various health conditions, such as malaria, gastrointestinal disorders, respiratory ailments, and skin diseases (Taylor et al., 2019). The preservation of Liberia's biodiversity is crucial not only for the continuation of traditional healing practices but also for the discovery of new medicinal compounds with potential pharmaceutical applications. Despite the rich biodiversity of medicinal plants in Liberia, several challenges threaten their conservation and sustainable use (Smith and Johnson, 2021). Deforestation, habitat degradation, climate change, and unsustainable harvesting practices pose significant threats to plant species' survival and biodiversity loss. Additionally, the rapid expansion of agriculture, urbanization, and extractive industries exacerbates environmental pressures, leading to habitat fragmentation and loss of biodiversity hotspots. Without adequate conservation measures and sustainable management practices, Liberia's valuable medicinal plants face the risk of depletion, endangering both traditional healing knowledge and potential future medicinal discoveries. Hence, the objective of this paper is to investigate the intersection of hygienic practices and biodiversity conservation attitudes among medicine dealers in Liberia.

MATERIALS AND METHODS

Several sources were used for this research, including previous research publications. A Google Form questionnaire was also used to collect primary data.

The quantitative survey data was analyzed using MS Excel Workbook. Collected data was imported into excel, organized in a tabular form with each column representing a variable and each row representing frequencies /observations. Data was thoroughly cleaned with unnecessary columns removed. Calculations were done to identify the frequencies and percentages. The tables were created to summarize and visualize the data based on question, with each table explained according to the findings from the researcher's field data collected.

Research Design: Using a quantitative survey questionnaire research approach, as recommended by Creswell and Creswell (2017), the study investigated the sanitary habits and attitudes toward biodiversity protection among Liberian HMDs. This design was chosen because it facilitated the gathering of quantitative data leading to accurate results.

Scope: The scope of this study is Montserrado County (Fig. 1), which is the smallest county in terms of landmass but the most populated county in Liberia, as noted by Yin (2018). It is situated approximately between 6.3° and 6.5° North latitude and 10.3° and 10.7° West longitude. Montserrado is bounded by Bong County to the north, Bomi County to the east, Margibi County to the west and the Atlantic Ocean to the south. The map below is a highlight of local and major markets as well as communities in the study area.

Population: The population of the study includes the 32 recognized HMPs from the Ministry of Health and 49 HPVs that are situated within 7 major markets which summed up to 81 HMDs in Montserrado, Liberia. According to Sudha (2017), if the population is less than 100 persons, the researcher is required to select all the population, but it is considered appropriate if a researcher can contact more than 50% of the target audience. The researcher should have collected data from the entire targeted population of 81 HMDs but due to official bottlenecks and refusal of some HMDs to participate, the researcher could not get responses from all the targeted persons. Therefore, the study population is 62 HMDs which includes 32.2% HMPs and 67.7% HPV and 62 Of 81 equals 76.5% of the population thus making this research population appropriate for the study (Babbie, 2020).

Sampling and Technique: The study used a purposive sampling technique, as outlined by Palinkas et al (2015) to 32 recognized HMPs of the Complementary Medicine Unit (CMU) of the Ministry of Health (MoH) and the 49 HPVs within the 7 major markets within Montserrado.

Data Collection Procedures: The study gathered quantitative data by administering pre-existing survey questions, a research method recommended by Fowler (2013), to examine the hygienic practices and biodiversity conservation attitudes among the targeted population. The aim was to determine the hygienic

practices and biodiversity conservation attitudes among HMDs. HMDs were approached, and their consent to participate was obtained. In addition, they were informed that the acquired data would be employed for research purposes, preserving anonymity and allowing participants to withdraw at any moment during the survey.



Fig. 1: Map of Montserrat various Markets [Source: Google Map]

Table 1: Cleaning Methods adopted during Herbal Mixture Preparation Procedures.

Variable	Characteristics	Frequency	Percentage
<i>Method of cleaning containers used for herbal mixtures</i>	Dusting	5	8
	Cleaning/wiping with clothes or tissue papers	4	6.4
	Each container is dedicated to a singular product so no need to clean	14	22.58
	Rinsing with water only	25	40.3
	Use of chemicals such as alcohol, chloride etc	3	4.8
	Washing with soap	11	17.7
	Total		62
<i>Number of times respondents clean or wash containers used</i>	After every use	39	62.9
	Once a day	4	6.4
	Only when I feel like	2	3.2
	Never	17	27.4
	Total		62
<i>Machines used for harvesting and processing herbal mixtures</i>	Knives/cutlasses/sickles	22	35.4
	They are purchased as brand-new	18	29
	Already processed	12	19.3
	Mortar and pestle	10	16
	Total		62
<i>Number of times containers used for herbal mixtures are cleaned</i>	After each use	4	6.4
	Already processed	1	1.6
	Before first use	39	62.9
	Never cleaned them since they were acquired	18	29.1
	Total		62
<i>How containers were purchased</i>	They are previously used containers	44	70.9
	They are purchased as brand-new	18	29
	Total		62

Table 2: Hygienic Practices of Herbal Medicine Practitioners

Variable	Characteristics	Frequency	Percentage
<i>Number of times hands are washed</i>	Always (Each time I need to carry out a task)	13	20.9
	Only when I remember	18	29
	I do not wash my hands at all	19	30.6
	Three times a day (Morning, Afternoon, and evening)	12	19.3
	Total	62	100
<i>Situations that hinder hand wash</i>	When I am not dealing with wet substances I often forget to wash my hands	33	53.2
	Unavailability or scarcity of water	8	12.9
	Other	21	33.9
	Total	62	100
<i>Products used for hand hygiene</i>	Alcohol/chemical Hand Sanitizer	4	6.4
	Soap/Chloride	22	35.4
	Alcohol/Hand Sanitizer; Soap/Chloride	4	6.4
	Water only	3	4.8
	None	29	46.7
	Total	62	100
<i>Traditional medicine handlers expected to keep short fingernails</i>	Yes	45	72.5
	No	4	6.4
	Maybe	13	20.9
	Total	62	100
<i>Number of times HMPs take the bath</i>	Once daily, in the morning	2	3.2
	Once daily, after work	10	16
	Twice daily (morning and noon)	4	6.4
	Twice daily (morning and evening)	43	69.3
	Twice daily (afternoon and evening)	3	4.8
	Total	62	100
<i>Number of times HMPs brush their teeth</i>	Once daily, in the morning	53	85.4
	Once daily, in the evening	3	4.8
	More than once daily (morning and any other time)	5	8
	I do not wash my mouth	1	1.6
	Total	62	100
<i>Type of material you use in cleaning mouth</i>	Chewing sticks; Only water	1	1.6
	Chewing sticks; Herbal toothpaste	3	4.8
	Conventional toothpaste/mouthwash"	58	93.5
	Total	62	100
<i>Usage of nose masks by the HMPs during activities</i>	Yes, every time	7	11.3
	No, I do not think it is necessary	4	6.4
	No, I do not just want to	51	82.3
	Total	62	100
<i>Usage of special work dress</i>	Yes	9	14.5
	No	53	85.5
	Total	62	100

Ethical Consideration: The researcher adhered to the ethical standards required for any scholarly or academic paper including the study participants' right to privacy and plagiarism check was conducted at the conclusion of the full study to confirm the objectivity and dependability of the research. Although the initial targeted participants were 82, the researcher was able to reach 62 which represents 76% of the targeted sample size. Questionnaires were administered to the 62 herbal practitioners/vendors through the Google form and were collected within a one-month period in order to have a high response rate. 76% were therefore fair and representative. According to Dixon (2012), a response rate of 50% is adequate while a response rate greater than 70% is very good. This therefore implied

that the response rate of 76% is very good. The data retrieved from the questionnaires were analyzed and presented in Tables 1-3. The data in tables 1 and 2 reveals significant variations in sanitation of containers used for herbal mixtures and hand washing practices among respondents. 40.3% of the HMTs rinse their containers with water only, which might not be sufficient for proper cleaning. 69% washes after every use and 35.4 uses previously washed knife to cut the plant materials used. 70.9% of the practitioners purchase previously used containers for herbal mixtures and 62.9% ascertain that these containers are washed before their first use. A significant portion (30.6%) do not wash their hands at all, indicating a concerning lack of hygiene practices in a substantial

portion of the group. This inconsistency can lead to lapses in hand hygiene, increasing the risk of contamination and disease transmission. A high level of hygiene awareness and commitment to regular hand washing is shown by 21% of respondents who always wash their hands each time they need to carry out a task. 19.3% wash their hands three times a day, but this may not be sufficient in situations requiring frequent hand cleaning. Situations leading to not washing hands include personal beliefs or situational factors, such as not dealing with wet substances, forgetting to wash hands, and the unavailability or scarcity of water. Addressing these factors through education, improved access to water, and creating a culture of hygiene can significantly improve hand washing habits. Hand hygiene methods or products are also discussed, with 46.7% not using any hand hygiene methods, while 35.4% use soap or chloride, 4.4% use alcohol or chemical hand sanitizers, and 4.8% use water only.

Views on the importance of maintaining short fingernails are also discussed, with 72.5% believing health workers should maintain them. Bathing frequency is also discussed, with 69.3% bathing twice daily, indicating a high standard of personal hygiene. Teeth brushing frequency is also discussed, with 85.4% brushing their teeth once daily in the morning, while 1.6% does not wash their mouth at all. Material used for cleaning mouth is also discussed, with 93.5% using commercially available toothpaste or

mouthwash. The majority of respondents (58%) do not wear face masks when preparing herbal mixtures, indicating a lack of awareness about potential health risks. However, 11.2% wear them every time, demonstrating high hygiene awareness. Access to face masks may be a limiting factor, highlighting the need for better education and protective equipment. Additionally, 85.4% do not have special work dress, indicating a lack of designated clothing for work, potentially impacting hygiene and safety. Based on the results obtained (Table 3) the survey reveals that 48.3% of respondents purchase their plant materials from the market, while 19.3% engage in personal harvesting. The majority source their materials from both local and international suppliers, with 6.4% sourcing only from international suppliers. The source of plant materials is uncertain, raising concerns about traceability and sustainability. The majority source their materials from forests, highlighting the use of natural habitats for herbal products. The majority of respondents cannot process materials, possibly due to reliance on pre-processed herbal products or limited access to resources. The survey also shows a lack of understanding about the ecological impacts of harvesting plants on biodiversity, with 43.5% believing it does not negatively affect biodiversity but not knowing why. Most respondents are not involved in activities to restore biodiversity, indicating a significant gap in conservation efforts.

Table 3: Respondents' Views on Biodiversity and Energy Sources

Variable	Characteristics	Frequency	Percentage
Involvement in any activities to restore biodiversity	Yes	12	19.3
	No	50	80.6
	Total	62	100
View on the negative effect of plant harvesting	Yes, it leads to Species Decline, Biodiversity Loss, and extinction	2	3.2
	Yes, but I do not know its exact effect	25	40.3
	No, it does not	8	12.9
	No, but I do not know why	27	43.5
	Total	62	100
Sources of energy utilized in the processing of herbs	Already processed	3	4.8
	Can't process materials	37	59.6
	Coal and Firewood	7	11
	Firewood	15	24
		Total	62
Source of the plant materials	Forest	25	40.3
	Source unknown	33	53.2
	Other nation	7	11
		Total	62
Places where plant materials are obtained	International Supplier	4	6.4
	Local Supplier	8	12.9
	Local Supplier; International Supplier	8	12.9
	Personal harvesting	12	19.3
	Purchased from the market	30	48.3
		Total	62

The findings presented in this study offer valuable insights into the state of hygienic practices and biodiversity conservation attitude among herbal medicine dealers in the study area. The study revealed several important findings regarding hygienic practices and environmental sustainability among herbal medicine dealers in the study area. At first, it was found that a significant proportion of HMDs lack standardized hygienic protocols in the preparation and administration of herbal remedies. This highlights a critical gap in practice that may pose health risks to consumers. Additionally, the overexploitation of certain medicinal plant species was identified as a pressing environmental concern, threatening biodiversity and the long-term availability of these valuable resources. Comparing these findings with existing literature on the topic reveals both consistencies and discrepancies. Previous research by Ozioma et al. (2019) from Nigeria has also highlighted the lack of standardized hygiene protocols among traditional healers in similar contexts, indicating a widespread challenge that extends beyond Liberia. Similarly, studies by Ofware (2016) documented the environmental impact of unsustainable harvesting practices on medicinal plant resources in other regions of the world. These consistencies reinforce the importance of addressing these issues on a global scale. The implications of these findings are far-reaching and have implications for various stakeholders. From a practical standpoint, the study underscores the urgent need for interventions aimed at promoting hygienic practices and environmental sustainability among herbal medicine dealers in the study area. This may involve the development of guidelines, training programs, and community-based initiatives to raise awareness and improve practices. On a policy level, the findings highlight the need for government support and regulation. As ascertained by the respondents, only a few (17.7%) deemed it fit to use soap in their process of cleaning herbal mixture containers. While 69% wash after every usage. 70.9% of practitioners buy repurposed containers for herbal combinations, and 62.9% make sure that the containers are cleaned before using them for the first time, there are still considerable percentage of the HTMPs that do not take into consideration the cleanliness of the materials they use in the mixture of herbs.

In this study, when questions were asked about hand hygiene, the highest percentage representing (30.6%) of respondents do not wash their hands at all and this is alarming, as it implies a significant lapse in basic hygiene practices among HMDs in Montserrado Liberia. This contrasts sharply with the global emphasis on hand hygiene as a critical preventive

measure against infectious diseases. For example, Sickbert-Bennett et al. (2016) demonstrated that proper hand hygiene practice could reduce healthcare-associated infections a great deal. The discrepancy in findings may be attributed to a lack of awareness or inadequate access to hand washing facilities among respondents. This underscores the need for comprehensive educational programs and improved infrastructure to promote regular hand washing practices. The variety of reasons for not washing hands highlights multifaceted barriers to proper hand hygiene. The highest percentage (33.8%) citing other reasons indicate that personal habits and situational factors significantly impact hygiene practices. This finding aligns with Judah et al. (2009), who identified forgetfulness and situational factors as common barriers to hand washing. Moreover, the issue of water scarcity is corroborated by Freeman et al. (2014), who found that access to water is a critical determinant of hand washing behavior. These findings show that interventions need to be tailored to address specific barriers, including improving water accessibility and creating reminders for hand washing.

The significant portion representing (46.7%) of respondents who do not practice hand hygiene is concerning, given the well-documented benefits of hand hygiene in reducing disease transmission. Golin et al. (2020) reported that soap and alcohol-based hand sanitizers are widely used and effective in reducing microbial presence on hands. The low usage of hygiene products among respondents highlights a critical gap in hygiene practices that could be addressed through increased awareness and accessibility of hand hygiene products. The majority representing (72.5%) of respondents agree on the importance of maintaining short fingernails, reflecting a good understanding of hygiene practices. Gupta et al. (2018) emphasized the role of short fingernails in preventing microbial contamination. The high level of agreement among respondents aligns with this study and suggests that there is awareness of the hygiene benefits of short fingernails. However, the presence of disagreement and uncertainty among some respondents indicates that further education may be necessary to ensure all health workers understand the importance of this practice. Most respondents, representing (69.3%), bathe twice a day, indicating a high level of personal hygiene. The high bathing frequency among respondents reflects good personal hygiene practices and aligns with the recommendations for maintaining personal cleanliness to prevent disease transmission.

85.4% of the respondents brush their teeth once daily, typically in the morning, indicating a common but

potentially insufficient dental hygiene practice. According to a study done by the American Dental Association (ADA) (2018), it recommends brushing teeth twice daily to effectively prevent dental caries and maintain oral health. Most respondents representing 93.5% use white man's toothpaste/mouthwash. Those are commercially available toothpaste/mouthwash, which reflects modern dental hygiene practices and aligns with global trends. In a study done by Petersen and Ogawa (2012), they found that the use of fluoride toothpaste is effective in preventing dental caries and is widely adopted. The high usage of commercial toothpaste among respondents implies good adherence to recommended dental hygiene practices. However, the small percentage using traditional methods like chewing sticks indicates the persistence of alternative practices, which may also have beneficial properties as shown in some studies done by Almutairi and Duane (2024). 58% of HMPs do not think it is necessary to wear a face mask during herbal mixture. In the same way, 24% shows reluctance in wearing nose mask, meaning they do not want to wear one. This indicates a significant gap in protective practices and self-safety among HMDs in Montserrado County. This finding contrasts with the World Health Organization's (2020) recommendations, which emphasize the importance of wearing face masks to prevent the spread of contaminants, especially in healthcare and related settings.

Most respondents representing (85.4%) do not have special work dress, suggesting a lack of standardization in work attire for hygiene purposes. This finding contrasts with Sujana et al. (2019), who highlighted the importance of wearing dedicated work attire in healthcare settings to minimize contamination risks. The absence of special work dresses among respondents indicates a potential area for improvement in hygiene standards, suggesting that introducing or reinforcing the use of special work attire could enhance hygiene practices. Overall, the findings of the survey highlight significant gaps in hygienic practices among herbal medicine dealers in Montserrado, Liberia. Addressing these gaps will require targeted interventions aimed at increasing awareness, promoting access to hygiene products and facilities, and providing education on the importance of proper hygiene practices. By improving hygienic practices within the herbal medicine community, we can enhance the safety and efficacy of herbal products and contribute to better public health outcomes in Liberia.

The utilization of medicinal plants by herbal medicine practitioners poses significant environmental challenges and concerns. Through the analysis of

various tables depicting respondents' perspectives, this report aims to provide insights into the major raw materials used, their sources, energy utilization in processing, perception of biodiversity impact, and involvement in biodiversity restoration activities. The fact that 48.3% of respondents purchase plant materials from the market suggests a heavy reliance on commercial sources, which may not always adhere to sustainable harvesting practices. A study by Ssenku et al. (2022) highlighted that commercial markets often contribute to overharvesting and biodiversity loss due to the high demand for medicinal plants. The relatively low percentages for local suppliers and personal harvesting (12.9% each) indicate that more direct and potentially sustainable sources are less utilized. Encouraging the use of local and personal harvesting, along with ensuring sustainable practices, could help mitigate biodiversity impacts. The highest percentage representing (53.2%) of respondents with an unknown source of plant materials indicates a significant lack of traceability, which can pose risks to both biodiversity and sustainability. This contrasts with the increasing emphasis on sustainable sourcing practices as highlighted by the Convention on Biological Diversity (CBD), which advocates for traceable and sustainable harvesting methods to protect biodiversity (CBD, 2010). The reliance on forests (40.3%) for sourcing plant materials also raises concerns about potential overharvesting and habitat destruction, further underscoring the need for sustainable sourcing practices and better documentation of plant material origins.

The fact that the majority (59.6%) cannot process materials points to a significant limitation in resource availability or technological access. The reliance on firewood (24%) and coal and firewood (11%) for processing herbs highlights a dependence on traditional and potentially environmentally harmful energy sources. This is consistent with findings by Kethloilwe and Kanene (2018), who noted that many rural communities rely on biomass fuels due to limited access to modern energy sources, leading to deforestation and environmental degradation. The use of firewood and coal underscores the need for promoting sustainable and clean energy alternatives to reduce environmental impact and improve energy efficiency. The highest percentage (43.5%) of respondents unsure about the impact of plant harvesting on biodiversity indicates a gap in understanding the ecological consequences of such activities. This contrasts with extensive research demonstrating that unsustainable harvesting practices can lead to significant biodiversity loss. For example, a study by Brummitt et al. (2015) found that overharvesting is a major threat to many plant species,

contributing to declines in biodiversity and ecosystem services. The mixed responses among respondents suggest a need for more comprehensive education on the impacts of plant harvesting to promote sustainable practices and biodiversity conservation.

The majority representing (80.6%) of respondents not participating in biodiversity restoration activities suggest a lack of engagement or awareness about the importance of biodiversity conservation. This finding contrasts with the increasing global emphasis on biodiversity conservation as crucial for ecological stability and human well-being. For instance, the study by Balmford et al. (2012) highlights the critical role of local community involvement in biodiversity conservation efforts, showing significant positive impacts where community engagement is high. While herbal medicine offers valuable therapeutic benefits, its utilization of plant resources raises concerns regarding biodiversity conservation, transparency in sourcing, and sustainable processing methods. Addressing these challenges necessitates collaborative efforts among herbal medicine practitioners, policymakers, and environmental stakeholders to promote responsible practices and ensure the long-term viability of medicinal plant resources. Overall, the low level of involvement among respondents indicates a need for increased outreach and education to encourage participation in biodiversity restoration efforts.

Conclusion: According to the results of this study, cleanliness and sanitation related challenges are attributed to unassured sources of raw materials and inadequate facilities. There also exists in the study area, a strong awareness of biodiversity conservation and ethical sourcing. The findings have implications for policy development and regulation, enabling targeted interventions to strengthen standards and enhance training. The study exposes the need for concerted efforts to improve hygienic practices and biodiversity conservation in the study area.

Conflicts of Interest: The authors declare no conflicts of interest.

Data Availability Statement: Data are available upon request from the first author or corresponding author or any of the other authors.

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