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## Project Proposal

### Details of proposal

#### A. Background and justification

Limited access to traditional protein sources in less industrialized regions can lead to food insecurity, with people often relying on cheaper, less nutritious options. Algae which are rich in nutrients and contained substantial amount of proteins and amino acids, may offer a viable alternative for those in need of protein [1, 2]. Freshwater algae and aquatic plants are integral to Southeast Asian diets and culture as they are an essential source of protein and other vital nutrients. Nonetheless, the significance of these organism goes beyond their consumption by humans. Algae play a critical role in wetland ecosystems by forming the base of the food chain, providing food for various aquatic organisms, and contributing to nutrient cycling and water purification. As a result, preserving the diversity of these local aquatic organisms is crucial for maintaining the ecological balance and resilience of wetland ecosystems, as it helps to ensure the survival of different species and maintain biodiversity and the population dynamics and species compositions within the ecosystem. In addition to ecological benefits, they also have economic importance, particularly for communities that depend on them as a source of income. They play a crucial role in addressing nutritional needs and enhancing food security essentially in the remote northern and northeastern parts of Thailand, where food security is a significant concern. The region is characterized by its unique ecosystems, including lakes, rivers, and wetlands, where various species of freshwater algae thrive.

The study will be conducted in 2 wetland sites in Thailand; Nong Bong Kai Non-hunting area (site no. 1,101), Chiang Rai representing the northern Thai culture and mountainous low-hill habitat. The area adjacent to the Lao and Myanmar borders. The Lower Songkhram River (site no. 2,420) of Nakhon Phanom Province in the northeast of Thailand and central/southern Lao. The site is home to a diverse range of ethnic groups, including Thai-Lao, Thai-Yuan, and Thai-Kha, and is at risk of overexploitation by the surrounding community and agricultural practices [3]. The local communities in these areas have a deep-rooted tradition of exploiting freshwater algae and aquatic plants, particularly those belonging to the Chlorophyta division such as *Spirogyra* spp., *Microspora* spp., and *Cladophora* spp. along with the Cyanobacteria such as *Nostochopsis lobatus* Wood em. Geitler [4-6] and aquatic plants such as duckweed (*Wolffia globosa*) [7]. However, it is important to note that while certain Cyanobacteria species have beneficial uses, such as their potential as a food source or in traditional medicine, some Cyanobacterial blooms caused by certain genera can have detrimental effects on water quality and ecological balance [8]. These blooms can result in the release of toxins known as cyanotoxins, posing risks to human health and the overall well-being of the ecosystem. Therefore, it is crucial to monitor and manage Cyanobacterial blooms to ensure the sustainable and safe utilization of freshwater algae resources by local communities. While the exploitation of freshwater algae in these communities supports their livelihoods and contributes to their food security, it is essential to assess the extent of this exploitation and its potential ecological threats. This requires a comprehensive understanding of the ecological dynamics and sustainability of algae harvesting practices. By shedding light on the ecological aspects of algae exploitation and its significance in local livelihoods and diets, the proposal aims to provide valuable insights into the relationship between communities and freshwater algae in the specific context of the Nong Bong Kai Non-hunting area and the Lower Songkhram River.

**B. The problem(s) to be addressed**

The diversity of freshwater algae and aquatic plants is under threat from wide range of factors, and addressing these threats will require a coordinated effort among different stakeholders. Climate change is a significant threat, as changes in temperature, rainfall patterns, and other environmental factors can alter freshwater ecosystems, leading to changes in the compositions of these aquatic organisms [9]. Human activities like wetland destruction, land use change, and pollution from industrial and agricultural practices can harm freshwater systems, leading to habitat loss and degradation that negatively impact their diversity [10, 11]. Overexploitation of freshwater algae by excessive harvesting, is also a concern, especially in regions where they are an essential source of food and income. Given the range of threats to the diversity of these organisms, there is a need for a coordinated effort among government agencies, scientists, and local communities to protect and conserve these important ecosystems. They also hold a significant cultural importance as it is deeply intertwined with traditional practices and harvesting methods. Documenting these traditional practices is of great significance to understand if any changes have occurred over time and to analyze whether these changes have contributed to the problem of overexploitation and loss of cultural practices. In doing so, we can gain insights into the dynamics of human-algae interactions and identify potential strategies to promote sustainable utilization while preserving cultural heritage. This documentation will help shed light on the cultural significance of freshwater algae and aquatic plants and its role in the community, contributing to the broader understanding of the intricate relationship between human societies and natural resources. Ultimately, it will contribute to the development of strategies and initiatives that promote the sustainable use of them, benefiting both the local population and the long-term health of wetland ecosystems.

In line with the strategic goal of Ramsar convention as for wisely using all wetlands, the measures to document the knowledge of utilization, add in the inventory of the existing literature of the available algae diversity and their habitats in the wetlands, along with creating the economic incentives for their conservation through their nutritional values should be included. These aspects are important for the conservation, management, research, and commercialization of these important species to ensure that these valuable and diverse systems are sustain for future generations.

**C. Objective(s)**

General Objective(s):

1. To promote the conservation of the biodiversity of the edible freshwater algae and traditional knowledges of utilization in two Ramsar wetlands in Thailand
2. To estimate the current environmental conditions of the wetland ecosystems based on growth and distribution of these microorganism

These objectives align with several Goals and Targets of the Strategic Framework (SF) of the Ramsar Convention, including

**Goal 1: Addressing the Drivers of Wetland Loss And Degradation**

Target 3: The public and private sectors have increased their efforts to apply guidelines and good practices for the wise use of water and wetlands.

**Goal 2: Effectively Conserving and Managing the Ramsar Site Network**

Target 7: Sites that are at risk of change of ecological character have threats addressed.

**Goal 3: Wisely Using All Wetlands**

Target 10: The traditional knowledge, innovations and practices of indigenous peoples and local communities relevant for the wise use of wetlands and their customary use of wetland resources are documented, respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention, with a full and effective participation of indigenous peoples and local communities at all relevant levels.

Target 11: Wetland functions, services and benefits are widely demonstrated, documented and disseminated.

Specific Objective(s):

1. To conduct a comprehensive survey of algae assemblage composition in two Ramsar habitats located in Northern and North-eastern Thailand, while also assess the corresponding ecological status and diversity
2. To collect and compile local knowledge of natural resource utilization to enhance understanding of the underestimated relationship between algae and other relating aquatic species, ecology, and the communities reliant on the Ramsar sites, thereby gaining the insights into the nutritional values, traditional practices, cultural significance, and ecological interactions associated of edible organisms present in these habitats. This understanding will guide the development of comprehensive guidelines for sustainable harvesting and processing of algae and phytoplankton species
3. To encourage long term community engagement and raise the awareness of responsible ownership of the natural resources

#### **D. Outputs**

1. Comprehensive scientific reports and documentation of the algae assemblage composition, nutrition along with potential social and economic importance of different species of edible freshwater algae and phytoplankton. The journal publication(s) will be prepared as the secondary output that adheres to any necessary copyright restrictions, and appropriate acknowledgement to the funder
2. Guidelines for harvesting and processing of the species in a way that minimizes negative impacts on the environment and ensures responsible consumption and their long-term availability
3. A case report or broadcast dissemination, such as an online course, that effectively highlight the significance of community involvement in environmental monitoring and conservation. This involvement can foster increased local stewardship, ownership of natural resources, and provide opportunities for education and capacity building, including training of sustainable practices

#### **E. Activities**

1. Study of algae composition, wetland water quality, and ecological status of the two Ramsar Sites.
 

*Sample collection:* The aquatic organism will be collected through a 10- $\mu$ m pore size plankton net. The fresh material will be soaked in 0.1N NaOH which later will be characterized by their morphology [12] and will be sent to Department of biology, CMU for identification confirmation. The population density is also assessed by cell enumeration using a hemocytometer under a light microscope thereby calculating the importance value (IV), sum of relative frequency (%R<sub>D</sub>) and relative frequency (%R<sub>F</sub>) [13]. The algal assemblage composition will be also estimated accordingly [14]. The activity will involve traveling from CMU to both sites, followed by necessary accommodations during the stays.

*Ecological importance:* At the distance of 5 meters from the edge, water current velocity was measured with a rotary current meter. The water depth was measured by a ruler following by the temperature, current conductivity. The water sample will be analysed for pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), turbidity, nutrients (nitrate nitrogen, ammonium nitrogen and soluble reactive phosphorus), total Coliform bacteria (TCB), faecal Coliform bacterial (FCB) following the standard methods for the examination of water and wastewater [15-17]. The composition, abundance, and diversity of algae species will be used as valuable information about the ecological conditions and water quality of the wetland. The obtained results will be compared and shared with the Water Resources Conservation and Rehabilitation Division, Thailand Ministry of Natural Resources and Environment, responsible for water quality assessment. This collaboration aims to engage the government and policymakers in discussions and decision-making processes regarding the significance of the research findings and their implications for water resource management and conservation.

*Chemometric analysis:* The relationships between algal community composition, species diversity, and environmental factors such as nutrient levels and pollution. This study focuses on using freshwater algae as bioindicators to assess water quality and ecological health. The relationship will be analysed using statistical software such as MATLAB.
2. Survey of local knowledge and relationship between the local communities who rely on these Ramsar sites and food resources.

*Ethnobotanical survey:* The knowledge and utilization of each edible algae and aquatic species collected will be conducted through using two-way knowledge-sharing mechanism between researchers and community members, leaders, local authorities, and volunteers surrounding the areas of study.

*Questionnaire:* The semi-structured questionnaire comprises of Part 1: Availability such as types, abundance, habitat profile, and whether the participants see the decline, change in algae compositions and diversity losses. This will determine if the algae are overexploited. Part 2: Utilization and marketing such as harvesting practices, preparation and the shift over the year. Amount collected per year: Is it sold? (Quantity sold per day/month/year), Part 3: Cultural importance, traditional beliefs associated with the wetlands, the harvest and use of algae [18]. The participants will be asked openly to share their traditional knowledge and experiences related to freshwater algae.

*Economic importance:* Economic impact of algae exploitation on the local economy considering the employment generation, income generation, and value chain development will be quantified. Contribution of algae-related activities to the livelihoods of local communities and their dependence on algae resources will be assessed through the interview.

*Nutritional values of algae:* Homogenous algae samples will be air-dried at 35 °C and milled to fine powder before being analysed for proximate, mineral compositions [5]. Amino acid profiling will be also evaluated [19].

3. Long term capacity building and dissemination

*Training and workshop:* A free online course modules cover topics ranging from the importance of community engagement to environmental monitoring techniques, data analysis, and conservation strategies along with environmentally friendly harvesting techniques, responsible cultivation method (if any), and value-added product development. Through accessible and interactive learning, the online course empowers local communities engaged in environmental monitoring and conservation efforts, promoting a deeper understanding of the role community involvement plays in safeguarding the environment. This will be under CMU-lifelong learning or public platform.

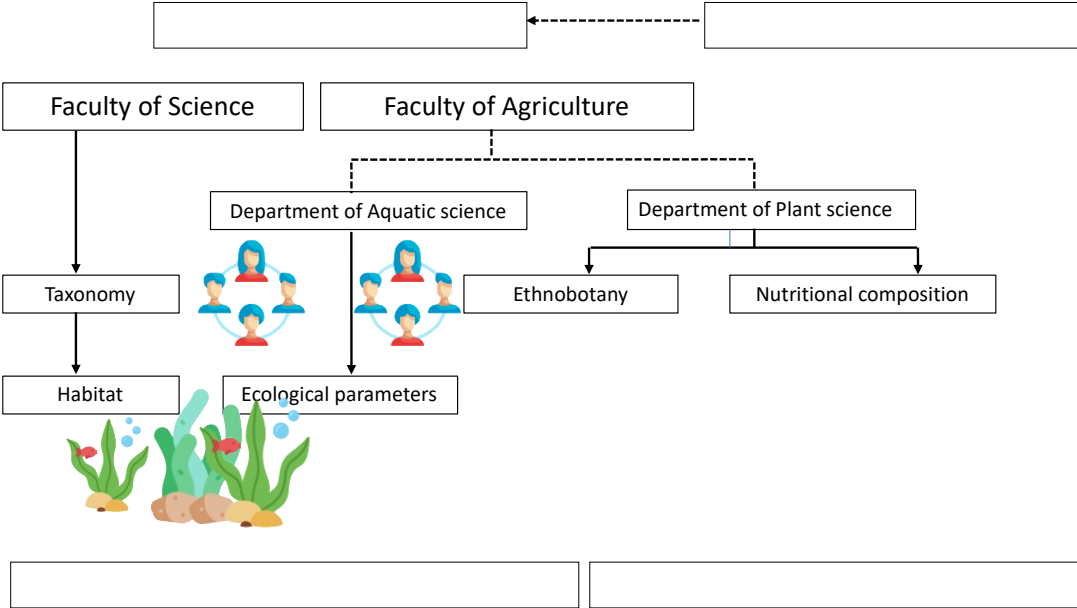
*Dissemination:* Successful case studies and best practices, along with practical guidelines for sustainable harvesting, improving diets, and maintaining ecological stability of algae, will be disseminated to a broad audience through online platforms. This will ensure widespread access to the information and knowledge. Policymakers and government authorities, such as the Thailand Water Resources Conservation and Rehabilitation Division, will be actively engaged in these sessions to facilitate discussions and emphasize the benefits of sustainable algae use for wetland conservation, fisheries, agriculture, and rural development.

**F. Logical frame of the project**

Problems	Objectives	Outputs	Activities
1. Lack of understanding of their biodiversity, composition and ecological status and their relationships	To conduct a survey algae and phytoplankton composition, wetland water quality, and ecological status	Scientific report on the diversity of freshwater algae and their ecological importance	Q1 The survey of the assemblage composition and diversity Q1-Q3 Economic and ecological importance Q4 Reports write-up
2. Traditional knowledge and harvesting practices in the sustainable manners are being neglected.	To collect and compile the local knowledge and to understand the underestimated relationship between the local communities who rely on these Ramsar sites and food resources.	Guideline for harvesting, processing and responsible consumption of the species which can increase the economic opportunities of communities that rely on natural resources Scientific report on result analyses of the nutrition and economic importance of the local freshwater algae	Q1-Q3 Survey of the local knowledge and relationship between community and the wetland resources , and analyse the nutritional values of edible freshwater algae and phytoplankton Q4 Reports write-up
3. Low level of engagements between the community and stakeholders which make it difficult for the initiation the sustainable conservation efforts	To encourage community engagement and sustain conservation practices	- Online course module - Online content such as YouTube video	Q3-Q4 A free training course or workshop via life-long learning platform focusing particularly on output 2 Q3-Q4 Content for online media

Q = quartile of research activity

G. Project management arrangements and stakeholders





## I. Budget

### i) *Budget summary*

Exchange rate applied: 1 US dollars = 35 THB

Funding source		Total funds	Total funds
NWF		(Thai baths)	(US dollars)
	SALARIES / WAGES / CONSULTANCY COSTS	160,000.00	4,571.43
	OFFICE AND FIELD	36,820	1,052.00
	PLANNED ACTIVITIES		-
	<i>Activities 1 and 2</i>		-
	Air fares	75,000	2,142.86
	Other travel costs	27,500	785.71
	Accommodation	160,000	4,571.43
	Meals	22,500	642.86
	Chemical and laboratory supplies	170,180	4,862.29
	Service of analyses	150,000	4,285.71
	Compensation for interviewees	20,000	571.43
	Ethic committee evaluation process	10,000	285.71
	<i>Activity 3</i>		
	Budget for online content preparation	50,000	1,428.57
	Contingency 10%	98,000	2,800.00
	<b>TOTAL</b>	<b>980,000.00</b>	<b>28,000.00</b>



ii) **Overall itemized budget**

Exchange rate applied: 1 US dollars (USD) = 35 THB

Description of budget item (include unit costs where appropriate)		Unit Cost (THB)	Number of Unit	Quanti fier	NWF (THB)	Total (USD)
<b>1. SALARIES / WAGES / CONSULTANCY COSTS</b>						
1.1 Supervisory Staff <i>No. of persons &amp; duration of employment on this project: 5 persons, lumpsum</i>		8,000.00	5.00	Person	40,000.00	1,142.86
1.3 Research assistant <i>No. of persons &amp; duration of employment on this project: 1 person x 10,000 thb/ month</i>		10,000.00	12.00	Month	120,000.00	3,428.57
SUB-TOTAL:					160,000.00	4,571.43
<b>2. TRAVEL &amp; ACCOMMODATION COSTS</b>						
2.1 Air fares <i>Domestic airfare of the research team members Chiang Mai to Bangkok and Udonthanee (ca. 3,000 THB/ trip x 5 trips)</i>		15,000.00	5.00	Person	75,000.00	2,142.86
2.2 Other travel costs Rental of van for field visit to Chaing Rai from Chain Mai 5,500 THB/ day		5,500.00	5.00	Day	27,500.00	785.71
2.3 Accommodation <i>5 persons x 3,200 thb/ night</i>		16,000.00	10.00	Night	160,000.00	4,571.43
2.4 Meals <i>5 persons x 450 thb/ day</i>		2,250.00	10.00	Day	22,500.00	642.86
SUB-TOTAL:					285,000.00	8,142.86
<b>3. OFFICE RUNNING COSTS</b>						
3.1 Office supplies and field equipments	36,820.00	36,820.00	1.00	Project	36,820.00	1,052.00
<i>A4 paper 6 reams/ box 850 THB/ box x 5 box</i>	4,250.00					
<i>Photopaper 600 THB/ ream x 2 reams</i>	1,200.00					
<i>Printer ink black 750 THB/ cartridges x 3 cartridges</i>	2,250.00					
<i>Printer ink black 1450 THB/ cartridges x 2 cartridges</i>	2,900.00					
<i>Hole puncher</i>	350.00					
<i>Paper clips 100 piece/ box 55 THB x 5 boxes</i>	275.00					
<i>Correction fluid 50 THB/ piece x 5 pieces</i>	250.00					
<i>Cutter 70 THB/ piece x 5 pieces</i>	350.00					
<i>Tape 35 THB/ roll x 10 rolls</i>	350.00					
<i>Highlighter tape 70 THB/ roll x 4 rolls</i>	280.00					
<i>Stapler small 120 THB piece x 2 pieces</i>	240.00					
<i>Stapler large 780</i>	780.00					
<i>Labels 120 THB/roll x 5 rolls</i>	600.00					
<i>Pencils: 10 HB 12 pieces/ box 80 TB x 5 boxes</i>	400.00					
<i>Ruler 25 THB x 5 pieces</i>	125.00					
<i>Scissors 95 THB/ pairs x 4 pairs</i>	380.00					
<i>Rubber 45 THB/ box x 2 boxes</i>	90.00					
<i>Binder clips 10 pieces / box 80 THB x 10 boxes</i>	800.00					

<i>Laminating pouches</i> 75 THB/ piece × 20 pieces	1500.00					
<i>A5 Note book</i> 120 THB/pieces × 12 pieces	1440.00					
<i>Plastic organizer</i> 450 THB/piece × 6 pieces	2700.00					
<i>A4 note book</i> 55 THB/ piece × 12 pieces	660.00					
<i>Document folder</i> 250 THB/ piece × 10 pieces	2,500.00					
<i>Whiteboard paper</i> 550 THB/ roll	550.00					
<i>Marker</i> 80 THB/piece × 20 pieces	1,600.00					
<i>Permanent pen</i> 120 THB/ piece × 20 pieces	2,400.00					
<i>Pen</i> 50 pieces / box 180 THB	180.00					
<i>Plankton net</i> 250 THB/M × 2 M	500.00					
<i>Sampling bottle</i> 100 THB × 10 bot	1,000.00					
<i>Sanpling bag</i> 150 THB 100 pieces/pk × 3 pk	450.00					
<i>Prunner</i> 350 THB/ pairs × 4 pairs	1,400.00					
<i>Mortar and pestle</i> 450 THB/set × 2 sets	900.00					
<i>Rain coat</i>	170.00					
<i>Highlighter</i> 150 THB/ piece × 20 pieces	3,000.00					
<b>SUB-TOTAL:</b>					36,820.00	1,052.00
<b>4. COST OF PLANNED ACTIVITY</b>						
<b>4.1.1 Chemical and laboratory supplies</b>	170,180.00	170,180.00	1.00	Project	170,180.00	4,862.29
<i>Methanol</i> HDPE 650 THB 2.5L/ bot × 3 bot	1,950.00					
<i>Methanol</i> HPLC grade 1250 THB/2.5 L/ bot × 5 bot	6,250.00					
<i>Ethanol absolute</i> (HDPE) 1250 THB/ bot 2.5L. × 3 bot	3,750.00					
<i>Ethnaol</i> HPLC grade 2150 THB/ 2.5 L/ bot × 5 bot	10,750.00					
<i>Phosphae buffer for HPLC eluent</i> 950 2.5 L/ bot × 5 bot	4,750.00					
<i>Dichloromethan</i> 2060 THB AR.4L/ bot × 3 bot	6,180.00					
<i>Hexane</i> S 99% 1800 THB /AR.2.5L/ bot × 3 bot	5,400.00					
<i>Hydrochloric acid</i> 37% 850 2.5L/ bot × 3 bot	2,550.00					
<i>Nitric acid</i> 950 THB 1.25 L/ bot × 2 bot	1,900.00					
<i>Ninhydrin Reagent</i> , 500 mg 900 THB × 2 bot	1,800.00					
<i>o-Phthaldialdehyde</i> , 2500 THB 500 mg/ bot × 2 bot	5,000.00					
<i>protein Bradford kit</i> 4,500 THB/ kit × 2 kits	9,000.00					
<i>500 mg aminoacid mix standard</i>	8,000.00					
<i>Amino Acid HPLC column</i>	35,000.00					
<i>Thimbles</i> ×50 p/pk	3,500.00					
<i>Vial Amber with cap 0.5 dram(2ml)</i> 650 THB/ box × 10 boxes	6,500.00					
<i>Vial Amber with cap 3 dram(12ml.)</i> 850 THB/ box × 10 boxes	8,500.00					
<i>Syringe filter Nylon 0.45um., 13mm., (100/pk)</i> 1200 THB/pk × 2 pk	2,400.00					
<i>Syringe filter Nylon 0.45um., 25mm., (100/pk)</i> 1800 THB/pk × 2 pk	3,600.00					
<i>Latex glove#S</i> 250THB 100/ box × 3 boxes	750.00					
<i>Latex glove#L</i> 350 THB 100/ box × 3 boxes	1,050.00					
<i>Blue tip box</i> 750 THB 1000ul.(100tip/ rack) × 10 racks	11,250.00					
<i>Yellow tip box.</i> 850 THB 200ul.(96/ rack) × 15 racks	12,750.00					

<i>Micro tip box 750 THB PP.0.5-10ul.(96tip/ box) × 15 racks</i>		11,250.00				
<i>Storage Box PP. for microtube 1.5-2.0ml.10×10 200 THB/ box × 10 boxes</i>		2,000.00				
<i>filter paper No.1 350THB/ box × 5 boxes</i>		1,750.00				
<i>Chemical disposable bag 100 p/pk 350THB</i>		350.00				
<i>DI water 20 L/ Gallon 450 THB × 5 Gallons</i>		2,250.00				
4.1.2 Service of analyses		150,000.00	1.00	Project	150,000.00	4,285.71
<i>Chemical analyses: Dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), turbidity, nutrients (nitrate nitrogen, ammonium nitrogen and soluble reactive phosphorus)</i> <i>Biological analyses: Total Coliform bacteria (TCB), faecal Coliform bacterial (FCB)</i>						
4.1.3 Compensation for interviewees <i>No. of intended interviewees: 20 persons × 500 tbb/ day</i>		10,000.00	2.00	Site	20,000.00	571.43
4.1.4 Ethic committee evaluation process		10,000.00	1.00	Time	10,000.00	285.71
4.1.5 Budget for online content preparation		25,000.00	2.00	Site	50,000.00	1,428.57
SUB-TOTAL:					400,180.00	11,433.71
5. MISCELLANEOUS						
5.1 Contingency 10%					98,000.00	2,800.00
SUB-TOTAL:					98,000.00	2,800.00
TOTAL:					980,000.00	28,000.00

## J. Follow Up

Evaluating the impact of the project can help to identify strengths and weaknesses, measure progress toward objectives, and inform future directions for the project. The community engagement can be monitored and followed up quarterly after project termination to demonstrate the impact, and continue to engage with participants and stakeholders. The documentation and reports will be filed and maintained at the Water Resources Conservation and Rehabilitation Division to establish a long-term connection and collaboration with the local communities. This will ensure that the research findings, knowledge, and insights gained from the project are readily accessible and can be utilized for ongoing conservation efforts and sustainable management of water resources.

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