

# Assessing the Sustainability of Small-scale Inland Fisheries: a case of the fisheries in Barito River of Indonesia

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Indonesia is an archipelagic country with land area that is approximately two-thirds of the its waters, and embraces 7,508 large and small islands with a coastline that stretches to a total of about 81,000 km (Bengen, 2002). From among the ASEAN Member States, Indonesia has the widest area of inland waters encompassing approximately 54 million ha, of which about 71.63 % or 39.40 million ha comprises floodplains and swamps, 22.13 % rivers, and 3.89 % natural and artificial lakes, and 2.35 % other puddles/ water irrigation, which are mostly (60 %) situated in the Kalimantan provinces. The potential biological resources contained therein provide substantial contribution and benefits to the socio-economic well-being of the people of Indonesia, primarily as source of food and animal protein, and more particularly, as springboard of various business ventures for the inland fisheries communities. The country is also endowed with many big rivers, such as the Musi River, Kapuas River, Mahakam River, and Barito River. This article provides some information on the status of inland fisheries in Barito River.

fisheries, and also the whole of Kalimantan in general. Barito River is inhabited by no less than 207 species of fish and shrimps, although Utomo & Prasetyo (2005) reported that some species have been difficult to obtain, become rare, and their stocks have sharply declined.

## Barito River and its Fisheries Features

Barito River is one of the major rivers in Indonesia with a length of about 900 km that originates from the Muller Mountain Range of North Kalimantan and flows from north to south traversing the island of Borneo to the mouth of Java Sea better known as Muara Banjar or Kuala Banjar (Figure 1). It is the most important river not only for Central Kalimantan but most especially, also for South Kalimantan Province (Figure 2) as the River in particular, services the province's requirements for transportation, recreation, livelihood, and

Figure 2. Barito River providing livelihood services to South Kalimantan Province

The several types of fish and shrimps that are of high economic value from the upstream to the estuary zone (downstream) in the course and flow of Barito River, include among others: *Macrobrachium rosenbergii*, *Pangasius djambal*, *Hemibagrus nemurus*, *Phalacronotus micronemus*, and various types of species from the Cyprinidae family such as *Thynnichthys*

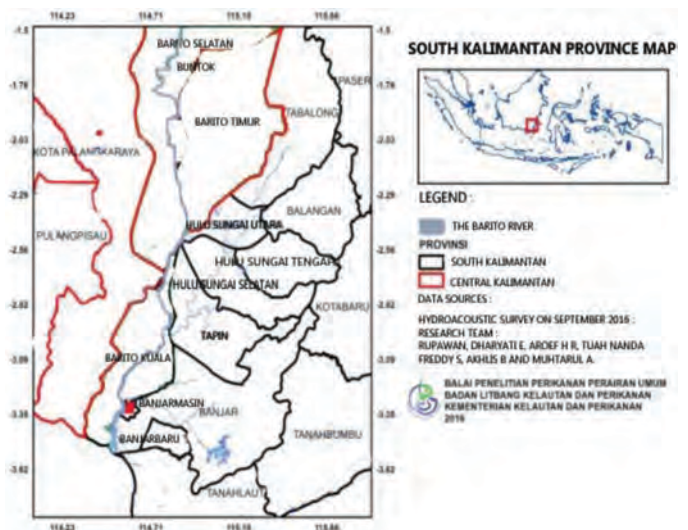


Figure 1. Map of Indonesia (left) showing the provinces of Kalimantan and Barito River (right) that flows through Central Kalimantan to Java Sea

*thynnoides*, *Osteochilus schlegelii*, *Puntioplites falcifer*, and *Puntioplites bulu* (Rais & Wulandari, 2020).

Known for its rich tropical waters, Indonesia hosts multi-species inland fishery resources, but each species has been reported to have relatively few individuals left as results from the unsustainable use of various types of fishing gear, of which the types and their methods of catching, as well as the catch follow the nature of life and the fishing areas (Genisa, 1998). Each type of fishing gear generally has their particular catch and productivity target species, so that every kind of fishing equipment is not the same because it is strongly related to the type of fishing gear and the fishing methods used, and abundance of the target fish stocks (Kolding & Zwieten, 2014).

Most of the fishers appear to be less conscious of the modern capture fisheries techniques that are dovetailed towards sustainability. Considering that even nowadays, the fishers still continue to make use of traditional gear and craft, there is a need to promote useful initiative to establish suitable fisheries management policies gearing towards sustainable inland capture fisheries. This paper attempts to convey the state of small-scale fishers, their fishing operations, and income derived from the services provided by Barito River of Indonesia. By knowing the status of the River's fisheries, we could be assured that the fishery resources in Barito River could still continue to provide livelihoods to the poor fishers' communities in the area, and also lend suggestions to decision-makers for them to come up with the appropriate measures for improving the socio-economic well-being of the fishers' communities.

## Fisheries Data Collection

With respondents who mainly come from the fishers' communities of Barito River in Kalimantan, Indonesia, primary data were collected through direct survey and interview of 25 fishers, while secondary data were obtained from related institutional reports and results of previous studies (Figure 3). The field surveys were conducted four times in a year from 2014 to 2016, to be able to obtain

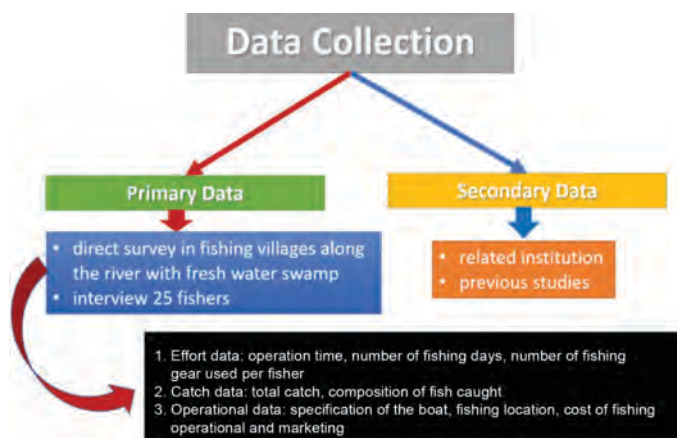


Figure 3. Fisheries data collection scheme adopted

representative data during the dry and wet seasons, as well as during the periods prior to the wet and the dry seasons. There are no fish landing sites along the River, so the fishers use their homes to transit their catch prior to selling this to markets or selling the catch to middlemen or for processing.

Based on the sample fishers and middlemen, designated enumerators collect the data that include the amount of fish caught every fishing operation and kind of fishing-gears used, and so on. Specifically, the primary data collected include: (1) Effort Data: operation time, number of days spent to catch fish, number of fishing gears used per fisher; (2) Catch Data: total catch, species composition of fish caught; and (3) Operational Data: specification of the boat, fishing location, operational costs incurred in fishing, and marketing.

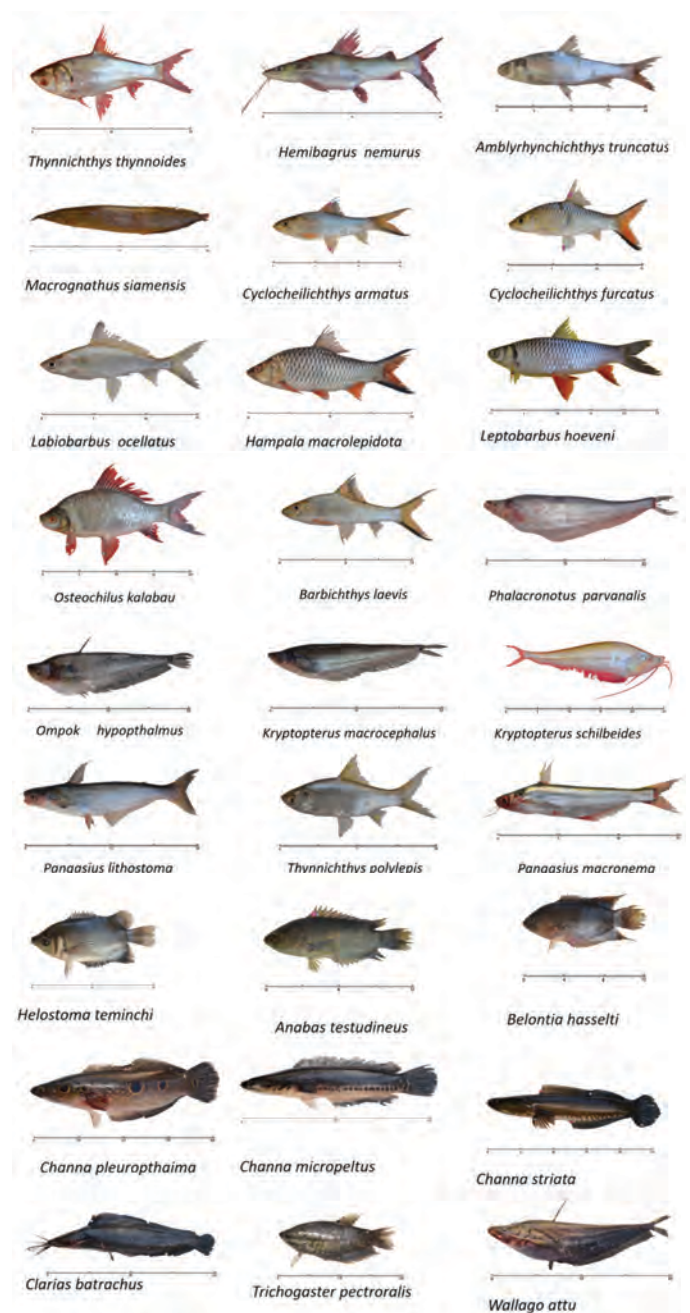


Figure 4. Some of the most economically important fishes that inhabit the Barito River of Indonesia



## Fishery Resources Biodiversity

Results of the survey suggested that Barito River still has diverse fishery resources. The fish caught during the surveys comprised 103 species (6,555 individuals) belonging to 42 families, some of which are economically important fishes (**Figure 4**). The Asian redbtail catfish (*Hemibagrus nemurus*) has been observed to be the most abundant species caught in the Barito River, especially in the flood plains comprising approximately 15-20 % of the total production (Rupawan & Rais, 2016; Rais & Wulandari, 2020), and is caught by the commonly used fishing gear in Barito River, *i.e.* traps with bait, and lines.

## Fishing Practices

Barito River has been playing an essential role in the country's inland capture fisheries, providing the source of income and animal protein, and contributing significantly to the livelihoods of people in the River's surrounding areas, especially the small-scale fishers (Béné & Friend, 2009). Fishing operations in Barito River are conducted the whole year round, using small boats that are motorized or non-motorized such as canoes (**Figure 5**) and traditional fishing gears. In some areas that get water flowing from Barito River such as Hulu Sungai

Utara (HSU) that consists of 65 % flood plains, the people are able to use boats as their main mode of transportation while doing their daily activities (Dinas Perikanan HSU, 2015). Moreover, the activities in Barito River focused not only on capture fisheries but also on aquaculture in floating cages as well as post-harvest practices such as drying and salting the fish catch.

As observed during the survey, four groups of fishing gears (**Figure 6**) are being used by fishers in Barito River, *i.e.*, hook and longline, pot traps, trap nets, and gillnet (Rais *et al.*, 2018). Fishing gear is the main tool used to exploit the potentials of the fishery resources for food and animal protein needs, and to support the economy, especially that of the inland fishers' communities (Koeshendrajana & Oscar, 2001; Beard *et al.*, 2011).

Rupawan *et al.* (2016) reported that 31 types of fishing gears are being operated by fishers from the upstream to downstream zones of Barito River. Nonetheless, the fishing gear utilization and distribution had always been changing following the hydrology situation, the fish distribution pattern that is adequately related to the topography and deeps of Barito River (Bhattacharjee & Bhaskar, 2017). Fishing gear utilization seems to increase during the dry season when the water level is



Figure 5. Small-scale boats, motorized or non-motorized used for fishing activities in Barito River





Gill Nets

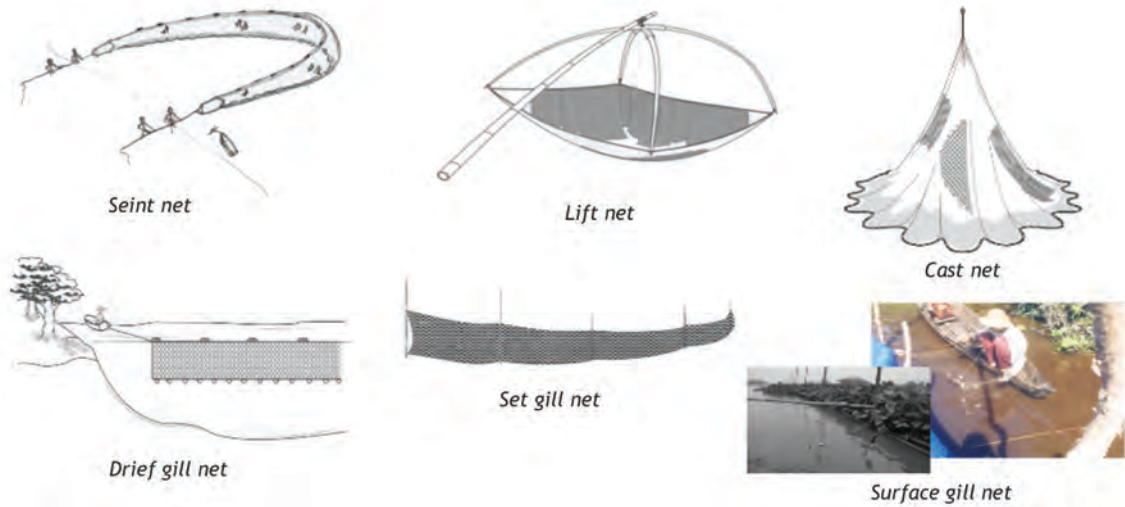


Figure 6. Groups of fishing gears operated in Barito River, Indonesia (Cont'd)

low, because the fish biomass will be flowed towards the areas with low water level or deep waters gathering into narrow areas or refuges, making the process of fishing operations efficient (Muthmainnah & Gaffar, 2017).

In some ecosystems however, particularly in flood plains with intensive fishing activities, fish production does not fluctuate following the conditions of the water level so that

production is steady for the whole year. The differences and variety of fishing gears used are the crucial factors that affect the amount of fish catch. The fishers become adaptive of the water fluctuations and target fish species by changing the type and selectivity of their fishing gears (Weiperth *et al.*, 2014).

Figure 7 shows the composition of fish caught by certain fishing gears operated in inland waters that are designed to

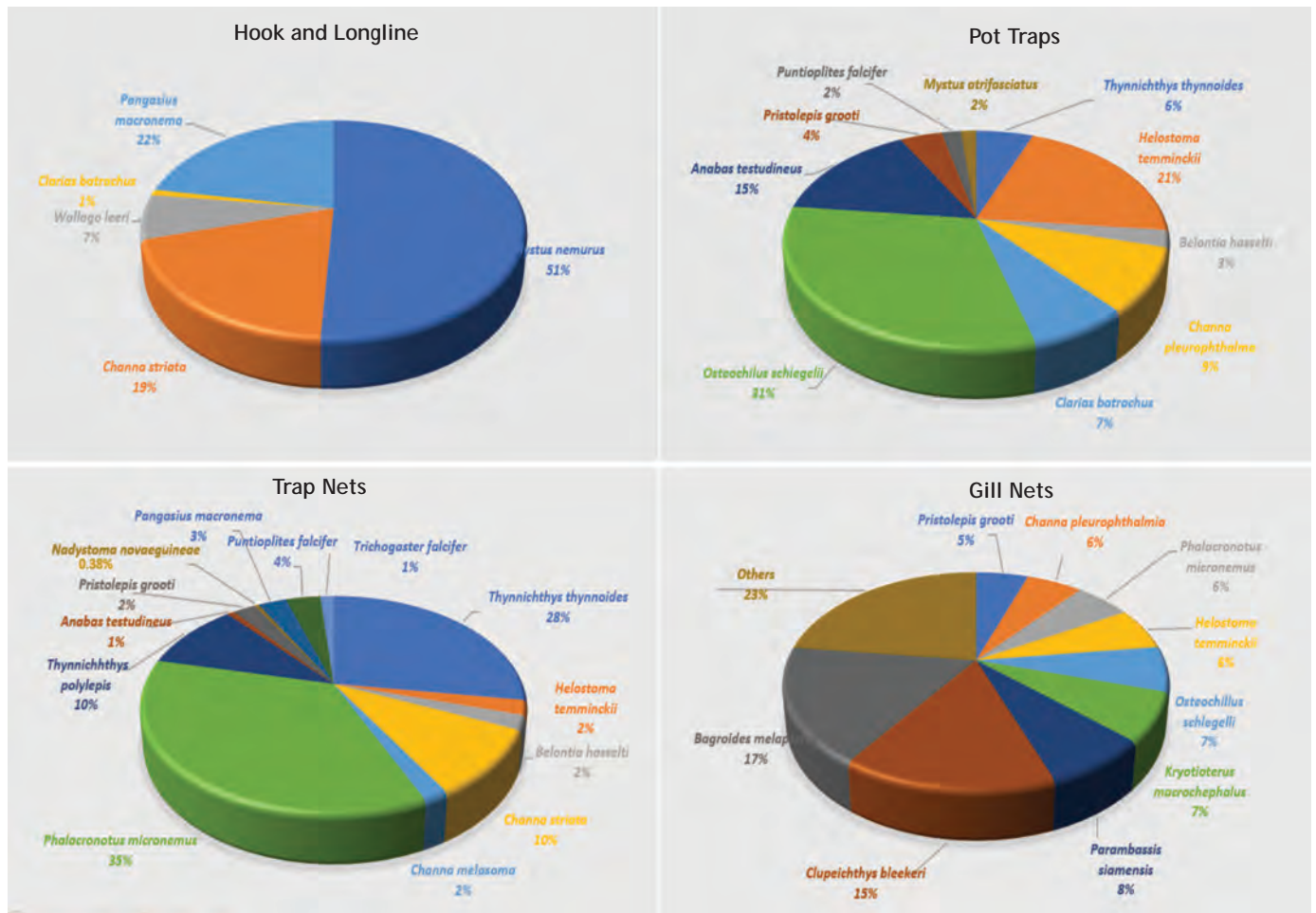


Figure 7. Composition of fish caught by types of fishing gears

be selective to the type of water ecosystem, *i.e.*, streams, flood plains or swamps, rivers, and bodies of steady waters (*e.g.* lakes, reservoirs). Some fishing gears, such as *jabak* and *lukah* that are classified as pot traps for catching specific target fishes, have also been modified to catch other specific fishes, *i.e.* baung or Asian red tail catfish (*Hemibagrus nemurus*).

Gill nets, such as *lalangit* (surface water gill net) had also been modified to be used for catching the labyrinth fish groups, *i.e.* climbing perch (*Anabas testudineus*), snakeskin gourami (*Trichopodus pectoralis*), and kissing gourami (*Helostoma temminckii*). Unfortunately, unselective, destructive, and illegal fishing methods, *e.g.* the use of poison and electricity, are still being practiced in Barito River.

### Traditional Fishing Gear: Beje

A pond trap, “beje” (**Figure 8A**) is a pool constructed adjacent to rivers, inlets, and lakes, and meant to capture fish, and had been used by the “Dayak” tribe, the largest tribe in Central Kalimantan and South Kalimantan Provinces. The design of this fishing gear is only found in the Kalimantan River Basin. “Beje” is rectangular in shape and usually measures 10-30 m in length, 5-10 m in width, and 1.5-2.0 m deep (Rupawan, 2006).

In the rainy season (October-April), the “beje” becomes filled with water that flows in from the adjacent rivers, inlets, and lakes. Simultaneously, the fishes would move into the “beje” from the primordial waters. When dry season (May-September) comes and the water level recedes, then “beje” is separated from the adjacent waters, and where the fishes from the primordial waters are left in the pool. The fish can therefore be harvested from or bred in the “beje,” which the fishers had covered with branches and twigs to attract the fish to come into the pool and also to serve as shelters for the fish in the pool. Most “beje” are connected to small canals

that serve as conduit for the fish to go into the “beje pool.” The dimension of the canal is 1.0 m wide, 0.5 m deep, and 20-50 m long (**Figure 8B**). The “beje pool” and canal have soil embankments on one side to keep the water and prevent the fish from escaping into adjacent waters.

Harvesting fish from “beje” makes use of a specific kind of tool called “rempa net” (**Figure 8C**), which is rectangular in shape and made of polyethylene nylon with 1.5-2.5 cm mesh size in the stretch. Before harvesting fish from the “beje pool,” fishers remove the branches and twigs from the pool, and put the “rempa net” on the surface of the pool. The edges of the “rempa net” are fixed to the side slopes of the “beje pool” using pegs. Once the “rempa net” is fixed, fishers sink the center of “rempa net” towards the bottom of the “beje pool” by loading soil onto the net. The fishes in the “beje pool,” especially the blackfish (swamp fish), will rise to the surface between the edges of “rempa net” and the “beje pool” to breathe. Some of the fishes would jump into the “rempa net” and get easily caught by the fishers. Harvesting of fish from the “beje pool” usually takes 2-6 hours, depending on the fish abundance, and is done only once a year, which is during the dry season.

### Fishers’ Income and Other Information

Data and information on operation time, total catch, and selectivity of fishing gears for one-year were obtained through the survey that interviewed 25 fishers in Barito River. In addition, the information on total gross income per fisher per month by fishing gears (**Table 1**) was also collected. Fish resources utilization in Barito River could be categorized as small-scale fisheries, and the average fisher’s family income of USD 4.27/day seems to be slightly below the Indonesian welfare standard (**Table 2**). Nevertheless, inland fishing in Barito River has in any way, been widely practiced and contributed meaningfully to people’s livelihoods, especially for the small-scale fishers.

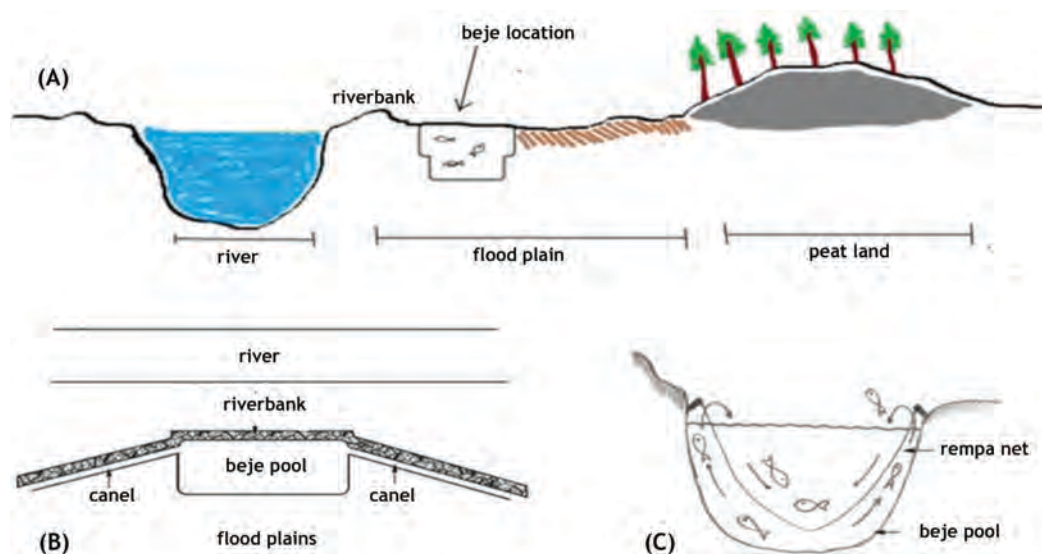


Figure 8. Proper location for constructing “beje” (adjacent to a river) (A), design of “beje” (B), and harvesting fish from the “beje” using “rempa” net (C)

Table 1. Operation time, catch and selectivity of fishing gears used in Barito River in one-year

No.	Fishing Gears	Fishers (person)	Operation time (hours)	Total Catch (kg)	Amount of Fishing Gear (unit)	Total Gross Income/ Fisher/Month (USD)	Selectivity
1.	Hook & Longline	6	580	2,314.50	1,380	44.19	<i>Hemibagrus nemurus</i> ; <i>Pangasius macronema</i> ; <i>Channa striata</i>
2.	Pot Traps	7	792	6,488.20	319	88.50	<i>Osteochilus schiegellii</i> ; <i>Helostoma temminckii</i> ; <i>Anabas testudineus</i>
3.	Trap Nets	7	794	20,003.00	16	238.07	<i>Phalacrotonotus micronemus</i> ; <i>Hemibagrus nemurus</i> ; <i>Thynnichthys polylepis</i>
4.	Gill Nets	5	266	3,109.00	51	45.09	<i>Pangasius macronema</i> ; <i>Phalacrotonotus micronemus</i> ; <i>Thynnichthys polylepis</i> ; <i>Hemibagrus nemurus</i>

USD 1 = IDR 13,204 (December 2016)

Table 2. Total net income per fisher per day

Expenditure Cost (USD/month/fisher)	
Boat cost	4.88
Fishing gear cost	5.31
Fuel	10.34
Bait	2.12
<b>Total</b>	<b>22.65</b>
Net Income (USD/month/fisher) = Total gross income - total expenditure cost	
Hook and ines	89.65
Pot Traps	110.93
Trap Nets	215.41
Gill Nets	96.91
<b>Total net income/fisher/day = USD 4.27</b>	

USD 1 = IDR 13,204 (December 2016)

From the survey, it was found that the landless fishers mainly depend on fishing for their livelihoods, but are living below the poverty line. Meanwhile, fishers with agricultural lands and aquaculture ventures are much better in terms of their socio-economic conditions, which seems attainable when the fishers have alternative livelihoods and not dependent only in fishing.

In general, poverty leads the fishers to have limited access to utilize the fishery resources, especially that they do not have sufficient catching ability to produce fish because of insufficient capital to purchase the necessary fishing gear. In many cases, their catch is directly sold to middlemen who had lent them money before they could catch any fish. The respondents also suggested that the Government could support the fishers by providing them fishing gears and disseminating the necessary information on catch management, and to certain extent granting the fisheries capital or seed funds. A

sustainability system should also be developed and promoted around the fishing areas, to include alternative activities such as aquaculture and agriculture. This way, the fish stocks in the River could be allowed to recover and increase through natural recruitment or by culture-based fisheries, as pressure from fishing would be diminished.

Furthermore, the respondents also considered it necessary for the Government to empower the fishing communities, including the men and women members, to enable them to participate in the community activities as well as in the decision-making processes. The fishing communities could play the active role of advocating to the fishers the need to restore, conserve, protect, and co-manage the fishery resources. Moreover, it is also necessary to strengthen the governmental fisheries agencies, e.g. Fisheries Department, as they are tasked to take the leading role in improving the fishers' welfare, sustaining fishing community training centers where sustainable fishing practices could be promoted, and supporting community fisheries organizations.

## Way Forward

From the results of the survey, it is clear that the socio-economic condition of fishers living in areas surrounding Barito River is not satisfactory. Most of the fishers appear to be less conscious of the modern capture fisheries techniques and practices as they continue to catch fish using traditional gear and craft. It is expected that the findings of this study would help the policymakers in taking the initiative to establish suitable fisheries management policies for the benefit of the fishers as well as that of the fishery resources in Barito River. The key messages about the sustainability of small-scale fisheries and the future of the fishers, as recommended by the respondents should be given attention by the Government agencies and the policy makers for the improvement of the socio-economic condition of the fishers and the sustainability of the fishery resources in Barito River.



## Acknowledgement

This study received funding support from the Ministry of Marine Affairs and Fisheries of the Republic of Indonesia through the Research Institute for Inland Fisheries and Extension, and SEAFDEC/IFRDMD under the project *Promotion of responsible utilization of inland fisheries in Southeast Asia* (2015-2019), of which the authors are most grateful. The authors also acknowledge the assistance of *Ms. Emmy Dharyati* and *Mr. Rupawan*, former Researchers of the Research Institute for Inland Fisheries and Extension; *Dr. Satoshi Honda* (former Deputy Chief of IFRDMD (2015-2017)); and *Dr. Safran Makmur* (Researcher of IFRDMD) during the field study. The authors also thank the Assistant Researchers for their help during the field survey and the Laboratory Assistants for the analysis of the data.

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