




Traditional fishing methods practiced by Ao and Sumi tribes in Dikhu River of Nagaland, India

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Abstract

Traditional fishing knowledge dates back to the early fish catching techniques passed down from forefathers in most of the Naga communities, Nagaland. Traditional fishing is mainly practiced for household consumption and is considered less intensive than industrial fishing practices, which can negatively impact riverine sustainability. However, there is a risk of loss of traditional knowledge in recent times. Hence, an effort was made to comprehend and document the indigenous traditional knowledge associated with fishing practices utilized by the Ao and Sumi tribal communities residing along the banks of Dikhu River. The diverse array of traditional fishing equipment and techniques employed has been categorised based on their specific functions, resulting in the documentation of three types of fishing gears, four fishing accessories, one fishing craft and three other types of fishing techniques. However, in some regions, use of detrimental fishing like dynamites and harsh chemicals were encountered. The results indicate that local fishers continue to rely on indigenous fishing practices for sustenance, and the majority of traditional fishing gears are constructed using locally available eco-friendly materials such as bamboo, wooden poles and cotton twine. The information obtained in this study can be preserved and implemented in contributing better resource management.

Keywords: fishing craft; indigenous traditional knowledge; Naga communities; traditional fishing gears

1 | INTRODUCTION

Traditional fishing in marginal areas are considered small-scale fishing by local communities involving fishing techniques based on local fishers knowledge, traditions, resources and skills. These types of sustenance fishing are often practice in regions that are economically disadvantaged with limited infrastructure and institutional development (Kurien 1998; Johnson 2006). According to FAO (2002), around 4% of the world's population is dependent on small scale fishing that has been significantly contributing to food security, livelihoods and cultural identity in many marginal areas. However, traditional fishing in marginal areas is facing increasing threats from environmental degradation, overfishing and competition from advanced fishing technologies (Béné 2003). In order to sus-

tain and improve the viability of traditional fishing, it is important to implement management based measures like community rights approach, ecosystem approach or protected areas to govern natural resource conservation and management measures taking into account the unique challenges faced by the native communities, such as poverty, poor governance and inadequate market areas (Cochrane and Garcia 2009).

Traditional fishing is a long-standing tradition among tribal communities in Nagaland, and certain fishing practices are still considered sacred and locally practiced. Fishing gear fabrication and execution of traditional fishing techniques can vary based on factors such as location, fishing season, fishing grounds, physicochemical characteristics of the water body, ecological morphology, work

force involved in fishing, fish migratory behaviour and raw materials available for gear construction (Sinha 1994). Indigenous gears are primarily made from sustainable and biodegradable materials, such as cane, bamboo, wooden branches, stones, and other locally available materials. However, due to the emergence and unrestricted use of modern fishing gears, the traditional knowledge associated with fishing is disappearing (Imchen and Joglekar 2017). Available data within the context of traditional fishing is limited and this knowledge gaps may exist due to insufficient research on a specific aspect of traditional fishing or limited exploration on ecological impacts, social and cultural dynamics, economic viability and environmental impacts of traditional fishing practices (Kirby 2004; Kittinger *et al.* 2013; Béné *et al.* 2016). Nagaland has relatively limited documentation of fishing practices compared to other northeastern regions of India. Therefore, documenting and preserving these ancestral practices that have been passed down orally or through folktales is imperative. Identifying and addressing knowledge gap is essential to comprehensively understand traditional fishing, develop sustainable management policies and support the livelihoods of local communities. Therefore, this study aims to document and analyse traditional fishing knowledge including gear construction and fishing techniques execution and assess the viability and sustainability of these methods among the local communities of Ao and Sumi tribes in Nagaland, India.

2 | METHODOLOGY

2.1 Study area

The Ao community is an ethnic tribe residing in the central Mokokchung district of Nagaland, which shares borders with three other major districts, namely Wokha (western part), Tuensang (eastern part) and Zunheboto (southern part) of Nagaland, as well as the Jorhat district of Assam state to the north (Imsennaro and Singh 2018). The Mokokchung district spans an area of 1719 km² and is situated between 26°23'43.4394"N Latitude and 94°31'16.3194"E Longitude at an altitude of 4347 ft. The Sumi Nagas are another major tribe of Nagaland, primarily residing in the Zunheboto district. The Zunheboto district shares its boundaries with Phek and Kohima in the south, Wokha in the west, and Mokokchung and fractions of the Tuensang district in the east (Kinny and Martemjen 2015). The district features mountainous hills, ground vegetation, rich cultural heritage and varied rivers and rivulets. The total area covered by the Zunheboto district is 1255 km², located at 26°1'5.52"N Latitude and 94°31'16.3194"E Longitude at an altitude of 6076 ft. Dikhu River, locally referred to as "Tzūla" in the Ao dialect and "Nanga" in the Sumi dialect, is one of the most prominent rivers in Nagaland. It originates from the Nuruto Hills of Zunheboto and flows westward to join the Nagin-

imora, Assam Brahmaputra Basin (Figure 1). The river spans 160 km and has a catchment area of 2996 km², with the Yangyu tributary of the Tuensang district and the Nangun tributary of the Mokokchung district being its two main tributaries (Ao *et al.* 2008).

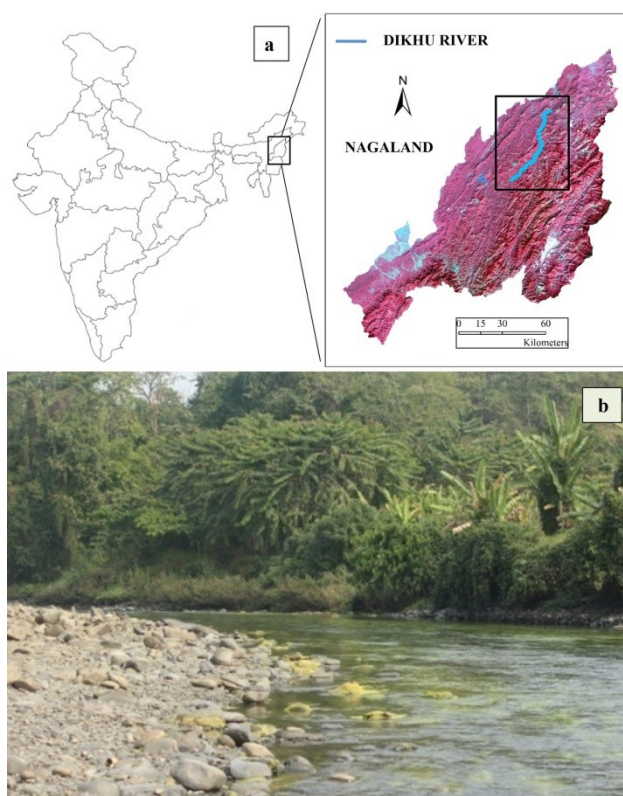


FIGURE 1 Map of India showing (a) location of Dikhu River and (b) view of Dikhu River.

2.2 Sampling framework

A survey was conducted from April 2018 to February 2020 to collect information on traditional fishing activities. A total of 10 villages with 119 informants were randomly selected for data collection from Mokokchung and Zunheboto districts in the vicinity of Dikhu River. The respondents included village heads, council members, traditional knowledge keepers, fishermen, fisherwomen and local communities from varying age groups. Of the total respondents, 11 were categorised as old age group (<65 years), 41 as middle age group (45 – 65 years) and 67 as adult age group (25 – 45 years). The primary information was collected through personal interviews, focused group discussions and field observations using a detailed questionnaire to obtain the desired information efficiently. In addition, information on fishing strategies like types of fishing gear and techniques used and information on the local ecological knowledge of the fishery, stated by the respondents were documented (Schonhut and Kieveltiz 1994; Gurumayum and Choudhury 2009). To gain a historical and cultural context for understanding traditional fishing practices, secondary data were obtained from sci-

entific literatures, published papers, historical records, books, and financial reports from governmental organizations. The adopted method enabled the collection of both primary and secondary sources of information.

3 | RESULTS

The Ao and Sumi tribes of Nagaland employ traditional fishing techniques (Table 1; Figure 2) to catch fish primarily for subsistence consumption.

3.1 Fishing craft

Fishing crafts are used as a mode of transportation by local fishermen for easy access to their preferred fishing grounds. The most common type of fishing craft is the bamboo raft. This is made primarily of long bamboo stems tightly woven into a mat-like frame with bamboo string. Long bamboo stems of equal length are usually preferred, although the number varies depending on the raft size and nature of the water current. They are then horizontally laid out on the ground and firmly bound with

the support of ropes or twines and are operated on for a year or two.

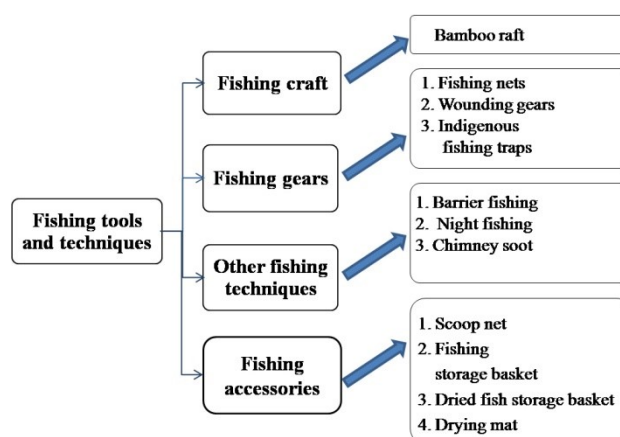


FIGURE 2 Flow diagram representing different fishing techniques practiced by Ao and Sumi tribes of Nagaland.

TABLE 1 Traditional fish-catching gears / accessories practiced by Ao and Sumi tribes in Dikhu River, Nagaland, India.

Fishing gears / accessories	Local name in tribes		Use in season	Longevity (years)	Material used in fabrication	Fishing efforts ^a
	Ao	Sumi				
Fishing nets						
Gill net	Fasi jal	Akhame	Post and pre-monsoon in shallow water	3 – 5	Nylon / polyester	≥ 2
Cast net	Zütsük	-	Whole season	5 – 6	Cotton / nylon, iron, or stone weights	1
Wounding gears						
Hooks and lines	Porki / Bulchi	Porki / Bulchi	Summer months	3 – 5	Sharp iron hook, nylon twine, bamboo / wooden pole	1
Harpoon	Anguakatsü	-	Whole season depending on visibility	3 – 5	Barbed iron, bamboo / wooden pole, ropes / rubber	1
Fishing Spear	-	Angu	Summer months	3 – 5	Wooden stick / sharp iron tip	1
Indigenous fish traps						
Tubular-shaped trap	Talu-Tatu kago	Kitsakhu	Shallow waters in summer months	2 – 3	Bamboo splits, nylon thread / cane strings	1
Funnel-shaped trap	Mashiba,	Mushohe	Monsoon months in rivers and paddy fields	1 – 3	Bamboo splits	1
Conical-shaped trap	Shiba	Akhu	Summer months in mild water current	2 – 3	Bamboo splits	1
Fishing accessories						
Scoop net	Tsüteptsü	Akhasho	Whole season	2 – 3	Nylon / cotton twine, plastic / bamboo / metal ring, bamboo / wooden pole	Single
Fishing basket	Angamakang	Shibakhu	Whole season for fish storage	2 – 3	Bamboo strips, stings	Single
Dried fish storage basket	Tsükden	Aqhupu	Whole season	2 – 3	Bamboo slits/twine	Single
Fish drying mat	Makang	Aqhesu	Whole season	1 – 2	Bamboo splits	Single

^a person required for setting up or operation

A long bamboo stick is employed as a type of oar for rowing activity. This raft aids the fishers in sailing in unruffled water (Figure 3a). The raft is made of approximately 18 – 50 bamboos of the light variety, bound together with coir / jute ropes, with the bigger ends of the trunks pointing toward the stern. Typically, these rafts are 3 – 5 m long and differ in their width (1.5 – 2.0 m) depending on the water current and the number of bamboos used. These rafts are large and require a lot of effort to move across the water with bamboo poles, but they have a fair life span (1 – 2 years). Typically, they are used for stagnant rivers and floodplain reservoirs.

3.2 Fishing gears

In this study, fishing gear has been defined as any equipment, implement, tool or non-mechanised device utilised for the purpose of catching, collecting or harvesting fish. The fishing gear documented in the study was found to be predominantly of the primitive category, with variations in size, shape and mode of operation. The fishers use different gear types depending on their skill and convenience of use.

3.2.1 Fishing nets

Gill net: Gill nets are popular fishing gears used in many parts of India. They are operated throughout the year from paddy fields to rivers. Fish catch composition can vary depending on mesh size. It is a rectangular-shaped net consisting of head and foot rope for stability. It is held vertically like a wall with the aid of sinkers or weights like stones, soil, or floats and positioned in the direction where fishes migrate (Figure 3b). It is one of the region's most-used fishing gears. As these nets are passive, their catching ability depends on the migratory nature or movement of fish. This gear's primary mode of operation is to entangle the fish while passing through the net unto the meshes. The nets are set overnight or for several days depending on the fishermen. The net is anchored with the help of bamboo or wooden plank attached to the bottom for support. The captured fishes are then taken out of the water along with the net. This fishing gear has gained popularity with the local fishing communities because of its cost-effective nature, ease of operation, and minimal investment. The durability of this fishing net can be from 3 – 5 years or more. In this type of gear, fishes such as *Pethia* spp., *Garra* spp., *Devario* spp., *Neolissochilus* spp., *Opsarius* spp. and catfishes are caught.

Cast net: Cast nets are circular and operated by launching the net on the surface of water widely from a fixed point, after which the net encircles a specific area and then the gear is hauled up carefully. It is conical in shape and forms a circle when stretched out. It consists of a cord attached to the pinnacle to support the net and a series of weights are attached at the base of the net for sinking purposes,

thus creating a circumference pocket where fish gets caught and entangled while attempting to escape. The operation of these nets involves expertise and practice (Figure 3c). The net is constructed from nylon or cotton yarn and has a fair life span of 5 – 6 years. Its length varies from 1.2 – 2.5 m, and the mesh size ranges from 20 – 40 mm. These nets are cost-effective and can be operated single-handedly. It is operated in shallow water throughout the year and at any time of the day. Species caught are mahseer, carps, catfishes etc.

3.2.2 Wounding fishing gears

Hooks and lines: This gear extensively operates in modern and conventional indigenous fishing techniques and is considered one of the oldest and most widely used fishing gears. In this type of fishing gear, the fundamental concept of fishing includes the food and feeding habit of the species targeted for capture. The gear consists of a long-extended bamboo rod, plastic pole or accessible wooden stick attached on one side of the pole with nylon or some other fibre thread and a metallic hook of varying sizes attached with a tight grip on the end of the twine (Figure 3e). In some cases, the line may not be connected to a pole and is referred to as the hand line. Depending on convenience, the length of the pole may vary from 1.5 – 3.0 m, and the hook is usually made of iron with sharp edges and curves bent for better entanglement. In some cases, floats and weights are also attached to serve as an indicator and proper stability in running water. Baits used are small fish, meat chunks, insects, earthworms, rice bran, flour, frogs, crab etc. They are attached to the hook to lure the fish for entrapment when they attempt to swallow the bait. After that, the fish gets entangled by pulling up the thread. This targeted species may vary from bottom-feeders to game fishes like trouts, carps, minnows etc. The longevity of the gear is 3 – 5 years. This method is non-destructive and can be operated by all age groups.

Harpoon: It is a particular form of traditional fishing gear that involves the catching of fish by being either impaled, grappled or wounded. This sort of gear usually captures bottom-dwelling fishes. It is made of bamboo poles or wooden sticks ranging in size from 9.0 – 1.2 m in length with 7 – 12 sharp barbed iron rods (0.05 – 1.0 m) connected to the anterior portion to pierce the fish and a pipe is attached to the tip of the pole with the aid of an elastic cord on the posterior part (Figures 3i – 3j). This approach involves extending and removing the elastic band to impale or wound the fish. These gears are typically operated in shallow water. It is suited for capturing fishes like carps, mahseer, catfishes etc.

Fishing spear: The fishing spear is a traditional gear used for many generations in tribal communities in hunting

and fishing. It is made up of two parts: a long wooden pole for grasping and the other is made of a sharp-pointed tool carved out from either metal or animal bone for impaling the fish. Generally, bigger fish are targeted for capture in this type of fishing technique which requires skilful expertise.

3.2.3 Indigenous fishing traps

Tubular-shaped trap: These traps are made of split bamboo tethered with nylon thread or cane strings. It is somewhat tubular-shaped, with two valves located closely on the trap's lateral side. The valves on the trap are designed to serve as trap doors from which it is easy to enter, but it is restricted from escaping. Typically baits such as earthworms, meat pieces etc. are used for luring the fish or shellfish into the pit. The trap typically ranges from 0.9 – 1.2 m in length and 0.3 – 0.4 m in width (Figure 3f). Trap shape and size can vary from one area to another. This trap is operated in shallow water and is positioned horizontally for a day or overnight along with the water current, aided by stones and leaves for coverage. Fishes captured depend on the seasonal variation and availability. Since these traps are constructed with readily available eco-friendly materials, cost-effective and low budget.

Funnel-shaped trap: It is a funnel shape-like trap woven from bamboo splits with a large mouth opening that slowly narrows down at the end (Figure 3g). It is low cost and it requires only one or two people to operate for ease of operation. Such traps are set against the water current, and fishes like *Opsarius* spp., *Puntius* spp., *Clarius batrachus*, *Channa* spp., *Mastacembelus armatus*, prawns etc. are captured. These are positioned at the river's apex mouth, where the water current is mild or operated in paddy fields during the monsoon season when water gets logged. It is an elongated trap made of bamboo (0.9 – 1.6 m) long, 0.15 – 0.3 m mouth diameter) with a wide conical opening on the anterior side with detachable ropes tied on opposite sides and a long tubular tapering end on the posterior side. The former acts as a fish aggregating tool and the latter is used for accumulating the fish in the cod end. When the water depth is high during the summer months, they are placed across various small gaps as water flows over low-lying fields. A number of those traps are set against the current in these gaps. The fishes caught inside the trap are collected by detaching the rear-end side of the trap.

Conical-shaped trap: It is an indigenous gear made of split bamboo comprising a long tubular structure, and its size and shape can differ widely. This trap can vary from 1.5 – 2.0 m in length and mouth diameter from 0.1 – 0.2 m (Figure 3h). During the Monsoon season, it is placed in rivers or adjacent paddy fields. Commonly species of fish

such as *Puntius* spp., *Channa* spp., catfishes etc. are captured in these traps. These are low-cost fishing equipment. A triangular rim encloses the mouth. During operation, the gear mouth is positioned in a stream or water channel against the current and kept undisturbed for a day or more.

3.3 Other fishing techniques

3.3.1 Barrier fishing techniques

Ahet (Ao) / Apili (Sumi): An area of a river is embanked and separated from the river's main channel, thereby creating a pocket or pool that is further enclosed with piles of stones, leaves, shrubs, logs or twigs of wood, making a boundary. After setting it up for a few hours, water is drained from the pool, and fishes are caught by either lifting or moving the stones trapped inside the stones for shelter. Sometimes chemicals are also used for stupefying the fish. Fish can be easily captured with bare hands using this method and are usually collected in storage baskets or cut bamboo stalks. The number of people interested in fishing varies from 10 to 50 or more, varying from young to old age groups. Fish caught in this technique primarily consist of loaches, minnows, barbs, and catfishes (Figure 3n).

Züra (Ao) / Aku (Sumi): In this method, fish are captured using bamboo, stones or tarpaulin to establish an enclosure in a selected section of the river. Then a number of indigenous conical shape storage trap made of bamboo is positioned at the opening of the enclosure to allow the fish to enter the trap while attempting to escape. After the barricade has been set up, the fish are stupefied using the crude plants pounded from the bark, roots or leaves of trees, such as *Juglans regia*, *Acacia pennata*, *Schima wallichii* etc. Then the fishes are collected using scoop nets or baskets and further fishes that are trying to escape are also captured in the traps set (Figure 3o).

Tzüyok (Ao) / Aichivu (Sumi): This technique is an age-old method of fishing practiced by local tribal communities and passed down from generation to generation. Local community fishing is referred to as "Tzüyok" in Ao cultural dialect, "Tzü" meaning water and "yok" meaning set free as a symbol of Divine Gods prayer to save them from illness or misfortune (Martemjen 2017). Since time immemorial, tribal villagers have practiced community fishing, considering it a religious activity not only for consumption or recreational purposes but also as a time for bonding, offering prayer and summoning God's blessings. On an auspicious day, the village community council members will gather to discuss the construction requirements, site, and date for setting up the barricade. In community fishing, many people of various ages, from young to old, are actively involved. The working manpower may vary from 20 – 100 people or more depending on the construction

size. This method of fishing is typically done once or twice a year by a single or number of local village communities depending from region to region before the monsoon or before the sowing season led by the community's men. Usually, these structures are constructed on the fish migration route where the water current is high. A barricade is constructed across the river using rocks, stones, bamboo or locally available wooden sticks or twigs so that after entering the pit, the fishes cannot easily pass by (Figure 4a). This area is kept untouched, allowing the fish to enter and settle for a few good days. It is set up within a day, and fishing can continue for several days. In some cases, fishing is achieved by using crude extract derived from plants (*Schima wallichii*, *Acacia pennata*, *Juglans regia* etc.) from stems, leaves, fruit and bark commonly used for stupefying the fish, after which they are harvested by handpicking or using equipment such as a long spear, cast net, dao (traditional machete), scoop net or other indigenous traps (Figure 4d). After the fishing event, fish catch is evenly distributed among the villagers.

3.3.2 Night fishing

Night fishing is a common activity in this region, especially during the summer months, when three or more fishermen are involved. It is operated at night when water is transparent and clear. The basic working principle behind this type of fishing involves using fish aggregating tools such as a battery torch or lantern for visibility and luring the fish, which are then impaled by a long spear or harpoon with a sharp multi-barbed iron edge or cast net.

3.3.3 Chimney soot used in fishing

This fishing practice is an age-old tradition where fishers use chimney soot for fishing. This method requires mixing mud and chimney soot in the same ratio and it is poured into the water where they believe the fish would be blinded for a considerable amount of time and then are caught using scoop nets or fishing baskets (Figure 4b).

3.4 Fishing accessories

3.4.1 Scoop net

Scoop nets vary from rectangular, triangular to circular in shape. The frame is built using a metal ring or locally available materials like bamboo or jute and a net of smaller mesh size, viz. nylon, cotton or mosquito net, is mounted to the frame (Figure 3d). A handle of the desired length fabricated from wood or metal is then attached to the frame. This type of gear is usually operated in shallow water and is employed to scoop out fish along with other fishing activities. It is operated all year round by men, women and youngsters. It is one of the most accessible means of catching fish. Depending on its utility it can last for 2 – 3 years. The catch varies from minnows, prawns to barils, *Channa* spp. etc., depending on the dimensions of the net (1 – 15 mm).

3.4.2 Fishing storage basket

It is an indigenous storage gear made of split bamboo of varying sizes and resembles an earthen pot. Usually, the fisherman wears it around the waist, using a string or rope to store fish when engaged in fishing. Since this basket can be conveniently carried around, they are used for marketing fish to local markets. Catch such as small fish, crabs and frogs are stored in this fishing basket (Figure 3k).

3.4.3 Dried fish storage basket

It is a traditional indigenous basket woven with split bamboo (Figure 3l). It is used as a fish storage basket after smoking the fish on fire or sun-dried; after that stored for a more extended period for consumption. These baskets can last for 2 – 3 years or more with proper usage.

3.4.4 Fish drying mat

It is a traditional mat weaved from bamboo interlocking. The design may vary depending on the size required. After harvesting fish, this mat is used to smoke fish in the fire or sun drying in either raw or cooked form (Figure 3m).

3.5 Detrimental fishing

3.5.1 Dynamite fishing

Local villagers engage in the production of blast sticks using gunpowder, which are subsequently enclosed in elongated, cylindrical paper tubes and utilised as explosive devices. The locally produced dynamites are commonly sold in packages of three, with prices ranging from rupees 350 to 500 or more, varying across different regions. The blast sticks are ignited using a lighter and thrown into the water from a considerable distance, where they explode to either stun or kill fish. Subsequently, the fishermen manually retrieve the incapacitated or deceased fish from the water's surface after a few minutes. This fishing technique is particularly effective in capturing fish species such as large minnows and carp and has become commonplace due to the unsuitability of rocky and unstable bottoms for large-scale fishing using nets or other fishing equipment (Figure 4c).

3.5.2 Use of chemicals in fishing

Fishing by stupefying the fish can be done by using synthetic chemicals. Chemical products such as lime, bleaching powder or pesticides are applied in the aquatic water body for stupefying the fish for capture.

3.5.3. Electric fishing

The utilisation of electric fishing has experienced an upsurge in popularity across several regions in recent years. Its fundamental principle involves the transmission of electric current into the water via a metal wire or plate powered by a charged battery, inducing temporary im-

mobilization of fish. Subsequently, the stunned fish are collected using scoop nets, baskets or manually while still in a state of shock for a brief period following the current's passage. This locally crafted fishing equipment offers the benefits of being low-cost and capable of capturing

ing fish while still alive (Figure 4e). However, while it can be useful for scientific research or management purposes, its impacts on small riverine systems can be significant and potentially harmful if utilised irresponsibly.



FIGURE 3 Traditional fishing crafts / gears / accessories. (a) bamboo raft; (b) gill net; (c) cast net; (d) scoop net; (e) hooks and lines; (f) tubular-shaped trap; (g) funnel-shaped trap; (h) conical-shaped trap; (i) tip of harpoon; (j) harpoon; (k) fishing basket; (l) dried fish storage basket; (m) fish drying mat; (n) Ahet (Ao) / Apili (Sumi) fishing; and (o) Züra (Ao) / Aku (Sumi) fishing.



FIGURE 4 Miscellaneous fishing techniques practiced by Ao and Sumi tribes. (a) Tzüyok (Ao) / Aichivu (Sumi) fishing; (b) Chimney soot used in fishing; (c) blast stick; (d) *Juglans regia* and (e) electrical fishing equipment.

4 | DISCUSSION

Fish is one of the significant protein source preferred and consumed in many parts of Nagaland in various forms like

smoked, sun-dried or cooked in local herbs. Fishing for sustenance is an important socio-economic activity for the Naga communities. Traditional fishing practices in

many tribal communities of Nagaland have been closely tied to religious rituals and traditions that seek to invoke the blessing of God and strengthen the bonds between tribal members. On the banks of Dikhu River, the Ao and Sumi tribes of Nagaland actively participate in fishing activities and they display a wide range of traditional fish catching equipment, passed down from generation to generation for subsistence and food security. Due to the dwindling fish population and the pressing need for conservation, both communities have taken an active role in enforcing bans on dynamite, lime and other chemicals in multiple zones of the river. Fish gears like scoop net, cast net, storage basket and fishing mat are practiced throughout the year similarly as reported from Nagaon district of Assam (Sarkar and Ponniah 2006). Hooks and lines are operated chiefly during the summer months when the water depth is high and targeted fishes are large. Fishing techniques like impoundment fishing and barricade fishing are commonly set up during community fishing and it is widely practiced among the Ao and Sumi tribes as well as other Naga communities.

Fishing with plant-based toxins is a common practice in many indigenous communities around the world (Van Andel 2000). The use of crude plant extracts, derived from various plant parts such as leaves, roots, fruits and barks, has been found to be an effective method for stupefying fish. One notable advantage of using plant extracts over harsh chemicals is their relatively short duration of effect, typically lasting for a few hours before wearing off gradually. In contrast, chemical-based products can have a more prolonged and harmful ecological impact on the ecosystem. Crafts and gears in traditional fishing are typically made from locally available and cost-effective materials that require less expertise and ease of operation than modern technical equipment. Increasingly, indiscriminate fishing has become a problem in aquatic waters due to modern machinery, while traditional fishing skills and practices have been lost. There is immense potential for fish production and aquaculture diversification in this region. However, limiting factors like inadequate infrastructure facilities for culturing fish, deficiency of good quality seeds, complicated land ownership and land pattern, inaccessibility of site, low funds and lack of efficient technologies and management are hurdles for fish development in these areas (Munilkumar and Nandeesh 2007; Saha *et al.* 2015).

5 | CONCLUSIONS

The "rich ethno-cultural heritage" of Naga tribal communities is at risk of extinction due to the widespread use of modern fishing equipment. As a result, documentation of indigenous fishing techniques is becoming urgent. The introductions of modern fishing techniques and increased anthropogenic activities in fishing have had an impact on riverine biodiversity. For indigenous gears, on the other

hand, many of the materials used are produced locally and are environmentally friendly, so no negative impact on the environment in their production or use. The long-term benefits for local communities can be realised by promoting sustainable fishing and resource conservation through the use of traditional methods. The availability of abundant aquatic resources in the Nagaland state makes it an ideal spot for fisheries development through upgrading the traditional fishing gears by incorporating modern technologies that can offer benefits in safeguarding and conserving aquatic biodiversity, boosting the economic growth of tribal communities and encouraging sustainable fishing.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

MK recorded the indigenous traditional knowledge concerning the fishing practices carried out by the Ao and Sumi tribal communities settled along the banks of the river Dikhu. PPP supervised the work and interpreted the indigenous fishing practices information gathered by the MK.

DATA AVAILABILITY STATEMENT

The data findings of this study are presented within this article.

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