

Conservation Of Lake Lanao: Knowledge, Attitudes and Practices from the Lens of Raya, Tugaya Settlers

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ABSTRACT

Natural resources are vital for sustaining human life and maintaining ecological balance. However, increasing human activities have significantly contributed to the degradation of freshwater ecosystems, including lakes. This study explores the conservation of Lake Lanao as perceived by the settlers of Raya, Tugaya in Lanao del Sur, Philippines. Utilizing a mixed-method approach, the study surveyed 217 respondents-including students, parents, residents, LGU members, and elementary teachers, a follow up interview conducted focusing on their knowledge, attitudes, and practices (KAP) regarding lake conservation. Follow-up interviews were conducted to gain deeper insights into the significance of the lake and gather suggestions for its preservation. Findings revealed an overall positive attitude toward Lake Lanao's conservation, economic, and cultural value. However, notable knowledge gaps were identified, particularly in understanding specific conservation practices and legal frameworks. While general awareness is high, there is limited familiarity with actionable strategies, emphasizing the need for targeted educational and advocacy efforts. The study also found a significant correlation between age and conservation attitudes, with older respondents displaying stronger environmental engagement. Additionally, gender was significantly associated with knowledge and practices, with 59.9% of respondents being female, suggesting that women play a key role in conservation efforts. The interview response further emphasized the importance of community involvement. Based on these findings, the study recommends that future researchers expand this work by exploring other nearby communities along Lake Lanao to compare conservation perspectives, assess long-term impacts of community education programs, and investigate policy awareness levels. Future studies may also benefit from using longitudinal designs to evaluate changes in KAP over time following specific interventions.

Keywords: attitudes, conservation, Meranaw, perception, practices, Lake Lanao

INTRODUCTION

Natural resources are one of the most important needs of humans to survive. It provides important habitat for human beings. Natural resources are significant for humans to support life and to maintain ecosystem balance. One of the natural resources is freshwater. People are depending on freshwater such as lakes as they serve as a source of income, source of water supply to the communities, hydro- electric power and livelihood of many people, just like fishermen who depend on lakes for fishing. Conserving the lake is needed for the own sake and benefits of everyone and for the future generations. Lakes are facing many challenges because of human activities. This study focuses on lake Lanao, an ancient and culturally significant lake located in the province of Lanao del Sur, Bangsamoro Autonomous Region in Muslim Mindanao, Philippines. Lake Lanao is one of the 17 ancient lakes of the world, renowned for its ecological uniqueness and the diverse array of endemic fish species it once harbored. It holds immense spiritual, cultural, social, political, and economic significance for the Meranaw people, who consider it their ancestral domain on the conservation of Lake Lanao.

Human activities are considered the primary reason for the degradation of lakes due to the significant impact of various actions on these ecosystems. Humans range from recreation and bathing or washing to disposal of solid waste. These are alarming that people must take action to solve these kinds of problems. Engaging in activities such as seminars, workshops, clean-up drives, and community outreach programs can significantly contribute to

lessening the degradation of lakes (Mitra et al., 2014). Thus, the researchers determined the perception of the people of Tugaya including the students in terms of knowledge, attitudes, and practices.

Moreover, the significance of the study is focused on the curriculum developers, local community, government and policy makers, and future researchers, to enhance existing policy and incorporate water conservation topics into relevant courses. Future researchers may gather more information about conservation of water for the protection on the ecosystem of the lake and other bodies of water. This may serve as a guide for further development of effective attitudes and practices towards the lake.

The study of Ramos et al. (2016) has primarily centered on lake Lanao's aesthetic appeal, water quality, and industrial advantages, while there is a noticeable dearth of research on the conservation efforts directed towards Lake Lanao. To address this gap, this study specifically investigated the conservation practices undertaken by the settlers of Raya and Tugaya in preserving lake Lanao.

The aim of this study was to determine the knowledge, attitudes, and practices of Raya, Tugaya settlers towards this vital ecosystem. The demographic profile determined if there is a relationship on the perception of the conservation of Lake Lanao and their knowledge, practices, and attitudes. The researchers proposed an intervention plan based on the findings of the study.

This concludes that water conservation is crucial for the protection of the ecosystem of the Lakes. Community engagement for the conservation of the lake are the primary role of the settlers near the lake to have an effective lake conservation integrates social, economic and environmental factors. Sustainable restoration initiatives foster lake vitality and community well-being (Gherardi & Mazzotta, 2018).

Statement of the Problem

This study aimed to determine the perception of Raya, Tugaya settlers on the conservation of lake Lanao. The following were the research questions in this study:

1. What is the demographic profile of the respondents in terms of Age and Gender?
2. What are the perceptions of the respondents on the conservation of Lake Lanao in terms of Knowledge, Attitude, and Practices?
3. Is there a significant relationship between the demographic profile of the respondents and Knowledge, Attitudes, and Practices towards conservation of lake Lanao?
4. How significant is the conservation of Lake Lanao from the settlers of Raya, Tugaya?
5. What are the suggestions or potential strategies for protecting the lake?

Review of Related Literature

Conservation Awareness

In their research entitled "Practices, awareness, and attitudes of Maranao farmers in three watershed barangays in Masiu, Lanao Del Sur, Philippines towards the protection and conservation of the Lake Lanao Watershed," Rascal, Aranico, Bracamonte, and Amparado Jr. (2012) sought to evaluate the practices, awareness, and attitudes of Maranao farmers in the Lake Lanao Watershed region in Masiu, Lanao Del Sur. The study utilized a combination of qualitative and quantitative methodologies to fulfill its objectives. A noteworthy discovery from the research is that all participants exhibited a heightened level of consciousness and displayed a deliberate stance towards the significance of conserving and safeguarding Lake Lanao Watershed.

In a recent research endeavor entitled "Exploration of Conservation Awareness and Strategies in Buluan Lake, Maguindanao, BARMM" conducted by Malaco, Dela Cruz, and Mangaoang (2023), the primary aim was to evaluate the indigenous understanding, cognizance, and perspectives of the Maguindanaon tribes concerning

biodiversity preservation in Lake Buluan, Tumbao, Mangudadatu, Maguindanao. The study employed a descriptive qualitative approach to collect data. The results unveiled a profound sense of duty among the local populace in safeguarding the ecosystem, cultural cohesiveness, and a heightened sense of communal attachment in Lake Buluan. Furthermore, the research identified a noteworthy association between community consciousness and age, alongside a significant link between knowledge, customs, and welfare. Nevertheless, the outcomes indicated that although individuals acknowledged the repercussions of human activities on the environment, they exhibited lesser concern regarding matters pertaining to biodiversity and conservation

A research study conducted by Agtong, Laudiño, Jumawan, and Elvira (2020) titled "Perceptions Regarding the Ecological State of Lake Mainit: A Focus on Utilization, Preservation, and Commercialization of Economically Significant Fish Species Among the Indigenous Communities of Lake Mainit Watershed, Philippines" sought to explore the viewpoints of local communities concerning the environmental status of Lake Mainit. The study specifically delved into the utilization, preservation, and commercialization of two economically vital fish species, *Glossogobius giuris* and *Channa striata*. The researchers gathered data through a Knowledge, Attitude, and Practices (KAP) survey involving 383 participants aged between 25 and 54 from five fishing communities surrounding the lake. An examination of the survey findings uncovered that the community engages with the lake for various purposes. Nonetheless, the participants exhibited only a moderate level of understanding regarding the current condition of the lake and its resources. The study advocates for the establishment of enhanced environmental initiatives that promote greater community engagement in the preservation of Lake Mainit.

A study of Leng, Weng, and Samat (2020) focused on river conservation in Pasir Mas, Kelantan. The study aimed to identify sources of river water pollutants, assess community awareness of pollution issues, and explore community involvement in conserving water quality. The research used a mixed-method approach, combining quantitative surveys and qualitative interviews. Findings revealed household wastewater disposal, solid waste dumping, and riverbank erosion as primary pollution sources in the Kelantan River. Approximately half of respondents were unaware of the impact of river pollution on water treatment costs and water supply issues. The study recommends public education campaigns to enhance community understanding of river pollution. It also suggests involving communities in monitoring and reporting activities near the river to control pollution. The proposed model of community-based water resource management is viewed as a practical approach to conserving river water quality and ensuring long-term water resource sustainability.

In a study conducted by Febriani (2017) titled "Water Literacy in Developing Country", the aim was to assess the water literacy of Indonesian citizens through an online survey followed by in-depth analysis. The survey specifically targeted middle-income individuals. The findings of the study revealed the following: The mean score of water literacy was lower among women compared to men.; The overall mean score of all respondents indicated a low level of water literacy; and the study identified cooking oil and personal care products containing micro-plastics as potential sources of environmental pollution. The study emphasized the importance of improving water education at the household level and recommended specific topics to be included in educational materials to address the issue of water pollution caused by households. These findings highlight the need for enhanced water literacy and awareness among the population to mitigate further water pollution problems.

In the study conducted by Gregory Odhiambo Ouko in 2012 titled "Factors Influencing Conservation of Lake Victoria Beaches in Kisumu East District", was guided by the cultural theory of Thompson et al which aimed at giving a description of the relationship between natural and human systems both at individual and society levels. The study adopted a descriptive survey design and both quantitative and qualitative techniques were used to collect and analyze data to establish major factors influencing the conservation of beaches in Kisumu East District. Based on the objectives of the study, it was established that fishing is the economic factor that mostly affects the conservation of Lake Victoria beaches. Observation was also used to beef up the quantitative findings of the study. Fishing activities, waste disposal mechanisms and intervention by Government agencies were established by this study as the main factor influencing the conservation of Lake Victoria beaches in Kisumu East District and thus the study recommended that environmental education should be given to both beach residents and visitors with a deliberate bias on the youth who constitute a bigger percentage of the target population.

In the study conducted by Lai, C. H., et. al., (2017) Titled "Mobilising Local Communities Towards Involvement in River Management: Lessons Learnt from The Sungai Pinang River Community Engagement Project In Penang, Malaysia" examines the Sungai Pinang River Community Engagement Project (SPRCEP) undertaken by a local NGO aimed at engaging local communities in conserving a river in Penang State, Malaysia. It discusses the contribution and challenges of the project in engaging local communities in river management. Based on the outcomes and observations made during the project's activities, educating the public on river conservation and raising public awareness on the SPR pollution issues can be made via organizing a series of water education programs. Referring to SPRCEP, the project demonstrated different approaches of educating local people from different age levels on the SPR pollution issue. For example, organizing indoor or outdoor education programs, quizzes with themes related to river conservation, and river clean-up activity can effectively raise public awareness on SPR pollution issue, especially the young generation. Spreading awareness, raising videos through social media can spread the message of conserving SPR faster and is able to reach people faster than organizing onsite programs. By spreading awareness through social media, it can also initiate discussion among users from social media to discuss the causes of SPR pollution issue and the solution of reducing it. For the public forum, it allowed the stakeholders from different sectors to discuss the causes of river pollution issue and the solution of solving this issue in the same platform.

Overview of Lake Lanao

In the study conducted by Garcia et al. (2016), Lake Lanao, the second largest lake in the Philippines, covers 35,660 hectares and has a volume of 21.254 km³. It is in Lanao del Sur and is biologically significant for its unique cyprinid fish species. Ecologically, it plays a crucial role in the local hydrologic cycle. Economically, it is vital as the primary water source for Agus hydroelectric power plants, generating over 60% of Mindanao's power supply. Socioculturally, it is central to the life and culture of the Maranao people, known as the "People of the Lake." The study emphasizes the importance of proper management of Lake Lanao due to its multifaceted significance. Effective lake management is closely linked to responsible oversight of the lake's watershed. The lake's significance lies in its biological, ecological, economic, and sociocultural value. The Maranao people consider Lake Lanao as the center of their life and culture, highlighting its sociocultural importance. The lake's role as a water source for hydroelectric power plants underscores its economic significance. Lake Lanao's unique cyprinid fish species originate from its waters, contributing to its biological importance. The lake's location entirely within Lanao del Sur further emphasizes its local significance.

According to Ferolin, Genon, and Pasandalan (2018), Lake Lanao in Mindanao, Philippines, is an ancient lake with cultural significance to the Meranaw people. It is a vital economic resource due to hydropower generation. The lake supports the livelihoods of the Meranaw community. However, unsustainable practices, pollution, illegal logging, and dam construction on the Agus River are causing its deterioration. If not addressed, the Meranaw people's livelihoods, health, and food security will be severely affected.

Lakes Conservation

The conservation of lakes necessitates collaboration among various stakeholders, such as local communities, lake associations, and government bodies (Bake & Sharma, 2019). They collectively aim to protect and preserve these ecosystems. Community involvement is crucial for maintaining water quality and ecosystem health. Community members monitor lake conditions, identify issues, and promote responsible stewardship practices. Scientific research emphasizes understanding the links between human activities and lakes, highlighting the need for sustainable restoration projects that address social, economic, and environmental factors (Polak & Snowball, 2019). These initiatives are vital for the long-term health and vitality of lakes.

Water Literacy

Water literacy, as defined in the study of Türker (2020), Water literacy, defined by Tubitak in 2020, encompasses individuals' knowledge and understanding of water, its resources, and related aspects. This includes sustainable water use, water management, and water's significance for life. Water literacy entails the capacity to address water-related issues using scientific data. Water-literate individuals are informed about water distribution, treatment, quality, and safety. They also comprehend water consumption levels and purposes.

Moreover, the study of diñç (2018), water literacy involves understanding and responsibility regarding water, recognizing and preparing for water-related risks. Water literate individuals to calculate their water footprint and practice sustainable habits for responsible water usage. Citizens' water behavior is influenced by their water knowledge and attitude, with a positive water attitude leading to higher water literacy levels. This attitude includes perceptions of water, responsibility towards it, and adherence to water ethics. A positive water attitude facilitates better understanding and awareness of water-related issues.

Furthermore, Dean et al. (2015) emphasize the importance of education in encouraging public involvement in environmental conservation, specifically regarding sustainable water usage. Education is seen as a key tool for enhancing knowledge, which is essential for promoting sustainable water management initiatives. According to Kelkar (2007), having knowledge is essential for effectively designing and implementing management strategies aimed at conserving and protecting natural resources. Rwanamiza (2009) asserts that education is a means of acquiring knowledge. Without education, information, and awareness about conservation and management, the implementation of projects in these areas would face significant challenges (Morar et al., 2012).

Morar & Peterlicean (2012) emphasize the importance of educating the current generation, especially children and youth, to prevent irreversible biodiversity loss. Early education can increase their awareness and involvement in conservation efforts, turning them into advocates for natural resources (Šorytè et al., 2019).

Influence of Gender on Water Conservation

Research on environmental values has illustrated gender differences in explaining the behavior toward natural resources. Boeve-de Pauw, et al. (2012) described environmental values as “how people view the natural environment and their relationship to it.” Women tend to be more sensitive to the feelings and needs of others; and are thus more concerned about the environment than men. According to Eagly (1987), females across cultures are socialized to be more expressive, to have a stronger ethic of care, and to be more interdependent, compassionate, nurturing, cooperative, and helpful in caregiving roles; males, however, are socialized to be more independent and competitive. In theory, women are more motivated to work for the environment compared to men who are more focused on economic issues, are the main earners, and see themselves as more detached from the natural world (Zelezny et al., 2000).

Empirical studies have shown that women seem to have greater concern for the environment than men (e.g., Zelezny et al., 2000; Dietz et al., 2002). The gender differences have been explained using gender socialization theory (Zelezny et al., 2000) which posits that women have a greater moral obligation to act pro-environmentally than men as a result of gender-based socialization processes (Lee et al., 2013). In the water resources sector, the study by Tong, et al. (2017) noted differences in the motivations to engage in water conservation practices between females and males. Female users adopted water conservation practices mainly to save water costs, whereas male users practice water conservation practices mainly to alleviate water supply shortage. Singha and Eljamal (2021) found significant positive behavior among female participants who exhibited a more optimistic attitude and were more concerned about water conservation. They were also more concerned about environmental issues than male participants, and more engaged to water conservation than males.

Influence of Age on Water Conservation

The study by Cater & Serafimova (2019), indicates that age is a significant factor in influencing ecologically and environmentally conscious consumer behavior. Their findings suggest that individuals in the youngest age group (30 and below) exhibit lower levels of concern for the environment and are less actively engaged in ecologically conscious consumer behavior compared to those in the two older age groups (31-50 and 51 years and above). Hence, some of the younger age group can have less knowledge on their concern to the environment. It was most likely on the study of Wang et. al. (2021) that in sustaining the environment, elderly or above age level can be the resource rather than the threat in sustaining the environment.

Knowledge of Water Conservation

According to Mohajan (2016), knowledge can be described as a compilation of relevant information, past

experiences, and expert insights, forming a basis for evaluating and assimilating new information and experiences. Jackson (2022) defined knowledge in this context as familiarity with, awareness of, or comprehension of a community as well as facts, information, descriptions, or abilities about the topic of interest that are acquired through experience or education through perception, discovery, or learning.

Water conservation knowledge is vital for sustainable water management and social water equity. Water literacy encompasses understanding water resources, attitudes towards conservation and sustainable behaviors (McCarroll & Hamann, 2020). Effective strategies include using visuals to communicate concepts, place-based learning, interdisciplinary curricula, and reflective development (Ma & Yang, 2022). Addressing knowledge gaps worldwide requires tailored approaches to water education (Miller, Davis, Boyd, & Danby, 2023).

Attitudes on Water Conservation

Attitudes significantly influence community characteristics and environmental protection (Wolf et al., 2020). Proper conservation attitudes mitigate degradation and depletion risks. Personal experiences and societal influences shape perceptions, emphasizing sustainable practices (Kasych & Vochozka, 2019). Effective lake conservation integrates social, economic and environmental factors. Sustainable restoration initiatives foster lake vitality and community well-being (Gherardi & Mazzotta, 2018). Community engagement, education and policy incentives enhance attitude shifts toward water conservation (Tiefenbacher et al., 2011; Renwick & Green, 2000). Economic benefits, cultural values and demographic factors also influence conservation behaviors (Gilg & Barr, 2006; Kaiser & Wilson, 2004).

Practices on Water Conservation

Behavior and customs play a significant role in shaping and reflecting an individual's mindset and outlook in specific circumstances, influenced by personal encounters and societal norms (Kasych & Vochozka, 2019). Conversely, practice has traditionally been viewed as the visible reaction of an individual or group to a given situation, illustrating how individuals or communities manifest their beliefs and knowledge through their conduct and demeanor. Community-based conservation deliberately encompasses a variety of practices related to the management of resources that directly or indirectly contribute to conservation efforts (Barrow & Murphree, 2001). To their understanding and concern, natural resources can be preserved or enhanced through their actions and contributions.

METHODOLOGY

This study utilizes a mixed-method approach, a combination of qualitative data and quantitative data, to determine the conservation of Lake Lanao from the lens of the Raya, Tugaya settlers (Creswell & Creswell, 2018). A survey questionnaire gathered quantitative data on the demographic profile, knowledge, attitudes, and practices of Raya, Tugaya settlers, while semi-structured interviews were provided as qualitative data to have further insights on the importance of conservation on Lake Lanao. These data streams were integrated to offer a comprehensive understanding of the conservation of Lake Lanao: From the lens of Raya, Tugaya settlers, providing depth of analysis.

Researchers employed a mixed method design to analyze, classify and tabulate data collected to identify trends and cause and effects relationships. This type of research combines quantitative and qualitative techniques to get the most accurate data and information. Quantitative data gathered through surveys determined the perception of the respondents on conserving Lake Lanao in terms of knowledge, attitudes, and practices, while qualitative data was collected through interviews to delve deeper into the perception of settlers regarding on Lake Lanao conservation. This research method also includes a questionnaire that is used to collect data to complement what was gathered during the study. Five questions were then asked for an interview.

The respondents of this study were selected through convenience sampling. Convenience sampling can help the researchers to gather data through the settlers of Raya Tugaya. Utilization of convenience sampling helped the respondents to participate in the study based on the time availability of the respondents. As defined, convenience sampling is the sampling technique that the researchers need to go to the location of the study and ask passers or

available respondent, Golzar et al. (2022). Hence, the researchers may collect data from settlers of Raya including Students, Elementary Teacher, Residents, Parents, and LGU members that could be available to participate in this study. The researchers enabled to determine the perception of the Raya, Tugaya settlers on the conservation of Lake Lanao using convenience sampling to simply select a respondent from 1,081 populations.

RESULT AND DISCUSSION

Socio-Demographic Profile of the Respondents

This section identified the frequency numbers and percentage of the given profile variables of the respondents. It includes their age from 10 to 55 above and their gender. The presentation of data is based on the findings of these profile variables provided by the respondents and is present in the succeeding tables.

Age

In this study, the age of the respondents was described to determine what age level of the respondents are more likely to conserve Lake Lanao. Table 1 shows the frequency distribution and percentage of the respondents' age level.

Table 1 Frequency and Percentage of Respondents' Age		
Age	Frequency	Percentage
10 to 18	92	42.4%
19 to 25	37	17.1%
25 to 35	35	16.1%
36 to 45	33	15.2%
46 to 55	19	8.8%
Above 55	1	0.5%
Total	217	100.0%

Table 1 presents the frequency and percentage of respondents' age. Most of the respondents are between 10-18 years old with a frequency of 92 and a percentage of 42.4% for the overall gathered data from the respondents, this is also followed by the respondents' age between 19-25 with a frequency of 37 and a percentage of 17.1% of the respondents. Respondents' age between 25-35 has a frequency of 35 with a percentage of 16.1% and their age between 36-45 has a frequency of 33 with a percentage of 15.2%. Only a few of them have the age between 46-55 with a frequency of 19 and a percentage of 8.8%, while only 1 frequency and 0.5% age 55 above. This indicates that many of the respondents are aged between 10-18 years old, that was in a younger range.

The study revealed that many respondents (42.4%) were aged 10–18 years, while only 0.5% were above 55 years old. These findings align with the study by Cater and Serafimova (2019), which highlighted generational differences in environmental engagement. Younger individuals may exhibit lower ecological consciousness compared to older age groups, who often demonstrate stronger environmental stewardship. This indicates the need for targeted educational interventions for younger demographics to foster awareness and engagement in conservation efforts.

Gender

This study analyzed the gender of participants to understand who is most involved in lake Lanao's conservation efforts—men or women. Table 2 shows the frequency distribution and percentage of the respondents' gender.

Table 2 Gender Distribution of the Respondents

Gender	Frequency	Percentage
Female	130	59.9%
Male	87	40.1%
Total	217	100.0%

Table 2 presents the gender distribution of the respondents. It shows that females have many of the respondents with a frequency of 130 and a percentage of 59.9%. While male has a frequency of 87 with a percentage of 40.1% of the respondents. This indicates that most of the respondents that participated in the study are female.

The sample consisted of 59.9% female and 40.1% male respondents. Consistent with findings by Zelezny et al. (2000) and Tong et al. (2017), females exhibited greater concern for environmental issues and were more likely to adopt water conservation practices. This supports the premise that women play a critical role in fostering environmental awareness and sustainability.

Perceptions of the Respondent on the Conservation of Lake Lanao

Table 3 Descriptive Statistics of Knowledge of Raya Tugaya settlers towards conservation on Lake Lanao

Items	Standard Deviation	Mean	Verbal Description	Mean Rank
² I am aware of the benefits that Lake Lanao provides to surrounding communities, such as water supply and recreation.	0.68	4.21	Strong Agree	1
⁷ I am knowledgeable about the importance of Lake Lanao conservation.	0.75	4.10	Agree	2
¹ I am knowledgeable about the importance of Lake Lanao in our ecosystem.	0.82	3.97	Neutral	3
⁹ I understand the role of Lake Lanao conservation in preserving natural resources.	0.89	3.94	Agree	4
¹¹ I am familiar with the role of Lake Lanao as a source of hydroelectric power for the region.	0.79	3.91	Agree	5.5
¹² I understand the connections between the health of Lake Lanao and the livelihood of the local community.	0.85	3.91	Agree	5.5
³ I understand the main threats to the health of Lake Lanao.	.85	3.88	Agree	7
⁸ I am aware of the Lake Lanao conservation practices that can be implemented in daily life.	.86	3.87	Agree	8
⁶ I am aware of the different species that live in the Lake Lanao	.92	3.82	Agree	9

⁵ I am aware of the different types of pollution that can affect Lake Lanao.	.95	3.80	Agree	10
⁴ I am knowledgeable about the laws and regulations related to the protection of the Lake Lanao.	1.01	3.51	Agree	11
¹⁰ I am aware of the historical and cultural significance of Lake Lanao for the Meranao people.	1.11	3.47	Agree	12
Average Mean		3.86	Agree	

Table 3 shows that the respondents strongly agreed on the statement "I am aware of the benefits that the lake lanao provide to surrounding communities, such as water supply and recreation", with the mean 4.21 and ranked 1st on the 12 statement on the knowledge of the respondents towards the lake. While the respondents agreed on the statement "I am aware of the historical and cultured significance of Lake Lanao for the Meranao people" with the mean of 3.47 and has the lower ranked of 12. However, the statement "I am knowledgeable about the importance of lake Lanao conservation" has a verbal description of Neutral, with the mean of 3.97 and ranked 3rd. This indicates that the respondents had a positive response and most of them agreed on the overall statement of knowledge about the lake.

The average mean of 3.86 indicates that respondents generally agreed they possess adequate knowledge about Lake Lanao conservation. High-scoring items, such as awareness of the lake's benefits (mean = 4.21) and the importance of conservation (mean = 4.10), highlight the respondents' understanding of the lake's ecological and socio-economic value. This aligns with Garcia et al. (2016), who emphasized lake Lanao's significance for hydropower, biodiversity, and cultural heritage. However, lower scores in knowledge about laws and cultural significance (mean = 3.51 and 3.47, respectively) point to gaps in awareness. These findings echo Mohajan's (2016) observation that education is critical for enhancing knowledge and filling such gaps.

Moreover, Jackson (2022), defined knowledge as the context of familiarity with the awareness or the understanding of the communities on the facts, description, information or the skills of the certain topics that can be acquired of the person's experience or education, discovery, and perception towards something. This signifies that knowledge is very important on the conservation of the lake based on the learning experience from them towards the lake.

Table 4 Descriptive Statistics of Attitude of Raya Tugaya settlers towards conservation on Lake Lanao

Items	Standard Deviation	Mean	Verbal Description	Mean Rank
1 Throwing garbage on Lake Lanao is prohibited.	0.68	4.62	Strongly Agree	1
2 Residents should be involved in protecting Lake Lanao.	0.61	4.58	Strongly Agree	2.5
3 I believe that Lake Lanao should be protected and conserved for future generations.	0.68	4.58	Strongly Agree	2.5
6 The protection of Lake Lanao is important to me.	0.73	4.47	Strongly Agree	4
4 I feel that more education is needed to increase public awareness about the importance of Lake Lanao.	0.75	4.42	Strongly Agree	5.5
5 I believe it is everyone's responsibility to protect the Lake	0.68	4.42	Strongly Agree	5.5

Lanao.				
8 Conserving Lake Lanao is important for the future well-being of the community.	0.64	4.41	Strongly Agree	7
9 I feel personally responsible for conserving Lake Lanao.	0.83	4.14	Agree	11
7 I am concerned about the current state of Lake Lanao.	0.85	4.13	Agree	12
10 I believe that conserving Lake Lanao can have a positive impact on our environment.	0.72	4.38	Strongly Agree	8
11 I am supportive of policies and regulations that promote the sustainable use of Lake Lanao's resources.	0.83	4.21	Strongly Agree	9
12 I believe that the well-being of the local community is closely linked to health of Lake Lanao.	0.77	4.16	Agree	10
Average Mean		4.38	Strongly Agree	

Table 4 shows a verbal description of strongly agree on the statement "Throwing garbage on lake Lanao is prohibited" with the mean of 4.62 and ranked 1 on their attitudes towards the lake. Statement "I am concerned about the current state of Lake Lanao" with the mean of 4.13 and ranked 12 of the overall statement. The statement "I am responsible in conserving lake Lanao" has a mean of 4.14 ranked 11. This indicates that concerning the situation of the lake it might not be more crucial to the settlers of Raya, Tugaya.

The respondents strongly agreed (average mean = 4.38) on the importance of protecting lake Lanao. Items like "throwing garbage in the lake is prohibited" (mean = 4.62) and "residents should be involved in protection" (mean = 4.58) received the highest ratings. These results are consistent with Kasych and Vochozka (2019), who noted that attitudes strongly influence conservation behaviors.

The findings underscore a strong moral obligation among respondents, particularly women, that has proactive roles in environmental conservation. Eagly (1987) and Singha and Eljamal (2021). In addition, the results unveiled on a study of Malaco, Dela Cruz, and Mangaoang (2023), a profound sense of duty among the local populace in safeguarding the ecosystem, cultural cohesiveness, and a heightened sense of communal attachment in Lake Buluan. This concludes that most of the respondents find that protecting Lake by not making it as waste disposal, provides great impact in preserving Lake Lanao.

Table 5 Descriptive Statistics of Practices of Raya Tugaya settlers towards conservation on Lake Lanao

Items	Standard Deviation	Mean	Verbal Description	Mean Rank
² Throwing garbage in Lake Lanao is not an acceptable practice.	0.78	4.34	Strongly Agree	1
¹² I actively seek opportunities to learn more about lake Lanao's ecosystem and conservation.	0.76	4.13	Agree	2
⁷ I participate in activities that help protect Lake Lanao.	0.80	3.93	Agree	3

⁶ Boating in Lake Lanao should be allowed as long as it is done responsibly.	0.94	3.90	Agree	4.5
¹⁰ I practice responsible waste disposal to prevent pollution in and around Lake Lanao.	0.95	3.90	Agree	4.5
⁹ I make an effort to reduce my water consumption to contribute to the conservation of Lake Lanao.	0.85	3.89	Agree	6
⁸ I actively participate in clean-up activities to maintain the cleanliness of Lake Lanao.	0.83	3.88	Agree	7
¹¹ I engage in sustainable fishing practices to preserve the fish population in Lake Lanao.	0.92	3.64	Agree	8
⁵ Engaging in recreational activities such as fishing or boating without following regulations and guidance for minimizing impacts on Lake Lanao.	1.26	2.49	Disagree	9
¹ It is important to restrict bathing in Lake Lanao to protect its ecosystem.	1.05	3.46	Agree	10
³ It is acceptable to use Lake Lanao as a toilet if there is no other options available.	1.12	2.07	Disagree	11
⁴ Disposing of Hazardous household waste, such as batteries or electronic devices.	1.15	2.02	Disagree	12
Average Mean		3.47	Agree	

Table 5 shows the descriptive statistics of the practices of Raya Tugaya settlers towards the lake. The statement "Throwing garbage in lake Lanao is not an acceptable practice" has verbal descriptions of strongly agree with the mean of 4.34 and ranked 1. While there is a disagreement of the three statement including "It is acceptable to use lake Lanao as a toilet if there is no other options available" with the mean of 2.07 and ranked 11 and "Disposing hazardous household waste, such as batteries or electronic devices" with the mean of 2.02 and raked 12. This indicates that most of the respondents have positive practices towards the lake and protect the lake by conserving its ecosystem even more.

The average mean of 3.47 indicates that respondents moderately agreed on engaging in conservation practices. While respondents strongly agreed on responsible waste disposal (mean = 4.34), there was disagreement on unsustainable practices like bathing in the lake (mean = 3.46) and disposing hazardous waste (mean = 2.02).

This aligns with Rascal et al. (2012), who emphasized that while communities are aware of conservation's importance, there is often a gap in translating this awareness into consistent practices. Leng et al. (2020) also highlighted the importance of community education to encourage active participation in sustainable practices.

Community engagement can be crucial for more protection on the lake. The study of Agotong et al. (2020),

emphasizes the establishment of enhancing environmental initiatives to promote a great community engagement in conserving the Lake Mainit. Hence, the settlers of Raya Tugaya may establish this kind of environmental initiative in promoting to protect the lake Lanao for further protection of the lake and its ecosystem. And the people near the lake will understand the importance of having responsibility to be part of the community that protects the lake.

Relationship Between the Demographic Profile of the Respondents and their Perceptions on the Conservation of Lake Lanao

Table 6 Correlation Test between Respondent's profile and perceptions in Conservation of the Lake Lanao				
Profile	Perceptions	Spearman's Rho	p-value	Remark
Age	Knowledge	0.16	0.018	Significant
	Attitudes	0.308	0.000	Significant
	Practices	-0.174	0.010	Significant
Gender	Knowledge	0.136	0.045	Significant
	Attitudes	0.028	0.680	Insignificant
	Practices	0.112	0.101	Insignificant
Level of Significance = 0.05				

Table 6 presents the overall correlation test between the socio-demographic profile of the respondents on the conservation of Lake Lanao. The age and perception of the settlers has the remark of significant in conserving the lakes and indicates that older individuals have stronger attitudes towards the lake ($p = 0.308$, $p < 0.05$). In the study of Cater & Serafimova (2019) identify that older age groups have exhibits a higher level of concern for the environment and the younger group has less actively engage in ecological. But it also shows that the respondents have an overall remark of significance in correlation between age and their perception. It was also suggested on the study of Wang et. Al. (2021) that older individual should take the lead on sustaining environment among younger individuals.

While gender on the other hand, shows that the genders are more influenced in knowledge ($p = 0.136$, $p < 0.05$) it shows that women have greater concern on the ecological environment of the lake than men. Zelenzy et. al. (2000). However, gender has insignificance of their attitudes ($p = 0.028$, $p < 0.05$) and practices ($p = 0.112$, $p < 0.05$). More likely to the study of Eagly (1987) that gender differences viewed the natural environment by their relationship to it. In the study of Lee et. al. (2013), indicates that women have moral obligation to be pro-environmental than men. In addition, women are more adopt water conservation to save water cost while men have the practices in conserving water to avoid water supply shortage Tong, et al. (2017). This conclude that women are more involved in conservation of the lake rather than men. This also indicates that the overall correlation between gender and the perception of the settlers towards the lake are more likely to be significant.

The study found significant correlations between age and knowledge, attitudes, and practices. Older respondents demonstrated stronger conservation attitudes ($p = 0.308$, $p < 0.05$), supporting Wang et al. (2021), who argued that older individuals serve as valuable resources for environmental sustainability due to their heightened ecological consciousness. Hence, the study of Morar & Peterlicean (2012) emphasizes the importance of educating the current generation, especially children and youth, to prevent irreversible biodiversity loss. Ensuring to educate younger one to have better understanding on how to conserve the lake will help them to protect the lake. Early education can increase their awareness and involvement in conservation efforts, turning them into advocates for natural resources Šorytė et al. (2019).

Gender significantly influenced knowledge ($p = 0.136$, $p < 0.05$) but was insignificant for attitudes and practices.

These findings partially support studies by Tong et al. (2017) and Zelezny et al. (2000), which found women to be more engaged in water conservation efforts. This was also on the theory of socialization of Zelezny et al. (2000), that women have greater moral responsibility to be pro-environmental than men because of gender-based socialization process Lee et al., (2013). The lack of significant gender impact on practices suggests the need for inclusive community-based initiatives.

The findings highlight the importance of knowledge, attitudes, and practices in Lake Lanao conservation. Consistent with Polak & Snowball, (2019), community involvement and education are crucial for maintaining ecosystem health. The gaps identified in knowledge and practices, particularly among younger respondents, emphasize the need for targeted educational programs, as suggested by Dean et al. (2015).

Moreover, the study corroborates the role of gender and age in influencing conservation behaviors, underscoring the value of engaging women and older individuals as advocates for sustainable practices, as highlighted by Singha and Eljamal (2021) and Cater and Serafimova (2019).

In addition to determining the conservation of lake Lanao, a thematic table presents the overall response of the respondent on their suggestions, knowledge, practices, and perspective on how they handle and act on protecting and conserving Lake Lanao.

Significance of the Conservation of Lake Lanao from the Lens of Raya, Tugaya Settlers

Question 1. How is Lake Lanao important to the community of Tugaya?

The overall response of the respondents on the question “How Lake Lanao is important to the community of Tugaya?” and identified with five main themes including the economic needs, livelihood supports, cultural significance, spiritual identity, and environmental significance. The four themes have 2 responses while the fifth theme has only 1 response. This indicates that the role of Lake Lanao was to provide livelihood support to the surrounding communities and the cultural, spiritual and environmental significance of the settlers towards the lake.

Theme 1. Economical needs

The people surrounding the lake may find it benefits to its people where the lake may serve as one of their natural resources. It could help them with their daily needs like hydroelectric power. As mentioned in the study of Ferolin et al., (2018), that due to the lake hydropower generation, lake is one of the vital economic resources of the community. In addition to the study of Gregory (2012), fishing is one of the economic factors that affects the conservation of lakes. Raya, Tugaya settlers find the lake as economic provider for their daily needs, and it is very crucial to maintain its ecosystem.

Theme 2. Livelihood support

Lake Lanao plays a crucial role in the community of Raya, Tugaya, where the settlers rely on its support in terms of their livelihood. Some of the settlers find the lake as one of the livelihood resources among fishermen as their source of income and the settlers find it as their source of water too. The lake supports the livelihood and day-to-day life of the Meranao community. Moreover, having knowledge can help the community to implement or design management strategies on how to conserve the lake and its natural resources in an effective and essential way. Kelkar, (2007) In addition, Meranao people, especially the settlers of Raya, Tugaya find the Lake as their source of livelihood in their daily lives.

Theme 3. Cultural Significance

The people of Tugaya shaped by their cultural significance on the lake where they are linked to its tradition from their ancestor and its belief in their living. As mentioned on the study of Garcia et al. (2016) to have effective management of the lake, its people has responsibility to conserve it. The behavior and customs of the people

may be influenced by their personal encounters and social norms towards Lake Kasych & Vochozka (2019). This indicates that the significance of culture serves as their way to conserve the lake more for them and its people.

Theme 4. Spiritual Identity

The people of Tugaya have a cultural and spiritual significance to the lake where many believe that the lake has traditions rituals by their ancestors where it has deep story about the people of Tugaya. Its significance to the people of Raya, Tugaya are closely linked to the environmental stability of the settlers, where the lake has served many benefits to each one of the settlers. The lake's significance lies in its biological, ecological, economic, and sociocultural value. The Maranao people consider Lake Lanao as the center of their life and culture, highlighting its sociocultural importance Garcia et. al. (2016). Economic benefits, cultural values and demographic factors also influence conservation behaviors (Gill & Barr, 2006; Kaiser & Wilson, 2004). Furthermore, some of Meranao people find the Lake as the way of their living, and the Meranaw called as people of the lake relating to its sociocultural Garcia et. al (2016).

Theme 5. Environmental Significance

Raya, Tugaya settlers find how Lake Lanao is important and beneficial to its people. Sustaining initiatives to conserve the lake is an effective way to protect the lake Gherardi & Mazzotta (2018). Protection of its ecosystem can also be crucial to the settlers of Tugaya and proper conservation attitudes mitigate degradation and depletion risks. Personal experiences and societal influences shape perceptions, emphasizing sustainable practices (Kasych & Vochozka, 2019). This concludes that protecting the lake is one of the responsibilities of its people to maintain and sustain its ecosystem.

Question 2: How important is the conservation of Lake Lanao, and what are the key aspects of its preservation?

The respondents on the question “How important is the conservation of Lake Lanao, and what are the key aspects of its preservation?” and was identified with the two main them the collective responsibility and actions and the environmental and social benefits. The first theme has 2 responses while the second theme has identified 3 responses. This indicated that the respondents have knowledge on conservation of the lake to be responsible for the significance of the lake and its benefits, people surrounding the lake should understand the importance of the lake.

Theme 1. Collective Responsibility and Actions

Community collaboration can help to conserve the lake, helping hand in hand to protect the lake and can sustain its beauty and its ecosystem. Most of the settlers take on their responsibility to protect the lake for the future generation. Community involvement is crucial for maintaining water quality and ecosystem health. Community members monitor lake conditions, identify issues, and promote responsible stewardship practices Polak & Snowball, (2019). By spreading awareness, raising video through social media was proposed on the study of Chee H. L. et al., 2017, that it can also initiate discussion among users from social media to discuss the causes of SPR pollution issue and the solution of reducing it. Furthermore, having a sense of knowing responsibility to protect the lake, can enforce certain attitudes to conserve the lake. Community members should take action to conserve the lake, for each benefit and the future generation.

Theme 2. Environmental and Social Benefits

Lake conservation can have long-term benefits to the people and the community, where people adhere to protect the lake for social benefits. Proper conservation helps to prevent the degradation of water quality and supports biodiversity towards its people. Proper conservation attitudes mitigate degradation and depletion risks Kasych & Vochozka (2019). This concludes that with proper conservation towards the lake, can enhance the benefits that it could give. People near the lake should learn how to protect and conserve the lake to maintain balance

and mitigate the risk that could cause.

Question 3: Based on your observations, what are the current practices of the people of Raya, Tugaya settlers on the conservation of Lake Lanao?

The response of the respondents on the question “Based on your observation, what are the current practices of the people of Raya, Tugaya settlers on the conservation of Lake Lanao?” and identified with the two main topic also includes the waste management and pollution control with 3 responses and the community-led initiative and awareness with 2 responses. With proper disposal of waste to avoid pollution and the community initiatives may help with conservation of lakes. This also indicates that most of the settlers have knowledge on how to dispose of the waste properly and the need of the community to enhance the protection towards the lake.

Theme 1. Waste Management and Pollution Control

Water literacy as part of knowing how to conserve lakes for own benefits of the people helps understand the importance of lake conservation. Lack of knowledge on the conservation of the lake may affect to have polluted lake and some of the settlers may find the lake at their waste disposal. This may lead to a certain risk where the lake gets polluted for not having proper waste management. In the study of Leng, Weng, and Samat, (2020), Findings revealed household wastewater disposal, solid waste dumping, and riverbank erosion as primary pollution sources in the Kelantan River. Perhaps pollution may affect the lack of knowledge and education needs in the conservation of the lake. The importance of improving water education at the household level and recommended specific topics to be included in educational materials to address the issue of water pollution caused by households Febriani, A., (2017). This concludes that having enough knowledge on how to conserve lakes will give a positive result to protect them more.

Theme 2. Community-led Initiatives and Awareness

Active participation in conserving the lake will lead to having a clean and safe lake. The involvement of the community and the leader will gather people to be inspired on protecting the lake and perform awareness to prevent destruction on the lake. As mentioned on the response of the respondents that active clean-up drive on the lake and to prevent lake from destruction. The study of Agtong, Laudiño, Jumawan, and Elvira (2020), advocates for the establishment of enhanced environmental initiatives that promote greater community engagement in the preservation of Lake Mainit. This shows that community engagement is a must for further protection and conservation of the lake.

Question 4: Are there any rules or policy regulating the conservation of Lake Lanao? If yes, what are the rules and policy that you have here in Raya, Tugaya that you must follow to conserve Lake Lanao?

Respondents on the rules and policies regulating the conservation of the lake. And answer the question “Are there any rules or policy regulating the conservation of the Lake Lanao? If yes, what are the rules and policy that you have here in Raya, Tugaya that you must follow to conserve Lake Lanao?” that also identified two main themes including the local regulations and practices with 3 responses and the national and local government with 2 responses. The community of Raya has specific rules in regulating the prohibition of children swimming on the lake and have knowledge on not throwing garbage on the lake. This indicates that the awareness of the community on a certain rule is crucial and implementing rules with the community for their awareness.

Theme 1. Local Regulations and Practices

Implementing certain rules and policies on how to conserve the lake may inform the people to be responsible for their actions towards the lake. Their practices will reflect on how the lake is protected by the leaders in implementing rules and policies. Letting the people know these rules and policies gain a positive behavior or practices towards the lake. Community-based conservation deliberately encompasses a variety of practices related to the management of resources that directly or indirectly contribute to conservation efforts (Barrow & Murphree, 2001). In addition, behaviors and customs play a significant role in shaping and reflecting an

individual's mindset and outlook in specific circumstances, influenced by personal encounters and societal norms Kasych & Vochozka (2019). For their understanding and concern, natural resources can be preserved or enhanced through their actions and contributions. Hence, providing effective rules and policies will contribute to the people on how they protect and preserve the lake properly.

Theme 2. National and Local Government

Local government implemented a rule on restricting fishermen to use poison or dynamite to the lake to avoid destruction on its ecosystem. To sustain the beauty and benefits of the lake, the settlers and leaders must adhere to the guidelines implemented in conserving the lake. Water conservation knowledge is vital for sustainable water management and social water equity. Water literacy encompasses understanding water resources, attitudes towards conservation and sustainable behaviors (McCarroll & Hamann, 2020). In addition, Fishing activities, waste disposal mechanisms and intervention by Government agencies were established by the study of Gregory Odhiambo Ouko in 2012 as the main factor influencing the conservation of Lake Victoria This can be the factors influence on conserving the lake. Having knowledge of conserving the Lake can sustain the needs of the lake and the people by protecting it. Furthermore, effective strategies include using visuals to communicate concepts, place-based learning, interdisciplinary curricula, and reflective development (Ma & Yang, 2022). National and local governments may use these strategies to develop knowledge on how to implement effective rules and policies towards the protection of lakes.

Suggestions or Potential Strategies for Protecting the Lake

Question 5: Can you suggest any potential strategies for protecting Lake Lanao?

The respondents on the question “How important is the conservation of Lake Lanao, and what are the key aspects of its preservation?” and was identified with the two main them the collective responsibility and actions and the environmental and social benefits. The first theme has 2 responses while the second theme has identified 3 responses. This indicated that the respondents have knowledge on conservation of the lake to be responsible for the significance of the lake and its benefits; people surround the lake should understand the importance of the lake.

Theme 1. Community Engagement and Action

Community involvement in implementing and suggesting guidelines helps the community leaders to engage its people in conserving the lake. Effective strategies should be implemented, and the people may contribute also on some of the effective strategies to be implemented. Effective lake conservation integrates social, economic and environmental factors. Sustainable restoration initiatives foster lake vitality and community well-being (Gherardi & Mazzotta, 2018). As observed in the study of Chee et al. raising awareness and educating the public on the conservation of the lake through social media can be the fastest way to promote conservation on the lake towards its people surrounding the lake. This shows that community engagement, education and policy incentives enhance attitude shifts toward water conservation Tiefenbacher et al., 2011; Renwick & Green, 2000). Therefore, acting on community initiative to protect the lake has positive effects to preserve the lake and its ecosystem.

Theme 2. Environmental Management and Monitoring

Enforcing sustainability on the lake can employ greater results to prevent people from destroying the lake. Asserting awareness and water literacy can have great impact on implementing effective protection and conservation of the Lake. Water literacy, defined by Türker, A. (2020), encompasses individuals' knowledge and understanding of water, its resources, and related aspects. This includes sustainable water use, water management, and water's significance for life. Water literacy entails the capacity to address water-related issues using scientific data. Water-literate individuals are informed about water distribution, treatment, quality, and safety. They also comprehend water consumption levels and purposes. This also includes that having a sense of knowledge in preserving the lake may show a great result for its sustainability.

CONCLUSION

Based on the findings of the study, the study concludes a significant gap between knowledge, positive attitudes, and the consistent practice of sustainable behaviors concerning Lake Lanao conservation. While respondents demonstrate a generally good understanding of the lake's importance and express strong support for its protection, the translation of these positive attitudes into consistent action remains a key challenge. Therefore, an intervention strategy is crucial to bridge this knowledge-attitude-practice gap. Respondents show a reasonable level of knowledge about Lake Lanao conservation, particularly regarding the lake's benefits and the overall importance of conservation. However, significant knowledge gaps exist concerning specific laws and the lake's cultural significance. Targeted educational initiatives are needed to fill these gaps and enhance understanding. Based on the Attitude, Respondents strongly support protecting Lake Lanao, particularly regarding prohibiting garbage disposal and involving residents in protection efforts. Furthermore, this positive attitude provides a strong foundation for promoting conservation behaviors. The study also highlights a strong moral obligation, especially among women, which should be leveraged in conservation strategies. Despite positive attitudes, the study reveals a moderate level of agreement on engaging in conservation practices. While responsible waste disposal is widely practiced, unsustainable practices like bathing in the lake and improper hazardous waste disposal persist. This indicates that interventions are needed to translate positive attitudes into consistent, sustainable actions.

RECOMMENDATIONS

This research on Lake Lanao conservation in Barangay Raya, Tugaya, reveals a critical need for a multi-pronged approach involving education, community engagement, policy enforcement, and ongoing research. The Curriculum developer should integrate Lake Lanao conservation and sustainability principles. The integration should be specific, not generic environmental education, and utilize age-appropriate, interactive teaching methods. Thus, the teachers require specialized training in environmental education to deliver this new curriculum effectively. Simultaneously, community leaders should be empowered to organize and lead workshops, awareness campaigns, and community events focused on practical Lake Lanao conservation strategies. These initiatives should actively involve residents in planning and implementation. Furthermore, a long-term successful implementation could be the factor when residents establish and lead community-based conservation initiatives.

To further enhance the conservation of Lake Lanao, the government and policymakers must actively enforce existing laws protecting Lake Lanao. This includes stricter penalties for violations and improved monitoring mechanisms. In addition, the LGU of Tugaya must allocate an annual budget for conservation initiatives, establish a Lake Lanao Conservation Office, develop environmental education programs, conduct regular monitoring and evaluation, facilitate community engagement, and collaborate with national agencies. The LGU should also provide support and resources, including training in project management and advocacy. Lastly, future research on Lake Lanao conservation should adopt a multidisciplinary approach, investigating ecological, socio-economic, cultural, and technological aspects.

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