

Unraveling complexities

Towards a Typology of Small-Scale Fisheries in Kaptai Lake, Bangladesh

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Non-mechanized subsistent fishing is an important livelihood activity in Kaptai Lake (Photo: Bodhi Kandu Chakma, 2021).

Abstract

A typology of small-scale fisheries in the Kaptai Lake, Bangladesh, is developed to unpack its complexities, heterogeneity, and dynamics. Based on the level of financial investment in fishing activities, three types of small-scale fishing activity were identified. They include: Type-1 fishers with the highest financial investment; Type-2 fishers with a lower financial investment; and Type-3 fishers with no financial investment. While each group faces different threats and challenges, a list of common threats to their livelihoods is identified. This typology identifies the multiple dimensions of small-scale fisheries in similar contexts. As developing countries have limited resources to support fishers, this typology will be helpful to point out the specific problems and needs of particular fisher groups. Thus, policymakers can invest in the most effective way where support is most needed.

Introduction

In small-scale fisheries, heterogeneity and complexity are inherent (Johnson, 2006). Small-scale fisheries may differ in socioeconomic settings, local arrangements, and cultural contexts (Coronado et al., 2020). The complexity of small-scale fisheries is rooted in the geomorphologic and ecological characteristics (e.g., coastline length and size, oligotrophic ecosystems) (Tzanatos et al., 2006), as well as in the availability of resources, fishing effort, production, socioeconomic conditions, markets and economic incentives (Coronado et al., 2020). According to Johnson (2006), to make sense of the world, the surrounding complexity can be reduced through categorization by selecting and ordering identical or different things, ranked or relationally neutral.

According to the Cambridge dictionary, the lexical meaning of typology refers to a system or study of dividing things into separate types. Typology simplifies the understanding of a complex system by categorizing the elements of that particular system according to their similarities and

disparities. Structuring typology for small-scale fisheries is an approach to organize and accumulate a variety of its element based on similarities and differences among them. It categorizes a highly complex fisheries system to ease its overall understanding (Coronado et al., 2020). This categorization is important because standardization of small-scale fisheries information is an arduous task due to their temporal and spatial fragmentation and haphazardness (Jacquet et al., 2010; FAO, 2017; Chuenpagdee et al., 2019). Against this backdrop, a typology can help organize dispersed data, identify information gaps, and generate sound information for better fisheries management (Glaeser, 2016; Coronado et al., 2020). Further, it puts forward new research questions about the monitoring and management tactics of small-scale fisheries (Coronado et al., 2020). This research was focused on developing a small-scale fisheries typology for Kaptai Lake fisheries. Small-scale fisheries-specific typology, as presented here, is the first attempt in Bangladesh to categorize a fishery system and its threat towards developing broad lessons for sustainable management.

Overview of small-scale fisheries of Kaptai Lake

The Kaptai Lake is the largest among the man-made freshwater lakes in the south and south-east Asia (Hoque et al., 2021). It is the largest lake in Bangladesh (Bashar et al., 2015). The average surface area of this 'H' shaped lake is 58,300 ha (Uddin et al., 2014). This reservoir's maximum and mean depths are 32 and 9 m, respectively (Bashar et al., 2015). The lake was created in 1961 by creating a large dam, 666 meters long and 43 meters high, with 16 spillways across the Karnaphuli River at Kaptai, about 40km downstream of Rangamati District and 70 km upstream from the estuary of this river (Haque, 2015; Karmakar et al., 2011). Though the primary purpose behind the creation of the lake was to produce hydroelectricity, it contributes to flood control, irrigation and drainage, riverine communication, transportation of harvested forest resources, tourism, and freshwater fisheries production. The total fish production was 12,696 metric tons in the 2019-20 fiscal years, representing 0.28 percent of the country's total fish production (DoF, 2020). The fisheries

system harbors 49-71 indigenous and five exotic fish species and supports small-scale fisheries by providing income and employment opportunities (Karmakar et al., 2011; Hoque et al., 2021).

Fishing in the Kaptai Lake can be done with or without fishing vessels. The fishing vessels may be non-motorized or motorized, and the length of these vessels ranges between 3.15 - 11.7 m. The motorized boats are wooden, without any roof, and use engines ranging from 3 to 16 horsepower (HP). The daily fuel cost for the motorized vessels ranges between 1.23 - 11.40 USD (1 USD = 85.56 BDT). The non-motorized boat may be with or without a bamboo roof. The main fishing gears used in the lake include hand lines, long lines, reel lines, cluster hooks, spares, traps, push nets, seine nets, and gill nets. Some fishers dive and catch fish with their bare hands. Fishers catch fish in places that are adjacent to their homes as well as those in distant areas. Their daily fishing area ranges between 644 - 311,724 m². Some catch fish alone, while most fish in a group. In groups, the number of fishers ranges from 2 to 13. The small group of fishers, with 2-3 members, is usually composed of family members, whereas in larger fishing groups, members come from the same communities. The fishers can be both full-time and part-time. Some wealthy fishers have their fishing gear and vessels, while fishers in the other two groups don't own fishing gear and boats. Among them, one group hires productive assets from the owner of fishing gear and vessels. The third group is represented by a fishing unit comprised of fishers who work as hired crew with other groups. Most fishers sell their catch at the local market to the fish dealers, who later transport fish to different parts of the country. The most catch is sold fresh, and a small percentage of the amount is sold as dried fish.

All fishers generally practice some rituals before using new gear. This is especially true for Hindu small-scale fishers, who also avoid fishing activities during the days of religious festivals. There are no strict social or religious rules related to fishing among the Muslim fishers, but some stop fishing on Friday and during religious festivals. Some fishers of the Chakma ethnic community do not fish during a full moon and religious festivals. Fishing is prohibited around the religious establishments of Buddhist people, which is maintained either all year-round or only on the days of festivals. The gift of

a large fish in marriage events is treated as a matter of honor in the Chakma ethnic community. The government prohibits fishing from May to July of each year. Although most fishers comply with this ban, some continue fishing during the ban. Moreover, a monofilament gill net is used rigorously in this lake.

Table 1: Key attributes of Kaptai Lake fisheries

Key attributes	
Vessel size	Between 1.7 - 3.15 meter
Vessel type	Non-motorized wooden: with bamboo roof, without the roof; Motorized wooden: without the roof
Size of engine	3-16 HP
Daily fuel consumption	1.23- 11.40 USD
Gear type	Hand lines, long lines, reel line, cluster hook, dive, spare, traps, push net, seine net and gill net
Monetary investment	Up to 14,843.84 USD
Distance of fishing area from living place	Close to and far from their living place
Fishing area	644- 311,724 m ²
Number of crew	2-13
Occupational status	Full time and part-time fishers
Fishing unit	Individual or family; a group of fishers from different families in a community
Disposition of catch	Household consumption; sales to local and national markets
Processing of catch	Mostly fresh and some dried

Typology of Kaptai Lake Fisheries

Based on the degree of monetary input in fishing, small-scale fisheries of Kaptai Lake are categorized into three types.

Type-1: High economic input

Fishers of this type are locally known as ‘*Boddar*’. They own fishing gear and vessels, and they predominantly invest in fishing gear, boats, maintenance,

fuel cost, and wages for the hired crew. They predominantly use seine nets and lift nets of different lengths and mesh sizes, made of different materials. They use both mechanized and non-mechanized wooden boats, ranging from 4.5 to 11.25 m. Mechanized boats have engines with 8-16 HP. They usually invest between USD 1,075- 14,840 for gear and vessels, with the yearly maintenance costs estimated to be from USD 115 to 1,755. Annual fuel costs range between USD 775- 3,310. They usually hire 6-15 fishing crews for nine months. The expense usually ranges from USD 8,835- 23,670, which is used for paying wages, food, and accommodation for the crew. Usually, 'Boddars' have to provide advance payment to the hiring crew, ranging from USD 175 to 470 for each fisher. Altogether, the yearly investment for type-1 fishers is between 9,725 – 28,735 USD. Furthermore, they are forced to pay annual extortion to influential local groups, which is determined by the number of vessels and the quantity of the fishing gear. Sometimes they need to buy fishing space on a yearly basis.

Most fishers in this group take loans locally known as 'dadon' from the fishing entrepreneur locally known as 'dadonder'. In return, they are forced to sell their catch to 'dadonder', at a lower price than the market value. In this way, 'boddars' lose a large portion of their profit. Many 'Boddars' consider 'dadon' as a trap; if anyone falls in it, it is quite impossible to come out. Taking a loan from a bank requires complex paperwork and collateral assets that most fishers cannot afford. According to the agreements between the 'dadonders' and the 'boddars', the 'dadonders' are bound to buy all the fish from the 'boddars'. If in any case the 'dadonders' are failed to take the fish from 'boddars' due to limited carrying capacity of their boat, they have to pay equivalent money to the 'boddars' for the fish.

The type-1 fishers are entirely dependent on fisheries for their livelihoods and income. Their annual fishing income ranges from 1,065 to 2,177 USD. In terms of socio-economics, these fishers are generally solvent, and they can meet their basic needs (e.g., food expenses, medical treatment, education) comfortably with their fishing income. Some of them hold leadership positions in society. They have a higher living standard, better managerial capacity to lead their communities, and manage one or multiple fishing units. They

may be involved in fishing full- or part-time. Most permanent fishers are fully dependent on fishing for livelihood, which contributes about 80- 100 percent of their yearly income. Part-time fishers do other jobs in the lean season to maintain their livelihood and earn 65-85 percent of their annual income through fishing. All 'boddars' are required to obtain a license from the Department of Fisheries upon a payment of 6.00 USD that allows them to fish for nine months per year. There are pre-determined fishing zones (locally known as *kop*) for each 'boddar'. For each haul, they usually cover an area of 7,284 – 201,430 m². They operate their net for 2-10 hauls in 24 hours, depending on the type and capacity of their gear. They catch all kinds of fish found in Kaptai Lake.

Type-2: Low economic input

These are fishing entrepreneurs who fish alone or with other family members and are occasionally supported by hired fishing crew. Their investment in fishing is lower than that of type-1 fisher. They own their gears and vessels and use the most diversified range of fishing gears, such as gill nets, seine nets, cast nets, push nets, fishing traps with different mesh sizes, wounding gears, and hook and lines. They sometimes capture fish bare-handed. The use of such diversified species-specific fishing gears helps to reduce the fishing pressure on a specific fish species. This type of fishing appears to be most sustainable as this group rarely implements unsustainable fishing practices.

The catch is either used for subsistent living or sold in local markets. With no pre-arrangements with fish dealers, fishers mainly sell their catch fresh in the local market or to fish retailers. A few fishers also sell the catch to fish dealers. Fishers mostly use non-mechanized fishing boats, which may be roofed or unroofed. A small number uses mechanized wooden boats (with 3-4 horsepower engines). The length of these mechanized and non-mechanized boats ranges between 3.15 - 6.75 m. The estimated fuel cost for the mechanized wooden boat ranges between USD 330-885/year. The fishers in this group invest between 35-622 USD for fishing gear and vessels. The income from fishing ranges between 630-2,101 USD. These fishers are poor to moderately

poor, and they can maintain their livelihoods with their fishing income.

Both part-time and full-time fishers are included in this category. The full-time fishers are entirely dependent on fishing to support their livelihood, and fisheries provide 75- 100 percent of their yearly income. The seasonal fishers do other jobs in the lean season to maintain their livelihood and earn 40- 77 percent of their annual income from fisheries. They usually fish within shorter distances, and their mobility ranges between 779–16,188 m². They can catch fish in any area except the zone used by the type-1 fishers. Due to poor economic status, some fishers use hackneyed boats, which are prone to sinking. There is a chance that fishing gear and boats can be stolen. To avoid this risk, at night fishers stay at the fishing site in a group and store their fishing traps in a protected place. Sometimes net and traps get smashed by the propeller of other vessels. Most of these fishers don't obtain licenses and continue fishing throughout the ban season.

Type-3: No economic input

These are paid fishers who work as fishing crew for type-1 fishers. They have no financial investments in fishing. They receive payments through two types of arrangements: either as a monthly wage or they work as a member of a fishing team and get a daily share of fishing income. The monthly waged fishers are further bifurcated into two sub-groups. Some take accommodation and meal support along with their monthly payment from their team owner (Type-1). In contrast, others take a portion of their daily fish catch for family consumption besides their monthly salary. The annual pay of those, who take accommodation and meal support, ranges from 945 to 1,050 USD, and the majority of them are migrant fishers from other regions of the country. On the other hand, the annual earnings of the fishers, who take only a portion of their daily catch along with their monthly salary, range from 1,472 to 1,577 USD, and they are mostly local fishermen. 73- 100 percent of annual income of the monthly waged fishers comes from fishing. However, the fishermen, who are paid a daily part of the fishing group's earnings, manage 75-100 percent of their annual fishing income, which ranges from 1,260 to 1,895 USD. Their

earnings fluctuate based on the amount of fish caught and the price of fish. In such groups, the team owner (Type-1) keeps one-fourth of their daily income for ownership of the gears and vessels, and the rest balance is divided equally among the crew fishers. Both local and migrant fishers are there in these groups of income-sharing fishers.

Migrant fishers often complain of high work pressure and inadequate compensation. Moreover, they don't receive wages if absent due to sickness or other emergencies.

Threats and coping strategies

The fishers reported several threats and stressors that hamper their fishing occupations, income, and wellbeing. The average size of fish caught decreases as nowadays larger-sized fish is almost extinct. The majority of catches are small and have a low market value. The amount of catch per fishing effort is also dramatically decreasing. While crabs are increasing in this lake, some high valued fish species, including Kuria Labeo (*Labeo genius*), Mottled Nandus (*Nandus nandus*), Gangetic Hairfin Anchovy (*Setipinna phase*), Olive barb (*Systomus sarana*), and Indus Garua (*Eutropiichthys murius*), are gone. Among the indigenous species, Gangetic Ailia (*Ailia coila*), Humped Featherback (*Chitala chitala*), and Loaches (*Lepidocephalichthys* spp.) significantly decreased. Low priced fish such as Indian river shad (*Gududia chapra*), Ganges River-sprat (*Corica soborna*), Nile tilapia (*Oreochromis niloticus*), and Mozambique tilapia (*Oreochromis mossambicus*) are now the major target species. Some fishers reported the introduction of predatory species Piranha (*Pygocentrus nattereri*) in the lake. An increase in water hyacinth is another nuisance.

The pollution of lake water is another big concern, and the major sources include land usage change, plastic (e.g., polythene bags), and oil from vessels. Furthermore, climate change has substantial negative impacts in terms of increased temperature, less rainfall, late arrival of winter, and warmer temperatures in the winter season. Such alterations in climatic variables in the lake cause destructive effects on the normal physiology of fish and their environment. Less rainfall reduces the water supply, and increased

temperature propels the evaporation of lake water.

Despite a low amount of rainfall, rainfall in upstream hilly areas, deforestation, and shifting cultivation in hills (locally known as '*Jhoom*') are causing siltation that leads to reduced depth of the lake while the adjacent creeks are drying up. According to one estimate, in 1964, there were 2,163 families involved in shifting cultivation which increased to 35,000 families in 2002 (Tripura & Harun 2003). The involvement of more people in *Jhoom* cultivation led to a more intense clearing of green hill covers. Thus, rainfall is likely to cause more denudation and ultimately more siltation in the lake. By plugging the pits inside the wooden logs and massacring the submerged vegetation, siltation is causing the rapid degradation of fish habitat. Siltation hampers migration routes and feeding areas of fish species. In addition, reduced depth caused by siltation facilitates a fast rise in water temperature and causes fish death. Again, a new layer of silt creates troubles for fishers when operating nets as they get stuck in this thick layer of silt. Siltation is reducing the water holding capacity of this lake. As a result, to keep the targeted amount of electricity production (which is the primary purpose of this lake construction), more water needs to be discharged, further lowering the lake's water level in the dry season. The Bangladesh Fisheries Development Corporation does not have any authority to maintain the water level of this lake, as fisheries management is a secondary purpose in the construction of Kaptai Lake (Ahmed & Hambrey 2005).

Reduction in fish production is a major threat to fishers, reducing their income. Consequently, fishers start looking for alternative job opportunities. During the yearly fishing ban from 1st May to 31st July, already marginalized fishers face further economic shock. While the government has a compensation scheme to support the poor and vulnerable fishers for their income loss, the scheme is insufficient and does not cover all affected fishers. To avoid economic hardship, most of the type-1 fishers become further indebted to the middleman, and the type-2 fishers fish illegally by non-complying to the fishing ban. Some fishers have changed their gears to reduce fishing costs that require less manpower. A section of fishers uses fine-meshed fishing gears to catch even undersized fish, increasing their fishing effort to cope with no- or

low-income situations.

Many fishers cannot cope with this situation and are shutting down fishing activity in the wintertime, which greatly reduces their profit. The remaining fishers take on additional debt from the middlemen. Some fishers have accused the government of mismanaging the duration of the fishing ban. Many fishers, mainly those in the type-2 group, do not obey the government's fishing ban, which diminishes the ban's effectiveness. Consequently, all other fishers failed to reap the benefits of not engaging in fishing activities during the ban. Almost all fishers have to pay extortion to multiple local political groups. Due to diminishing profit from fishing, the type-1 fishers cannot increase the wages for paid fishers (type-3) on their fishing team. As a result, the Type-3 migrant fishers from other districts don't stay employed for long due to poor payment and the high intensity nature of the work. Some local influential groups are also involved in fishing and forcefully displace other fishers from fishing in certain zones.

There are also significant health risks. The increasing incidence of thunderbolts poses a real threat to the lives of fishers. Storms and torrential water during monsoons are additional risks for those who fish without vessels or in smaller size vessels. Accidents may happen during fishing operations, such as when pulling a seine net with bamboo structures; fishers can get injured by tearing the rope of the fishing net or breaking the bamboo structure. Fishers can get wounded by fish, wooden logs, or other submerged sharp materials during bare-handed fishing. There are also poisonous snakes in the bushes of water hyacinth. Fishers are usually careful to avoid these risks. Some fishers suffer from different dermal diseases due to fishing in polluted water. Some fishers regard superstitions as a risk. To protect themselves, they use religious shields.

Conclusion

The typology developed in this study reveals insight into the small-scale fisheries system in Kaptai Lake, which has not been previously generated for any other fisheries system in the country. The outcomes of this study

confirmed the complexity and diversity within this small-scale fisheries system. The study discussed three types of small-scale fisheries in this region based on monetary input invested in fishing activities. This study has successfully simplified the complex structure of the Kaptai Lake fishery, which will help researchers identify information gaps, understand the structure of this fishery and use this knowledge in further research on Kaptai Lake. It also underscores the small-scale fisheries' attributes, which can differ within communities. Given that we have limited resources to support fishers, and this typology points out the specific problems and needs of specific fisher groups, this research will help respective authorities distribute support most effectively and devise efficacious management plans for this lake. Moreover, as a first structured typology, this model can be replicated for all other small-scale fisheries systems in Bangladesh, including coastal, *haor*, and riverine areas. Though this research addressed some threats and challenges to all three types of small-scale fishers, better management of the fisheries systems alone will not ensure their wellbeing and sustainability of resources. For effective and efficient fisheries management, it is important to understand the environmental variables that the fisheries system is experiencing (Cochrane & Garcia, 2009). In such a case, ecosystem-based management can be a priority. The fishers' involvement in management is essential. External drivers, including siltation due to *jhum*, pollution, the proliferation of exotic fish species, such as tilapia, and the fluctuation of water level by dam control, should be carefully monitored by the governing bodies.

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