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Note

Economic assessment and sustainable management of artisanal fisheries: Insights from River Jhelum, Kashmir, India

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Abstract

This study was conducted to comprehensively assess artisanal fishers' economic and financial viability, relying heavily on a shared resource, namely the River Jhelum. Employing a proportional multi-stage stratified sampling approach, a total of 200 fishers were interviewed across six districts in Kashmir, covering the entire length of the river. The Benefit Cost Ratio (BCR) of 1.1, coupled with a positive Net Present Value (NPV), underscores the economic profitability of artisanal fisheries. Constraint analysis highlighted that fishermen express substantial concerns regarding the ongoing decline in both catch and the composition (Garret score: 83) of native fish species, particularly *Schizothorax,* and pollution in the river (Garret score: 73). Considering the perspectives of all stakeholders, it becomes evident that comprehensive sustainability measures are imperative. To achieve this, multiple stakeholders must collaborate and establish a unified administrative body, solely dedicated to the protection of riverine resources. In addition to implementing a two-month fishing ban and modifying the licensing policy, maintaining a detailed record of daily fish catches, including both biological and economic data, at each fishing site is also crucial. Such actions will facilitate the implementation of optimal exploitation levels for this invaluable inland water resource.

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The debate regarding what to label as artisanal fisheries or small-scale fisheries persists (Schorr, 2005; FAO and WorldFish, 2008). What might be considered a small scale fishery in a developed nation like the United States could be classified as a large-scale fishery in a developing country such as India (FAO & WorldFish, 2008). Typically, these fisheries are associated with underdeveloped, vulnerable and small fishing communities residing near water resources, with their immediate survival directly linked to the benefits they derive from these resources (Schorr, 2005). However, in the context of the current study, artisanal fishers are defined as traditional fishers hailing from the temperate region of Jammu and Kashmir, India. They engage in fishing activities using wooden boats and draw upon indigenous technical knowledge passed down through generations, or even centuries. In recognition of the vital role artisanal fisheries play in ensuring food security, alleviating poverty, and promoting sustainability, 2022 has been designated as the International Year of Artisanal Fisheries and Aquaculture (FAO, 2023). Out of the total global capture fisheries production, which amounts to 92 million t valued at 77 billion USD, approximately 37 million t (valued at 19 billion USD), or 40%, are attributed to artisanal and small-scale fishers. Furthermore, they are involved in approximately 90% of the value chain activities within the global capture fisheries sector (FAO, 2015).

Globally, India holds 3rd position in fish production and 2nd position in cultured fish production. India's contribution to global inland capture production stands at 14%, equivalent to 1.7 million t in 2020 (FAO, 2020). The country boasts extensive inland fisheries resources, encompassing rivers and canals that span approximately 2.52 lakh km (DoF GoI, 2022). India is home to an

inland fisher population of 2.3 crores, comprising roughly 1.7% of the nation's total population (DoF GoI, 2020). Within this demographic, 17,396 fishermen are residents of the Union Territory (UT) of Jammu and Kashmir, accounting for 0.12% of the UT's population. The report highlights that the UT is endowed with abundant inland water resources, including rivers and canals (22,781 km), lakes (60,000 ha), reservoirs (7,000 ha) and ponds (17,000 ha).

These water resources serve as the foundation for the livelihoods of artisanal and small-scale fishers, forming the bedrock of their sustenance. To ensure the sustainable utilisation of these inland resources, particularly the rivers, it is imperative to delve into the intricate relationship between the resource and the individuals who rely on it. Maintaining a harmonious equilibrium in the relationship between resource and user is crucial for achieving sustainability. Moreover, determining the extent of exploitation hinges on the economic reliance of users on the resource. When the rate of exploitation surpasses a certain threshold, the depletion of natural resources becomes an imminent concern, raising numerous critical questions. These questions encompass whether fishers obtain maximum or minimum benefits, whether they can sustain these benefits over the long term, and what future repercussions the resource might face. At this juncture, the field of fisheries economics assumes a pivotal role in addressing these complex dynamics.

Globally, significant research has been conducted on the economics of both small and large-scale fisheries within the marine sector (Narayanakumar *et al.* 2009: Narayanakumar, 2009a, 2012b; Belton and Thilsted, 2014; Aswathy *et al*., 2015; Jamnia, *et al.* 2015; Pio *et al.* 2016; Radhakrishnan *et al.* 2018; Sangun *et al.,* 2018; Viswambharan *et al.,* 2018; Rodrigues *et al.,* 2019; Carvalho *et al*., 2020; Peixer *et al.,* 2020; Fabinyi *et al.* 2022; Johnson *et al.* 2022; Raju *et al.,* 2022; WorldFish, 2023). These studies consistently indicate that the transition from traditional to modern fishing methods enhance the economic and financial viability of fisheries.

Nonetheless, there remains a scarcity of studies addressing the economic viability of artisanal fishers operating within inland water bodies, specifically rivers, across the world. The River Jhelum is a unique watercourse that meanders through the heart of the Kashmir Valley, originating from a spring source known as "Veri Nag" in the Anantnag District. This river traverses through six districts *viz.,* Anantnag, Pulwama, Srinagar, Ganderbal, Bandipora, and Baramulla. Stretching across a total length of approximately 221 km in Kashmir Valley (IWAI, 2017), the River Jhelum plays a vital role in providing sustenance to 6095 fishermen who directly depend on it for their livelihoods, primarily engaged in capture fisheries activities (DoF j&K, 2022).

Our attempt focused on examining the cost and benefit structure, economic and financial performance, as well as the challenges encountered by artisanal fishers along the River Jhelum in India. The aim has been to gain deeper insights and bolster the sustainability of artisanal fisheries by integrating the principles of social development and responsible fisheries within the region.Data collection for this study were carried out between 01 May 2022 and 15 November 2022. To streamline the sampling process in terms of convenience and time constraints, a total of 200 artisanal fisher households were selected from all six districts through which the river traverses. The proportionate multistage and stratified sampling methods were employed to gather primary data from fishers across these six districts. To ensure representative samples, we selected fisher households from each district in proportion to the number of active licensed fishers in that district relative to the overall number of fishers in the River Jhelum. For instance, Anantnag District, with 931 active fishers, contributed 31 (15.27%) fisher households. Similarly, Pulwama District, boasting 959 active licensed fishers, provided 31 (15.73%) households. With 1,827 active fishers, the Srinagar District contributed 50 (29.98%) fisher households. Ganderbal District contributed 19 (9.73%) households out of 593 licensed fishers. In the Bandipora District, 15 (7.4%) households were selected from 451 and for Baramulla District, 44 (21.89%) fisher households were proportionally included.

In the second stage of our sampling process, we selected only those tehsils (blocks) within each district through which the River Jhelum flowed, as fishers primarily resided in these areas. In the third stage, we chose fishing sites (villages) within each tehsil (block) based on criteria such as the intensity of fishing activity, settlement patterns and demographic factors. In the fourth stage, an equal proportion of fisher households was randomly selected from each fishing site, following the pre-set criteria for a total of 200 fisher household samples. We selected the top four fishing sites with the highest number of fisher households from each district along the entire river in the Kashmir Valley, as depicted in Fig. 1. This decision was made due to the challenges associated with covering all fishing sites from each district, including significant time and financial constraints. Subsequently, primary data regarding social, economic, and financial parameters, craft, and gear sizes were systematically collected from an equal number of active and experienced fishermen on a household basis through interviews conducted across the selected sites. The equal distribution of sample households from the top four fishing sites was chosen as precise data about the number of fisher households at the village level was unavailable.

The cost and benefit structure were constructed employing the fundamental formulae as advocated by several studies (Narayanakumar *et al.,* 2009; Narayanakumar, 2012; Pio *et al.,* 2016; Radhakrishnan *et al.,* 2018; Viswambharan *et al.,* 2018; Rodrigues *et al.,* 2019; Johnson *et al.,* 2022) to examine the economic feasibility and financial performance of traditional wooden boats in the region.

The variable cost (VC) per trip encompasses expenses such as bait, food as well as the repair and maintenance of nets. The flowing river often carries various materials such as wooden logs, polythene bags, dead animals and other debris, increasing the likelihood of daily wear and tear on fishing nets. This, in turn, affects the quantity of catch for these traditional fishers. The imputed value of family labour was excluded, as these fishers are considered artisanal and categorised as unskilled labourers (DoLE J&K, 2022). For these traditional fishers, fishing holds cultural and ancestral significance, and their lack of alternative skills limits their capacity to earn a livelihood from other activities. An examination of the economic and technological viability of global fishing fleets, particularly those in the European Union, also supports the exclusion of unpaid labour costs (FAO, 2021).

Fixed cost (FC) comprises depreciation of gear, craft and weighing balance, license fee, repair and maintenance of boat and interest on fixed capital. Total cost (TC) includes a total variable cost (TVC) and total fixed cost (TFC).

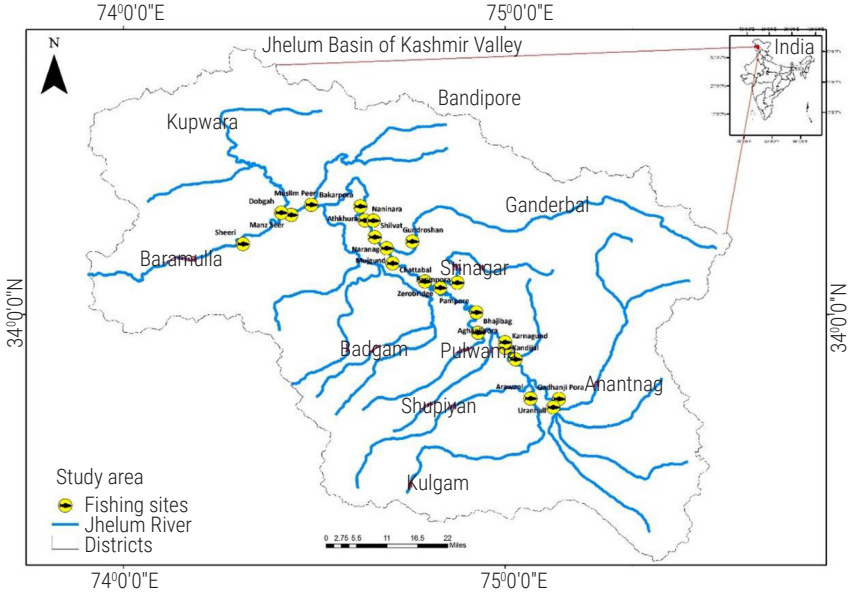

Fig. 1. Map showing the study area

To assess the economic and financial feasibility of the traditional fishing venture, the following indicators were used:

Gross profit (revenue) = $\sum (Q \times P)$

where, Q = Quantity of fish catch in kg; P = Price fish per kg of fish; Net profit (revenue) = Gross profit - Total cost

Net present value (NPV) = $P_1 1+r1+P_2 1+r2 \ldots\ldots P_n 1+rn$ - C+ Junk value

where, P_n = Net cash flow in year N; R = Discount rate and C = Initial cost of investment

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Discounted stream of profit}}{\text{Discounted stream of cost}} \times 100$$

$$\text{Payback period (PBP)} = \frac{I}{E}$$

where, PBP = Payback period in years, I = Investment, E = Expected annual net profit

$$\text{Profit margin} = \frac{\text{Net profit}}{\text{Gross profit}} \times 100$$

Economic performance was assessed through profit margin, which is essentially the ratio of net profit to gross profit. A percentage exceeding 10 indicates strong economic performance.

$$\text{Return on capital} = \frac{\text{Net profit}}{\text{Total capital investment}} \times 100$$

Return on capital is determined by dividing the net profit by the total capital investment made by the owner. Returns exceeding 10% indicate favourable financial performance.

The Garrett Ranking method was employed to identify and prioritise the constraints faced by fishers, with rankings ranging from the highest constraint assigned the number 1 to the least significant constraint assigned the number 10. The formula utilised for the Garrett ranking method is:

$$\text{Rank} = \frac{(Rij - 0.5}{Nij)} \times 100$$

where, R_{ij} = Rank given for the i^{th} variable by j^{th} fisherman

N_{ij} = Number of variables ranked by j^{th} fisherman

In the Jhelum River basin, all the interviewed respondents were males and actively involved in fishing, while females primarily sold the catch. The fish sale occurs either at home, in nearby areas, or at local markets, and the price and resulting revenue depend on the local supply and demand dynamics. In times of abundant supply, fish are typically sold at local markets or to local contractors at lower prices. Conversely, when the supply is limited, consumers are forced to buy fish by visiting the fishers' home or the river banks where fishers are available. It was observed that a larger proportion of fishers, 144 individuals (72%), hailed from rural areas, while 56 individuals (28%) came from urban areas. This difference could be attributed to the availability of various alternative livelihood opportunities for fishers in urban areas, such as selling fruits, and vegetables, auto driving, construction work, and more. Additionally, it is worth noting that the rural population of fishers is more than their urban counterparts. Due to their limited daily earnings from fishing (₹415 day^{-1}), younger individuals tended to view fishing in the River Jhelum as less profitable compared to other available livelihood options like sand mining, boulder lifting from the river (₹1000 day^{-1}), agricultural daily labour and construction worker (₹650 day^{-1}). In contrast, older fishers often mentioned that they lacked skills for other occupations except fishing in the river, which had been their traditional livelihood practice for generations. Therefore, most of the fishers fall in the 35 to 59 age group 114 (57%), followed by less than 35 age group 64 (32%) and more than 60 age group 22 (11%). The average age of fishers was found to be 43 years. Additionally,

it was observed that all fisher households belong to the low-income category, with an income level of less than ₹24000 and the average monthly fishing income amounted to ₹13,825.

Table 1 presents the techno-economic and operational characteristics of traditional fishing crafts. On average, the sampled population has approximately 27 years of fishing experience. The fishing craft's typical lifespan is 11.8 years, while fishing gear has an average lifespan of 2.8 years. Fishers engage in fishing operations for approximately 237 days each year. Each boat typically accommodates two family members, with one fisherman responsible for rowing the wooden boat and the other handling the fishing gear. The length of the boats varies within the range of 5.5 to 6.7 m, while the size of fishing gear, like cast nets, ranges from 1.3 to 1.6 m in diameter and hooks and lines can span from 100 to 1000 m. The choice of craft and gear size depends on factors such as the fishers' preferences, fishing location and the abundance of fish. Cast nets and hook and lines are used in areas with rich fish populations, but in less abundant areas, cast nets are the primary choice. Hook and lines are predominantly employed during winter, specifically from December to February. The bait typically consists of salt-baked flour and granulated wheat or salt-boiled potato pieces. On average, the distance covered per day by each boat from their homes ranges from 5 to 15 km along the river stretch. The average catch per trip per boat is approximately 3.1 kg, achieved over 9.1 h. This translates to a catch of 340 g per boat per h or 170 g per fisherman per h. This figure is lower than the observation made by Khan and Ali in 2013 (210.36 g) and significantly less than what Sunder and Bala reported in 1984 (4.9 kg per man-hour). These statistics indicate a continuous increase in fishing effort and a drastic decline in fish catch per man-hour over the years.

There are multiple reasons for the decline in fish catch in the River Jhelum and no single activity can be solely held responsible. The decrease in fish catch and changes in fish composition in the River Jhelum can be attributed to various human activities, including the continuous increase in water pollution, unscientific and illegal sand mining and overfishing. (Hussain and Rashid, 2021; Khanday *et al*., 2021; Shafi *et al*., 2021; Bhat *et al*., 2022; Dar *et al*., 2023). According to these studies, if these problems are not addressed promptly, there is a risk of permanent changes in the river's water chemistry, which could harm its ecosystem. These effects extend beyond aquatic life, as it is not only the fish that are impacted (Ahmed *et al*., 2017); ultimately, the fishermen become the victims of these anthropogenic activities.

The cost structure of inland traditional fisheries in the region was categorised into two main groups: variable costs and fixed costs. Among the variable costs, food expenses constituted the highest cost component, amounting to ₹11,042 (78%), followed by bait expenses at ₹2,311 (16%) and repair and maintenance of nets at ₹797 (6%). Fixed costs were primarily attributed to the depreciation of gear and craft, totalling ₹7,039 (65%). This was followed by costs such as interest on fixed capital at ₹2,393 (22%), license fees at ₹800 (7%) and boat repair and maintenance at ₹664 (6%). The analysis of the cost and returns structure is presented in Table 2. With an initial capital investment of ₹53,178, the annual gross revenue per boat was determined to be ₹198,910. The total cost was calculated at ₹22,481, consisting of ₹11,452 in variable costs and ₹11,028 in fixed costs. Consequently, the net profit per boat per year was estimated at ₹176,429.

Table 3 presents the financial feasibility of traditional fishing crafts in the region. The positive values of all indicators indicate that the fishing venture generates profits over time. The benefits from the traditional fishery venture outweigh the costs, as evidenced by the Benefit-Cost Ratio (BCR) value of 1.1% and a relatively shorter payback period of 0.3 year. This is in contrast to the findings of Radhakrishnan *et al*. (2018) in Tamil Nadu, India, where they observed a longer payback period of 4.08 years. The Net Present Value (NPV) was also positive, with a value of ₹1.88 lakhs.

The traditional fishing craft in the region has demonstrated strong economic performance. The profit margin ratio is notably high at 89%, surpassing the 10% benchmark observed in studies by Narayanakumar *et al*. (2009), Radhakrishnan *et al*. (2018) and Johnson *et al*. (2022). This positive economic performance can be attributed to the relatively low operational cost within the inland traditional fishing sector in the region.

Table 1. Techno-economic and operational characteristics of the artisanal fishing sector

Criteria	Mean±SE	Min	Max
Fishing experience (years)	27±.75	10	50
Distance covered from home (km)	12.7±.33	5	22
Annual fishing days	237±.09	210	260
Craft size (m)	6.34±.07	5.5	6.7
Gear size (m)			
Cast net length (m)	3.6±.02	3.5	4.5
Diameter (m)	1.5±.01	1.3	1.6
Hook and line (m)	522±20.4	100	1000
Craft life (years)	11.8±.32	1.5	22
Gear life (years)	2.7±.09	0.3	5
Number of fishing hours	9.1±.10	6	13
Fish catch per day (kg)	3.1±.02	2	4
Price per kg (₹)	268±3.02	170	350
Number of persons per boat	2		
Ownership	Individual		
Peak fishing season	May to June		
Lean fishing season	December to February		

Table 2. Cost and returns of inland artisanal fisheries in River Jhelum

Content	Amount (₹) per year
Initial capital investment	53178
Gross revenue (profit) per boat	198910
Variable cost excluding family labour	11452
Depreciation	7039
Interest on fixed capital (4.5%)	2393
Fixed cost	11028
Total cost	22481
Net profit (revenue)	176429

Table 3. Financial feasibility of the artisanal fishing sector

Criteria	Traditional sector
NPV (₹)	188264
BCR (%)	1.1
PBP (years)	0.3
IRR (%)	36

Table 4 outlines the constraints faced by artisanal fishers in the region. The most significant challenge identified was the continuous decline in native fish catches, which received a Garrett score of 83. Fishermen recall that two to three decades ago, they used to catch up to 25 kg of various local fish species such as *Schizothorax* spp., *Triplophysa* spp., *Botia birdi*, migratory *Tor putitora*, and a small amount of exotic common carp species (*Cyprinus carpio*) per boat per day. However, due to changes in catch composition, the catch now predominantly comprises *Schizothorax* species alongside exotic carps, constituting up to 50% of the total catch (DoF J&K, 2022). This trend is supported by studies conducted by Qureshi *et al*. (2007), Khan and Ali (2013), Qureshi *et al*. (2016), Ahmed *et al*. (2017) and Hamid and Singh (2019), all of which report a decline in local fish catch and composition over the years. The second most significant issue artisanal fishermen perceive is water contamination (Garret score: 73) This contamination is primarily due to the continuous inflow of untreated sewage, micro and macro plastics and agricultural fertilisers and pesticides. It indicates the ecological impact of developments in other economic sectors, such as sand mining, industrialisation, urbanisation and modernisation in agriculture, affecting the river's ecological health and consequently, the economic and social well-being of artisanal fishers, who are immediate users of this common pool resource. The third-highest constraint fishermen report is their lack of knowledge of scientific fishing methods (63). Additionally, other constraints such as the absence of schemes (62), high input costs (58) and lack of insurance coverage (55) were ranked fourth, fifth and sixth, respectively. The regional institute must ensure the equitable distribution of facilities to the fishing community. Lack of marketing facilities (53) is the seventh most significant constraint faced by the sampled fishermen. Establishing centralised marketing units with necessary facilities in each district could address this issue. The eighth most common constraint is the scarcity of raw materials (47) for boats and net construction. Fishing during harsh winters, ranked ninth (42), poses difficulties due to natural factors. However, this period aligns with the lean season, and providing post-harvest training in activities such as value addition could help mitigate this issue. Fishermen expressed least concern (30) about dependence on middlemen. The price of fish is influenced by local supply and there is considerable demand in the region. Additionally, the availability of fisherwomen selling catches at home, in nearby villages, or in the local market also affects the price.

According to local fishermen, the presence of fish in the River Jhelum is highly volatile and there is a significant degree of risk and uncertainty regarding the daily catch quantities. This unpredictability arises from the migratory nature of indigenous fish species, whose movements up and down the river depend on favourable conditions, breeding grounds and the season. Unfortunately, these critical factors are being severely impacted by various economic activities such as sand mining and industrial waste discharge (Hamid and Singh, 2019), as well as untreated household sewage (Ahmed *et al*., 2017). Studies have conclusively shown that the decline in native fish species can be attributed to encroachments along the riverbanks and the direct influx of agricultural waste (Qureshi *et al*., 2013; Ahmed *et al*., 2017), along with pollution in the river itself (Hamid and Singh, 2019). Some fish species, such as *Tor putitora* (Golden mahseer), have completely disappeared from the River Jhelum, while others like *Schizothorax plagiostomes, S. curvifrons, S. esocinus* and *S. labiatus* are found scarce in catches (Qureshi *et al*., 2013). These adverse effects ultimately have a detrimental impact on the economic well-being of artisanal fishermen in the region. So far, neither the Department of Fisheries (DoF) nor the research institutes have successfully artificially bred these native fish species. Additionally, the quantity of fish caught (3.1 kg per boat per day) and its composition have decreased.

Table 4. Constraints faced by the artisanal fishers of River Jhelum

Constraints	Garret score	Rank
Decline in local fish catch	83	I
Contamination of water	73	II
Lack of knowledge of scientific fishing	63	III
Lack of schemes	62	IV
High cost of inputs	58	V
Lack of insurance	55	VI
Lack of marketing facility	53	VII
Scarcity of raw materials	47	VIII
Fishing during harsh winter	42	IX
Dependence on middle man	30	X

The status of fisheries management in the River Jhelum is significantly lacking due to variety of reasons.Several studies, including those of Mehmood *et al*. (2017); Khanday *et al*. (2021) and Gul *et al.* (2023) have correlated the decline in the fish population in the River Jhelum with elevated pollution levels and changes in water chemistry resulting from various human activities. The activities responsible for this include significant land system changes (Romshoo and Rashid, 2014), unplanned urbanisation (Bhat *et al*., 2014), deforestation (Singh *et al*., 2012; Rather *et al*., 2016), soil degradation (Rashid *et al*., 2011), growing tourism activities (Mushtaq and Pandey, 2013), uncontrolled use of agricultural and horticultural pesticides and fertilisers (Ali and Jain, 2001; Bhat *et al*., 2014; Hamid and Singh, 2019; Bhat *et al*., 2022) and biological contamination (Sheikh *et al*., 2022). Cold-water fish species of the River Jhelum in Kashmir require clear water for their growth and replenishment, as highlighted by Ruqaya *et al*. (2012). Unfortunately, due to the rising pollution levels, these fish struggle to tolerate the deteriorating water conditions (Shafi *et al*., 2021). As a result, this leads to reduced growth and increased stress in the reproductive biology of these fishes (Khan and Ali, 2013; Farooq *et al*., 2018). Many studies, including those carried out by Sultan and Kant (2016), Hamid and Singh (2019), Hussain and Rashid (2021) and Dar *et al*. (2023), have further supported the claim that ongoing unauthorised sand and boulder extraction has seriously harmed flora and fauna in the River.

Both illegal and licensed fishermen consistently violate regulations concerning mesh size limitations and engage in overfishing (Khan and Ali, 2013; Sultan and Kant, 2016; Ahmed *et al*., 2017; Maqbool and Gull, 2019; Hussain and Rashid, 2021). According to the Fisheries Act, 2018, fish measuring less than 5 inches in length should be allowed to escape using a suitable mesh size of one and a half inches (1½″) for fishing. However, it has been observed that fishers in the River Jhelum also use a half-inch (½″) mesh size to catch juveniles. Furthermore, these fishers employ banned gill nets at night when manpower is unavailable in the field, retrieving them early in the morning to avoid detection by fisheries guards. Consequently, due to this extended non-compliance, the fish population in the river has significantly declined.

The management of the River Jhelum is primarily overseen by the Department of Geology and Mining as well as the Department of Irrigation and Flood Control, Govt. of Jammu and Kashmir. Other stakeholders involved in the river's management include the Department of Ecology, Environment and Remote Sensing, the Department of Wildlife and Protection, the Department of Forestry, the Department of Public Health Engineering and the Department of Tourism. However, the DoF is primarily concerned with fishing rights and has limited authority. Furthermore, district DoF officials have reported their inability to enforce necessary measures, including penalties for illegal fishing, due to a lack of authority and workforce.

The survival of artisanal fisheries in the River Jhelum depends on the rejuvenation and profitability of fishery resources within the region. This study is dedicated to ensuring the long-term survival of both the fish and the fishermen. Currently, the artisanal fishery enterprise in the area is economically profitable and financially feasible. However, the sustainability of this common pool resource remains an unanswered question. Fishing activities in the river persist throughout the year without adherence to a closed season. To address this issue, a fishing ban should be implemented for a period of two months, specifically during May and June, to coincide with the breeding season of native fishes. Simultaneously, a ban on sand mining and boulder lifting should also be enforced. The Department of Geology and Mining (DoGM) must ensure the effective on-field implementation of regulations concerning both activities and prohibit using mechanical methods. In addition to mesh size regulation, there is an urgent need to revise the licensing policy, considering the imposition of an upper catch limit on non-bonafide fishers. The absence of reliable fish catch data hinders the ability to draw critical inferences. Therefore, for a comprehensive analysis and the development of effective policies, maintaining a detailed record of daily fish catches, encompassing both biological and economic data, at each fishing site is crucial to ensure the optimal utilisation of these resources.

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