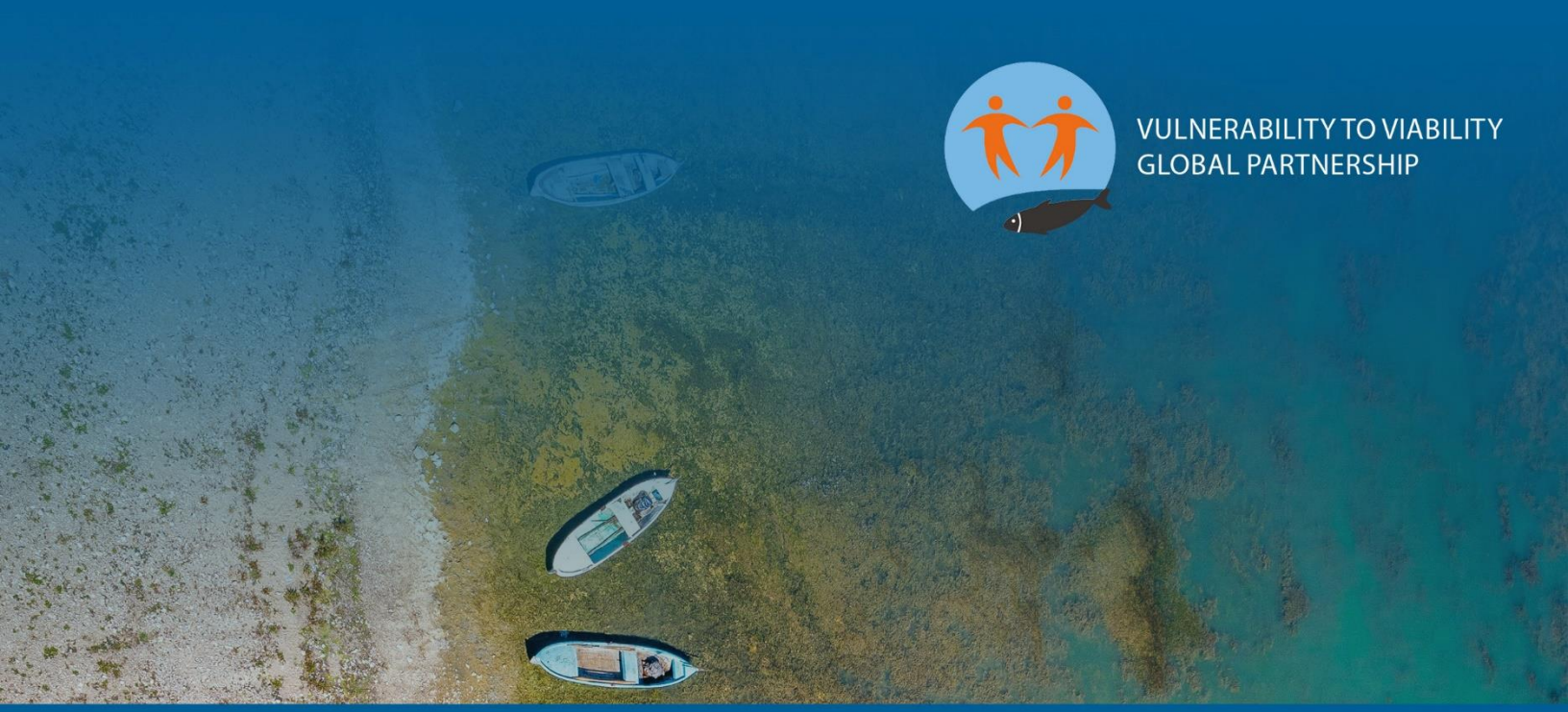

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A Situational Analysis of Small-Scale Inland Open Water Fisheries in India: From Vulnerability to Viability

V2V Working Paper 2022-8

Basanta Kumar Das, Pranaya Kumar Parida, Piyashi DebRoy, Aparna Roy

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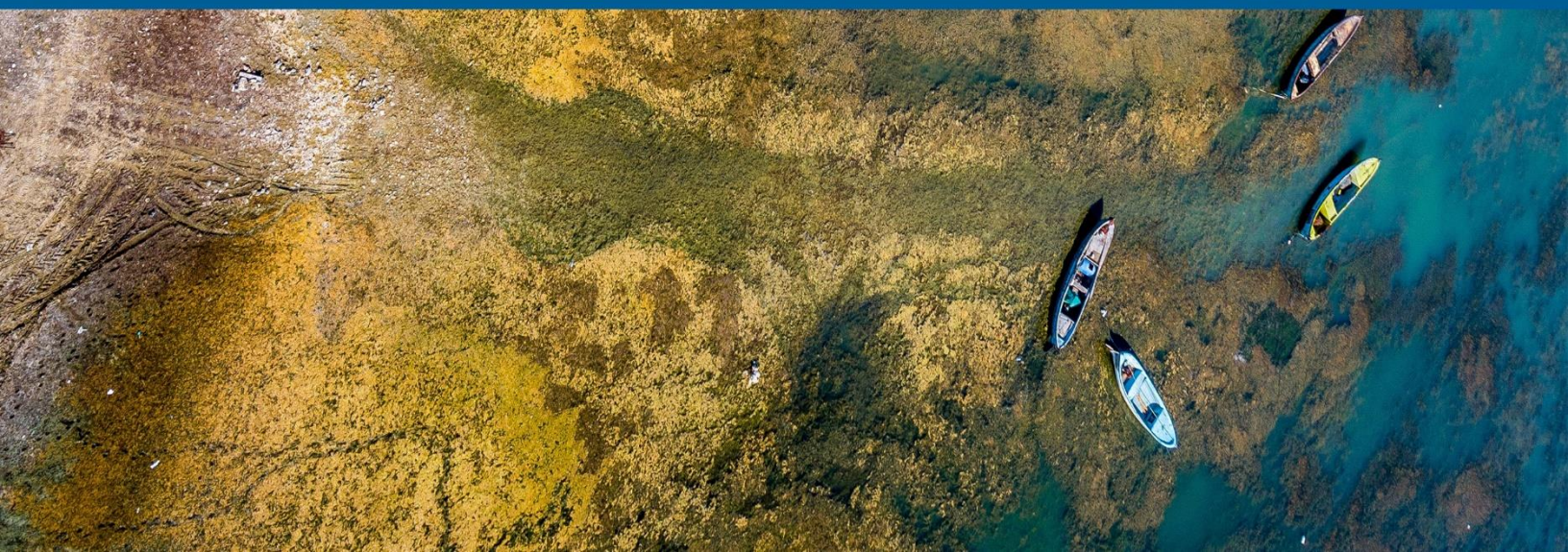

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A V2V Situational Analysis of Small-Scale Fisheries

Small-scale fisheries (SSF) are an important economic resource, both at the local and global level; their depletion has ramifications on fundamental aspects of life, spanning from food security to society's wellbeing and culture. On the global scale, SSF provide food security and a source of livelihoods and income for more than 100 million people. The objective of the V2V Situational Analysis is to build a global perspective on key vulnerabilities and opportunities associated with SSF viability across six countries in Asia (Bangladesh, India, Indonesia, Japan, Malaysia, Thailand) and in six countries in Africa (Ghana, Malawi, Nigeria, Senegal, South Africa, Tanzania). Each country-level situational analysis identifies the key social-ecological drivers of change, emerging issues and challenges confronting SSF, and important policy and governance concerns.

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A Situational Analysis of Small-Scale Inland Open Water Fisheries in India: From Vulnerability to Viability

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1. Introduction

Extracting fish or other aquatic organisms from inland waters is practised in inland fisheries. In India, this practice produces more than 8.4 million tonnes of fish, which significantly contributes to the livelihoods of 23.12 million inland fishers in the country (Department of Fisheries, Government of India, 2020). Inland capture fisheries are dynamic in nature in the way that inland fisheries are an important source of protein and nutritional security while also providing a source of income and to millions of rural households in India. India is bestowed with diverse inland fisheries resources that are distinctively different from their marine counterpart. A wide range of drivers often influence inland fisheries, and the inland open water fisheries sector is largely small-scale in nature.

In general, Small-scale fisheries (SSF) in India are defined as traditional fisheries involving fishing households for mainly domestic consumption in a particular state or region. SSF use relatively small amount of capital and energy, relatively small fishing vessels and only make short fishing trips close to the shore (Matthew n.d.). A major share (81%) of Indian fisheries is composed of SSF, which plays a pivotal role in providing employment, income, food and nutritional security to a vast majority of the population. The inland open water fisheries sector in India which includes culture-based fisheries, natural stocking and harvesting, enclosure culture (cage and pen culture) and capture fisheries, is generally small scale in nature and itprovides a sustainable means to nutrition, food security, poverty alleviation and trade. Other ancillary activities such as net-making, boatbuilding, engine repair and maintenance, also provide additional employment opportunities, with a direct relation to food and livelihood security of backward and marginal fishing communities. SSF cater to the livelihood of over 20 million people in the country. The participation of women in fisheries in India is very pronounced, with their participation in the workforce reaching 56% (Department of Fisheries, Government of India, 2020) .

Fisheries in India are categorized into marine fisheries including island fisheries and mariculture; inland fisheries including riverine fisheries, reservoir fisheries, lake fisheries, wetland fisheries, estuarine fisheries, cold water fisheries, ornamental fisheries and recreational fisheries; freshwater aquaculture; brackish water aquaculture; and the post-harvest sector. SSF in each of these categorized sectors assumes its characteristics depending on the place and context. Such characteristics are not distinctly compartmentalized but are thinly intertwined based on which resource use patterns, trade-offs and governance strategies for fisheries management in each system are defined. SSF in India is characterized by a huge diversity of fishes and fishing practices (Jena & George, 2018). Indian Major carps (catla, rohu and mrigal), exotic carps (common

carp, grass carp and silver carp), minor carps and small indigenous fishes (SIFs) dominate the inland SSF scenario.

Indian Council of Agricultural Research (ICAR) – Central Inland Fisheries Research Institute (CIFRI) mandates its vision to conduct research and developmental activities in the fisheries sector in India's inland waters. India has vast inland open water resources, comprising of 45,000 km of rivers, 0.3 million ha estuaries, 0.19 million ha backwaters and lagoons, 3.52 million ha reservoirs, 0.35 million ha floodplain wetlands and 0.72 million ha upland lakes (ICAR-CIFRI, 2020). Fish production from inland open waters in India is 8.9 mmt (2018-19) which contributes significantly to India's fish production through capture fisheries, culture-based fisheries, pen culture and cage culture. Inland open water resources also provide employment and livelihood support to 1.24 million inland fishers.

ICAR-CIFRI is an institutional testimony to the historical development of inland fisheries in India. The Institute, which was established on 17th March 1947 is of the pre-independence era of India. ICAR-CIFRI has been instrumental in supporting the backbone of SSF in India since the pre-independence time. The ICAR-CIFRI is the mother institute of present ICAR – Central Institute of Freswater Aquaculture (CIFA) at Odisha, ICAR – Directorate of Coldwater Fisheries Research (DCFR) at Uttarakhand and ICAR – Central Institute of Brackishwater Aquaculture (CIBA) at Tamil Nadu. It has contributed to landmark fisheries achievements including the development of induced breeding of Indian major carps (1957-58). The technology of induced breeding of Indian major carps has been developed by the Scientists of ICAR-CIFRI, which was subsequently disseminated to the whole country. This was a remarkable milestone in the annals of Indian fisheries, which created a revolution in aquaculture and subsequently the country witnessed blue revolution during early 1970s, increasing fisheries production manifold in the country in the future. During this decade, the technology of composite fish culture in the country was also developed by CIFRI. In fact, to commemorate the achievements in the field of inland fisheries, the then P and T Department (presently the Department of Posts, Ministry of Communications), Government of India released a special postage stamp of 5 paise denomination on 26th November 1979. Again, pathbreaking achievements in artificial fecundation of hilsa (*Hilsa ilisha*) fish were obtained. The other fish species where induced breeding were achieved for the first time was mullet (*Mugil cepahlus*), silver carp (*Hypophthalmicthys molitrix*), grass carp (*Ctenopharyngodon idella*), trout (*Schizothorax niger*) and tiger shrimp (*Penaeus monodon*).

In inland open water fisheries, fishers are dependent on aquatic resources for livelihood, nutritional security, domestic life and transport. Many water bodies are also being harnessed by governments and industrialists for energy generation (hydro-electricity and existence of thermal power plants besides water bodies), small and minor industries, and for tourism. Following the Millennium Ecosystems Assessment (MA 2005) approach, inland open water fisheries in the country contribute to provisioning (livelihood), regulating (water quality, carbon sink, climate mitigation) and cultural services (celebration of traditional water-based festivals and aqua-tourism initiatives) of the ecosystem to its stakeholders. The Millenium Ecosystems Assessment provides an integrated assessment of the consequences of ecosystem change for human well-being and to analyze options available to enhance the conservation of ecosystems and their contributions to meeting human needs. This approach links ecosystem services and determinants and constituents of well-being. Ecosystem services include products such as food, fuel and fibre; regulating services such as climate regulation and disease control; supporting services such as soil formation and nutrient cycling; and nonmaterial benefits such as spiritual or aesthetic benefits.

The economic benefits provided by inland fisheries to its fishers varies from state to state depending on the aquatic ecosystem. However, the most common, characteristic of inland open water fisheries is that it is conducted on a subsistence scale, which upholds the household nutritional security of the fishers.

In the wetlands of West Bengal and Assam states in eastern India, fishing is conducted throughout the year where a very high fish-eating population of the country is present. Most inland fishers are dependent on more than fishing to support themselves, earning income from secondary and even tertiary sources of occupation. They mostly engage themselves in farming and work as daily wage labourer when they are not fishing. However, fishers have low level of education and small operational holdings of units of land available for any sort of farming activities, which hinder their ability to maximise income. The monthly income of inland fishers is also low ranging from ₹ 2,500 to ₹ 10,000. Along the value chain also exist women fishers involved in fishing, post-harvest, fish trade, and ancillary activities;co-operative societies, auctioneers; wholesalers; and retailers who facilitate trade and marketing.

Governance regimes are through co-operative (reservoirs and wetlands) and community-based management (rivers) governed by state fisheries acts since fisheries is a state subject. The Indian Fisheries Act of 1897 was largely cited for inland fisheries regulation in the country, but it has been repealed in 2015. The Draft National Fisheries Policy of India is in place now which aims at inclusive development of the inland fisheries sector. Participation of the private sector within the existing regulatory framework and guidelines has been emphasized in the new policy.

Issues confronting SSF of inland open waters of the country are habitat degradation, institutional management, leasing policies (DebRoy et al., 2021), gender equity issues, difficulty in the proper implementation of schemes and programmes due to political issues, migration (Nayak, 2017; Roy et al., 2015), resource-use trade-offs, climate change and stakeholder conflicts (Roy et. al., 2018).

Jena and George (2018) have pointed that improvement in SSF in inland open waters requires the establishment of strong policy-based governance reforms including strengthening of credit systems, responsible management practices, enhancing income, providing opportunities for additional livelihoods, increasing consultation and participation in decision-making and empowering women to leadership and decision-making roles.

Gender equity is a core issue in SSF in India. Keeping into consideration the increasing participation of women in the sector, ICAR-CIFRI undertook multiple initiatives to include a gender perspective in its research and extension activities. It was revealed from a study in the Hoogly estuary that overall, 62% of fisher-women community had a medium level of participation in various fisheries and income generating activities. On the other hand, 16% of women had a high level of participation while the rest (22%) had a low level of participation in inland fisheries activities (Roy & Bhaumik, 2012). Rural livelihoods integrally connected with seasonality (Roy et al., 2017) Spawn collection, fishing and fish drying is a seasonal activity: for this reason, women living in rural Sundarbans are also involved in other income generating activities like planting of the crop (56% of women are fully involved), rearing animals (42% fully involved), livestock selling, crop processing, hired casual labour, selling cooked food, serving and knitting (Roy et al., 2015). Women in inland fishing communities take on households tasks like cooking, childcare, and family health independently. However, they consult their husband or others in case of income generating activities (Roy & Bhaumik, 2013).

Migration is another relevant issue in SSF. Decline in small-scale riverine fishery is the major reason of migration to other jobs in the rest of India. During spawn collection activities, the fish seeds of other important species are often destroyed which leads to loss of biodiversity in the natural waters as well as decline in catch. Hilsa is a prized fish in eastern India, specially West Bengal state. Like Bangladesh, this fish also has socio-cultural importance in West Bengal state. Large number of fishing boats operating in the northern Bay of Bengal, resulting in overexploitation of the fish biodiversity and hilsa population as well. Due to use of small mesh-size nets, haul of juveniles are caught indicriminantly, which are detrimental

to fish stock.Catching of hilsa juveniles significantly contributes to the decline of adult hilsa production; as a result, the livelihood of the associated fishers is threatened, and the younger generation of the fishermen community has lost their interest in fishery particularly from hilsa fishery due to uncertain income(Roy & Manna, 2015) and migrating to urban other areas in search of jobs.

Finally, stakeholder's conflict further hinders the operations of SSF in India. In the case of wetland fisheries conflict with the agricultural sector is very common. Water use conflict between fisheries and dry season agriculture; water use conflict between fisheries and summer rice (boro) cultivation and water uses for jute retting and wetland fisheries are the major reasons of conflicts (Roy et al., 2018).

2. Meaning and status of small-scale inland fisheries

2.1 Small-scale inland fisheries contribution to India

The SSF sector has immense importance in the socio-economic development of the country, primarily because it is the source of livelihood for around 28 million people employed in different areas of the industry (fishers, fish farmers, fish workers, vendor at the primary level and across the value chain (Handbook of fisheries statistics, 2020)). Inland fish production in the year 2019-20 is 10.43 MMT that is 5.84% of world fish production, i.e., 178.5 MMT. About 2.31.17, 820 people are involved in inland fisheries out of which 43.7% are women (Handbook of fisheries statistics, 2020). Table 1 presents the monthly average household income of inland fishers of India.

Table 1

Monthly Average Household Income of Inland Fishers of India

Inland Fisheries Resource	Income (₹)
Wetlands	9,500 (average monthly income of fishers of Katiganga and Bishnupur wetlands in Murshidabad district in West Bengal, source: ICAR-CIFRI Annual Report 2018-19)
Reservoirs	6,500 (average monthly income of fishers of Derjang reservoir, Odisha); 9,000 (Patratu reservoir, Jharkhand, source: ICAR-CIFRI Annual Report 2018-19)
Rivers	2,610 (Katiha et al., 2017)

Inland fisheries play an important role in the social and cultural aspects of the communities. ICAR-CIFRI looked into the socio-cultural system of various fishing communities across India and documented Indigenous Technical Knowledge (ITKs) used by these communities. Rabhas are primitive tribe and are very close to nature. The socio-cultural perspective of the Rabha community revealed that SSF contributes significantly to the life of Rabha Tribes: socially, culturally and even economically. For example, as fishing activity is assimilated in their culture in the form of dance (Roy et al., 2018).

Fish is an integral component in marriage and other traditional customs in Bengali, Assamese and Manipuri communities of the country. Traditional dishes from these cultures suggest a deep connection between these communities and their local fish, with the majority of Bengali eating for almost all their meals.

In Indian mythology, whenever the universe was turmoil, Lord Visnu has taken incarnation as 'Avatara' and 'Matsya' (Fish) was the first among the ten major Avatar's of Lord Vishnu, who saved the first man 'Manu'. Fish and fisheries are a part of history and tradition in India, especially eastern and southern India(Hora,1951). In various tales, Potery; 'Kavya' we get the mention of open water fisheries. We also get the name and cooking style of various types of fishes, for example, 'Manasa Mangal Kabya'.

The historical importance of inland SSF would be incomplete without mentioning hilsa fisheries in India. Hilsa fisheries form a very important component of the inland fisheries sector in the Eastern and North-eastern regions of India especially with Bengali and Assamese population of the country. The hilsa fish is considered a delicacy in meals consumed mainly in special occasions, festivals and customary traditions. It is also an expensive fish where the price may soar upto ₹ 2,000 per kg which is five times more than Indian Major Carps at present times. For this reason, many efforts have been directed by CIFRI to supporting hilsa fishing. After the first artificial fecundation of hilsa in 1970s, it was successfully bred during 1990s after confirming upstream migration of hilsa across Farakka barrage. Hilsa ranching has been undertaking since then to restock the depleted stretches of river Ganga. However, wanton destruction of hilsa juveniles through indiscriminate exploitation with small, meshed nets was observed starting from 1990s. The socio-economics and livelihood of hilsa fishers has been in the limelight of researchers and policy-makers since then.

The technology of pen culture developed by ICAR-CIFRI has been an epoch-making technology in SSF in India. The word 'pen' stands for small artificial enclosure for animals; in this case, it relates to fishes and prawns for aquaculture. Pens are required for raising juveniles to replenish fish stocks in large water bodies when culture operations are taken in the some restricted area of open water systems. Fish culture in pens has been experimented in Japan during the early 1920s (Sharma, 2012). In India, pen culture has been experimented in an oxbow lake in Bihar (Banerjee & Pandey, 1978), Beels in Assam (Yadava et al., 1983) and swampy tank at Bhavanisagar in Tamil Nadu (Abraham, 1980) for raising carp seed. Similarly, since 1982, carp spawn produced in excess than the capacity of fish farm at Tungabhadra dam is cultured in pens erected in a protected bay area of the reservoir (Swaminathan & Singit, 1982). In the year 1996 there were innovations in pen culture technology by the CIFRI which is suitable for large-scale adoption in the wetlands of West Bengal (Sinha, 1996). At that time the pen was constructed by split bamboos which are woven together with coir ropes. The mats were erected in the wetlands and they were covered with close meshed nylon cloth. CIFRI has also developed a low-cost and simple technology for fish culture in pens erected in reservoir margins. From 2003 bamboo screen was prepared by weaving split bamboo (4-6 mm in thickness) with coir or HDPE thread, leaving a narrow space between splits for water exchange. To prevent the possible escape of fry, a fine meshed and cheap HDPE net was stitched with the bamboo screen. The materials used for the pen construction are: fencing screen of HDPE of width 1.83 m with mesh size of 5 mm; PVC poles of length 3 m; nylon webbing of one foot width (mesh size: 5 mm); foot rope of 3 mm diameter and twine of 1 mm thickness (Alam et al., 2017).

2.2 Small-scale inland fisheries profile in India

In general, SSF in India is defined as traditional fisheries involving fishing households using relatively small amounts of capital and energy, relatively small fishing vessels, making short fishing trips, close to

shore and mainly for local consumption. The SSF definition that we have used in the context of SSF inland fisheries are defined as fisheries activities including fishing and small scale community-based aquaculture intended mainly for subsistence followed by small-scale trade and carried out in a scale of extensive and modified-extensive operations involving low level of inputs (seed stocking and feed in pen culture if applicable) in inland waters of the country that includes reservoirs, lakes, rivers, wetlands, estuaries, canals, derelict water bodies, watershed areas and community tanks, involving small groups of fishers who may be organized in the form of fisheries co-operatives, SHGs, FPOs or informal groups, sometimes integrated with governmental departments for technical and managerial support.

Table 2

Summary of small-scale inland fisheries profile in India

Terms used in SSF	Gear types/ target species	Vessel types[1]	Ecosystem types	Ecosystem detailed types
• Artisanal • Indigenous • Inland • Small boat • Small scale • Subsistence • Traditional	• Cast nets: catla (*Labeocatla*), rohu (*Labeo rohu*), mrigala (*Cirrhinusmrigala*), common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodonidella*), bata (*Labeobata*) • Gillnets: small indigenous fishes, e.g., mola (*Amblypharyngodon mola*), puntius etc. • Hooks and lines • Lift nets • Recreational fishing gears: mahseer • Seine nets • Surrounding nets • Traps: walking catfish/ magur (*Clariusbatrachus*), Asian stinging catfish/ singhi (*Heteropneustesfossilis*), murrels (*Channa striatus*, *Channa punctatus*)	• Canoe (dug-out canoes) • Wooden	• Marine • Freshwater • Brackish	• Estuary • Intertidal • Lagoon • Lake • Mangrove • Reservoirs • River • Wetlands

[1] Crew size: 2 to 5 persons per boat.

2.3 The relevant linkages between ecosystems and small-scale inland fisheries in India

India's freshwater resources consist of 1,95,210 km of rivers and canals, 3.54 million hectares of minor and major reservoirs, 2.4 million hectares of ponds and lakes and about 0.8 million hectares of flood plain lakes and derelict water bodies.

2.3.1 Riverine fisheries

The river system of the country comprises 14 major rivers, 44 medium rivers and innumerable small rivers and desert streams. Different river systems, with a combined length of 29,000 km, provide one of the richest fish genetic resources in the world. A large number of people is directly dependent on the rivers and estuaries for livelihood. The rivers and estuaries are the abode of precious fish germplasm, besides supporting huge biodiversity. The Indus, Brahmaputra, Ganga, Narmada, Tapti, Godavari, Krishna, Cauvery and Mahanadi are the major river systems of India. Multi-species, multi-gear fish assemblage in these rivers support the livelihood of the fishers. In case of Hooghly river,the contribution of the hilsa fishery in the family income of a fishermen's household is 38.84% yearly (Roy et al., 2016). The number of active fishers along the surveyed stations in the Cauvery river ranged from 35 to 372 and are mostly, either landless (59%) or small and marginal farmers. Average income from riverine fisheries has been estimated as ₹ 5,500 per month. So, riverine fisheries have an immense contribution tolivelihood and income generation of SSF fishers.

2.3.2 Canal fisheries

Canals are the second most important (26%) source of irrigation covering 17.0 mn ha in India. The total length of the canal is 1,26,334 km. These resources are often used for SSF, but the harvest from these canals isnot taken into account of inland fisheries production. No standard technology is available for canal fishery in the Indian context. Hence, ICAR-CIFRI has introduced viable management practices in select canals of Sundarbans with the objective to provide livelihood support to the rural populace.Conflict of interest between agriculture and fisheries is the major challenge in canal fisheries development,as most of the cases canal have been constructed for irrigation purpose. However, it can be encountered through the community mobilization process (Sinha et al., 2022).

2.3.3 Wetland fisheries

In India, the floodplain wetlands (locally known as *beel*, *baor*, *haor*, ox-bow, chaur), a depressed land mass, receive floodwater from the main river or from their catchment areas during the southwest monsoon season, and are a major source of SSF. These wetlands include typical ox-bow lakes (the river meanders), meander scroll depressions, back swamps, residual channels and tectonic depressions. These wetlands - mainly associated with the Ganga and Brahmaputra river basins cover an area of 3.40 lakh hectares and constitute important fishery resources in the states of Assam, West Bengal, Bihar, Manipur, Arunachal Pradesh, Tripura and Meghalaya. *Beel*s are highly productive aquatic ecosystems and provide breeding and nursery grounds for a number of aquatic organisms including commercially important fishes. In tandem with its surrounding agricultural lands, water and forests, these *beels* are one of the world's most important life support systemsfor many endangered species. They play a vital role in inland fish production of the eastern and north-eastern regions of the country through SSF. Wetland fisheries in India is linked to food and nutritional security in the following ways:

- Provide income to the community living in the adjoining areas through capture fisheries which also helps in meeting the food security;

- Generate livelihood assets for the fishers which improve socio-economics of the local populace;
- Women are collecting fishes through traditional traps for household consumptions which provides nutritional requirements.

2.3.4 Reservoir fisheries

Reservoirs are the man-made impoundments built across rivers or streams obstructing the surface flow, form an important source of fish production and are vital resources for supporting livelihood and provide several socio-cultural and ecological services. India has enormous reservoir resources. In the past several decades, India has made incredible developments in reservoir fisheries. The fish yield from Indian reservoirs has been enhanced through fingerling stocking and through the adoption of improved management practices. However, this increase in productivity is about one-third of the present production potential. Evidently, there is still enough scope for developing more efficient and sustainable strategies for enhancing the fish yield. Reservoirs and wetlands are the major resources where culture-based capture fisheries enhancement tools can boost production. This would increase the availability of animal protein throughout the country, benefitting the rural population, both in terms of poverty alleviation and of food security.

3. Social-ecological changes and key drivers of change in inland fisheries in India

Many factors contribute to the socio-ecological changes in SSF in India. We call these factors "drivers of change;" below, we review eight of them.

3.1 Climate change

Ecological changes in terms of the effect of climate change in inland fisheries have been already felt in India. In Asia, most of the problems observed in climate change relating to fisheries is that fishery resources are anthropogenically disturbed and vulnerable to climate change (FAO, 2011). Since the year 2011, scientists in the fishing and agricultural sectors are carrying out a national project on National Innovations on Climate Resilient Agriculture (NICRA) under the umbrella of Indian Council of Agricultural Research. It was found that in the inland fisheries systems, the onset period for the breeding of Indian Major Carps (rohu, catla and mrigal) was delayed by the late arrival of monsoon season (Das et al., 2019). This is affecting the carp production cycles and consequent harvest and seasonal demand from consumers. In addition, a decline in fish spawn availability in river Ganga has been documented. The Indian Major Carps are the fish with the highest domestic demand in the country for a majority of the freshwater fish-eating population.

ICAR-CIFRI initiated research on climate change from 2004 under ICAR network project on Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change in India and subsequently is continuing the research under the umbrella of National Innovations on Climate Resilient Agriculture. The research focuses on climate change on major river basins, impact of changing climate on gonadal maturation, breeding and spawn availability in inland open waters, assessment of thermal tolerance of species, carbon sequestration potential of wetlands and vulnerability assessment framework in the inland fisheries resources of the country (Das et al., 2019).

Climate change is evident in India from increased air temperatures, regional variation in monsoons, frequent occurrence of droughts and increase in severe storm incidences in coastal states of India. Das et al. (2013) reported that 0.99°C increase in the minimum water temperature was found in the upper stretch of river Ganga and 0.5°C to 1.4°C in the aquaculture farms of West Bengal. Geographic shifts of warm water species such as *Glossogobius giuris* and *Xenetodon cancila* have been recorded to colder stretches of river Ganga. The prey-predator relationship in the middle stretch of river Ganga has also declined drastically. The prevalence of IMC has decreased from 41.4% to 8.3% while that of miscellaneous and catfishes has increased (Vass et al., 2009). According to Das et al. (2013), there is a probability of 3% to 11% submergence of aquaculture areas in response to 1 to 2 meter rise in water level due to sea water incursions in South 24 Parganas district of West Bengal. ICAR-CIFRI research studies also show that five districts in West Bengal are highly vulnerable with low adaptive capacity of fishers while mapping the vulnerability of districts (Das et al., 2013).

3.2 Importance of small indigenous fish

Small Indigenous Fish (SIF) in inland fisheriesholds a pivotal role in nutritional security (Mohanty et al., 2016; Roy et al., 2020). SIF constitutes a major portion of the hidden harvest which is often unreported at small-scale inland fishers' households. There is also a growing demand from urban and peri-urban consumers in the inland sectors of the country for SIF in addition to carps and catfishes. This is mainly because people have become aware of the high nutritional benefits of SIFs. ICAR-CIFRI has developed a fish nutritional database called NutrifishIN where the nutritional profile of several SIFs have been analyzed and documented for further nutritional recommendation for the public according to medical standards. The fact that SIFs need to be conserved is not only necessary from the nutritional standpoint but also from the biodiversity point of view. Nevertheless, many species of SIFs are being endangered at present owing to habitat degradation, pollution, invasive species issues and anthropogenic pressures.

3.3 Occupation migration

Fisheries alone are not sufficient in sustaining the household incomes for their families at present times. The dependence on SSF as livelihoodis undergoing rapid change because many fishers are met with the incumbent need to seek more lucrative employment opportunities. The need for other sources of income is leading many fishers to opt for daily wage labours, seeking employment in urban areas. This is giving rise to the phenomenon of job migration, characterized by a widespread need of additional livelihood and livelihood diversification. A prominent example of this occurrence is young Sundarbans fishers migrating to urban and per-urban areas of West Bengal (Roy & Manna, 2015).

3.4 Changing food habits

The trend of value-added fishery product consumption in the form of fast food from fish fillets is increasing at an unprecedented rate. Indian youth is becoming increasingly more aware of the health benefits of fish protein consumption versus meat protein. With young Indians counting for 34% of the population (CSO, 2017) and with the widespread use of social networks to share this knowledge, fish consumption has spiked, changing the country's dietary preferences. A considerable share of these fish products are sourced from inland fish, such as pangas. All these factors have acted as drivers of increasing awareness about fish as

health food and its increasing demand. The increasing awareness about the health benefits of fish consumption in comparison to other protein sources such as meat is a direct driver for the increase in such demand. To meet the demand of the fastfood industry, the supply of fish has to be increased through culture-based fisheries intervention also in inland open water fisheries.

3.5 Formation of a new Ministry of Fisheries

A recent change that has taken place in the fisheries political arena of the country is the creation of a separate ministry for fisheries management which was carved out of the previous Ministry of Agriculture and Farmers' Welfare. The new ministry has been named as Ministry of Fisheries, Animal Husbandry and Dairying. This has promised newer initiatives for the all-round development of the fisheries sector of the country. Foreseeing the immense potential the Government of India, in its Union Budget 2019-2020, declared a new scheme, called the *Pradhanmantri Matsya Sampada Yojana*, which sanctioned a total estimated investment of ₹ 20,050 crores for five years hoping to harness fisheries potential in a sustainable, inclusive and equitable manner (DoF, 2020).

3.6 Adoption of FAO voluntary guidelines on SSF

Recently, a lot of concern for the wellbeing of SSFhas been spreading throughout the country. The extent of the adaptability of the FAO Voluntary Guidelines on Small Scale Fisheries in India is now being studied and the gaps are being addressed. The participatory process for fisheries co-management with co-operatives, SHGs, Fish Farmer Producer Organizations, NGOs, women entrepreneurs etc. needs to be strengthened by the State Departments of Fisheries by ensuring active involvement of the fishers and fishfarmers in the planning and implementation stage of welfare policies and schemes .

3.7 Political governance

A lot of attention regarding SSF management has been geared toward political governance. The adaptive capacity of institutions involved in governing inland fisheries resources have started taking advantage of the opportunities for bringing inland small scale fisheries to the forefront at policy levels.

3.8 Factors that influence inland fisheries sustainability

Demand is always the prime driver or main actor that playsa major role in regulating any type of activity. In the same way demand for food, nutrition and income is the driving force that influences the small scale inland fisheries in India (Table 3).

Table 3

Direct factors that influence inland fisheries sustainability

Factor	Contrivance	Consequence	Way out
		Natural Factors	
Climate change	Drought; shift in seasons(prolong dry spell/ erratic rainfall)flood and extreme climatic events	Decline in fish production; breeding failure; increased abundance, introduction invasive species, siltation etc	Man is still helpless in face of nature. Mitigation and adaptive strategies can be taken up like- Climate resilient net pen-culture in wetlands, changing in water extraction policies etc
		Human and Social Factors	
Demand	Demand for income Demand for food	Over-fishing Exploitation of open water resources Excessive fishing pressure	Demand is relative dependent on human population and which is not in control of the fisheries sector
Damming for Hydropower	Dammining for hydropower or for irrigation purpose	Interrupt the migration path ways of fishes present in the rivers, disrupt natural flow which alters the natural spawning ground of the fishes, siltation in riverine resources	Environmental flow studies
Industrial influence	Pollution due to industrial waste Water abstraction	Habitat degradation persuades loss of bio-diversity	Checkpoint for effluent discharge, control sewage discharge
Agricultural impact	Water abstraction Pesticide pollution Eutrophication	Less water available for fish; natural habitat destruction for fish and other aquatic organisms, extinction of many small indigenous fish species	Appropriate land-water use policy
Encroachment	Inland water resources often encroached by agricultural activities, human settlements and commercial activities	biodiversity loss, rapid aging extinction or invaluable resource	Appropriate land-water use policy
Lack of access and control over inland resources	Fisher's traditional resource use often not recognized by other users	Water used by other agencies, loss of biodiversity, habitat degradation, loss of income of the fishers	Legal acknowledgment of traditional property rights
		Governance and Management Factors	
Production enhancement	Introduction of alien species through stocking/ ranching	Increases production , but may cause genetic contamination , damage to existing fish stock	Follow the accepted guidelines for stocking and introduction of species
Unregulated fishing	Use of destructive fishing gears	Over-exploitation	Mesh-size regulation, fish sanctuary, regulation on destructive fishing gears

4. Emerging issues and challenges

4.1 Conflict in water use

Many groups are interested in the aquatic resources of wetlands and reservoirs. In the case of wetland, the water is mainly used for agricultural purposes. Lot of water abstraction from the wetlands affects the ground water recharge and also the water retention in the wetlands. Agriculture is the primary activity surrounding wetlands. Water is required for agriculture and it comes from either wetlands or from the ground through underground water pumps. Moreover, jute retting and other type of developmental activities often hampers fisheries development in the wetlands (Roy et al., 2022). Due to jute retting, less water intensive crops may be promoted in the surrounding area to curb against the overexploitation of wetland water.

Similarly, in the case of the reservoir, water is mainly used for drinking, irrigationor for hydroelectric purposes. The ownership of the reservoirs are with the irrigation department. The water is released from the dam as per the demand/requirement of agriculture. So the need of the fishers or the fisheries activities often neglected.

4.2 Siltation

Accumulation of silt is known as siltation. It has affected the water holding capacity of the rivers. The rainwater used to bring a lot of soil along with it from the catchment area to inland waterbodies due to deforestation in the catchment area. Siltation or sedimentation in wetlands, floodplains, rivers reduce the aquatic habitat which is now become a challenge to the small scale fishers.

4.3 Encroachment

The local encroachment mainly in the urban and peri-urban area has affected the water spread area of the inland water bodies. In the urban and peri-urban areas, urbanization has enhanced the encroachment process through increased real estate activity. The encroachment is affecting the livelihoods of the fishers; at the same time, more flash flood instances have been occurring in the rural and urban areas.

4.4 Loss of connectivity of wetlands with Parent River

River connectivity allowed wetlands to get natural fish seeds from its parent rivers, especially during monsoon season when open beels/seasonally open wetlands get connectivity with their parent rivers. Moreover, during monsoon, indigenous fishes breed and so, there is abundance of fish sed in the natural waterbodies during monsoon. Loss of connectivity of the flood plain wetlands from the main river due to various anthropogenic activities has affected the productivity of the wetlands and also water retention in the wetland. The wetlands used to get water from the main river, atleast during the monsoon period. However, due to various anthropogenic activities, the connectivity has decreased. This caused the fish production in wetlands to decrease.

4.5 Climate change

Climate change has affected the breeding behaviour of fishes (breeding failure of Indian major carp in river Ganga is due to climate change), which is directly related to the production of fish from the natural water bodies. Climate variables of importance to inland fisheries viz. enhanced water temperature, extreme events like flood and drought, storms and water stress, require specific adaptation actions. Integrated water shed management strategy is essential going from the village level to the basin level in a unified manner to tackle the climate change impact on inland waters (Vass et al., 2009).

4.6 Increase in input cost

The input cost for fish production, such as lime, Net Pen, IMC seeds is increasing day by day but the fish price has not increased at the same pace. This discrepancy has affected the profit margin of fishers.Live fish is having better market demand than fresh storage fish. So, the new marketing opportunities like live fish marketing, value added fish product marketing, e-marketing integrated cold storage cum retail chain, need to tap for a better market price and this will also be helpful to reduce the post harvest loss as well as will boost domestic consumption.

4.7 Loss of biodiversity

SIF is generally considered as a micronutrient-rich product and it is recommended by doctors for a healthy diet (Roy et al., 2020). Due to various anthropogenic activities like the introduction of exotic species, estate development, wanton destruction of brooder fishes, use of chemical pesticides in the paddy fields (Roy et al., 2015) the production of SIF is affected. So, a certain region of inland water bodies can be considered as no fishing zone or a conserved area to maintain the diversity of fish species. SIF has the potential to improve the income and to empower the community to access education, health, nutrition and better living standards (Roy et al., 2015) that can ensure food and nutritional security of rural communities.

4.8 Economics and political governance

The fishing sector is under the jurisdiction of the Indian government, who oversees the leasing out of inland waterbodies. The leasing price, i.e., the amount paid by the lessee to the Government for use of an open waterbody for a period of time, is fixed by the Government, mainly based on the area and the waterbodies that are given lease to private parties, though little consideration for the fishers cooperative society. The leasing should be given to the primary fishers' cooperative society (PFCS), so that they have the right to catch fish from the inland waterbodies. This said, oftentimes PFCS have to fight with private players for leasing rights over waterbodies. With due discussion with fishers, the leasing amount may be fixed and the water area may be fixed taking the help of GIS and remote sensing data.

4.9 Over exploitation

In a few places, the natural flood plain wetlands are considered as pond ecosystems and intensive culture practices are going on. The intensive culture practice will have a negative impact on the ecology and sustainability of the ecosystem. In the intensive culture practice, aquatic weeds need to be cleared from the

waterbodies. Clearance of all aquatic plants from the wetland will affect the water quality and in long run the sustainable production from the wetland and increase the siltation/sedimentation process of wetland. Moreover, use of small meshed nets, intensive aquaculture by using chemicals and antibiotics in natural waters will impact the biodiversity and the ecosystem as well, which will ultimately hamper sustainable fish production from the open waters.

5. Policy and governance

5.1 Policy and governance in small scale inland fisheries: case study of West Bengal Fisheries Policy 2015

The West Bengal Fisheries Policy 2015 envisions to manage, protect, enhance and develop fisheries and aquaculture in the state. Through viable and sustainable eco-friendly strategies, it aims to generate employment opportunities, providing sources for livelihoods, as well as ensuring nutritional security, a better socio-economic status, and better welfare for Bengali fishers. The policy emphasizes building resilient livelihoods through a process-oriented approach by valuing the strengths and capacities of fishers through strong social cohesion, community institutions, competitiveness and women empowerment within fishers' household. The following two points are important from the level of stakeholder-driven co-management regimes as spelled out strongly in the policy. First, the policy has a mission to promote private investment and public-private partnership in developing, managing, preserving and sharing fishery resources for the benefit of society. Second, it aims to reform the fisheries co-operative societies and strengthen their resources, improve fisheries governance and re-define resource access for fishers.

The policy further aims to ensure fishers that they earn a sustainable livelihood through the effective involvement of the local communities. The fishers who have seasonal employment in fisheries benefit from a comprehensive welfare programme. This includes: education of fisher-women and fishermen; vocational training on improved fisheries techniques; provision of specialized health-care facilities and health insurance for fishing community; sanitation and social security issues; resettlement and rehabilitation of coastal fisher; extension of saving-cum-relief scheme; housing; group-accident insurance scheme to the fishing community (inland and marine); alternate and supplementary livelihood options; social benefits to migratory fishers and fishers without landholding.

5.2 Management of riverine, reservoir, wetland and estuarine resources

Conducting resource assessments (e.g., through surveys using remote sensing for inland fisheries land use and land cover change) as well as developing, propagating, preserving and protecting riverine fisheries in general and threatened fish species, in particular, are important features for inland fisheries management and development in the policy. The regulatory measures that are taken up for achieving the targets of the policy are: (i) grant of licenses for a fee, (ii) restricted fishing efforts, (iii) prohibition of destructive fishing gears, (iv) prohibition of fixed/ stake nets in naturally flowing waters for undisturbed migration and natural propagation of fish, (v) declaration of fish breeding grounds in rivers as sanctuaries and protected areas, (vi) closed season of fishing, river ranching through the same riverine stock, (vii) restoration of degraded river systems, and (viii) introduction of fishing bans in reservoirs and wetlands whenever necessary.

Although in many wetlands and reservoirs no fishing seasons have been declared, illegal fishing practices still take place, predominately in large water bodies. Implementation of regulations in large open water

system is a challenge due to a lack of an organized monitoring mechanism. All inland open water bodies including irrigation canals will be introduced with culture-based fisheries. Paddy-cum-fish culture and cage culture are promoted in flood plains and drainable ponds. Regular stock enhancement programmes should be undertaken in selected wetlands and reservoirs for sustaining fish productivity and production. The establishment of captive hatcheries, nurseries, fry and advance fingerling raising centres, fish landing and handling sheds and ice plants would be undertaken. A concerted strategic action plan would be evolved and implemented to conserve and protect the rich aquatic biodiversity of the State.

5.3 Nutritional security through SIFs: the hidden harvest

Along with carps grown through composite fish culture, SIFs such as minnows, mola carplet, barbs, gobies, gouramies, gangetic leaf fish, catfishes, etc. have come under the considerable attention of the policy because of their richness in micro-nutrients, vitamin A, calcium, iron and zinc. SIF is a major portion of the hidden harvest of the small-scale inland fishers of the state. The fact that small-scale inland fishers are dependent on SIF for their nutritional wellbeing is well recognized by the policy. Collaboration with ICAR institutes for research and development in the management, production and accessibility of SIFs through sustainable low-cost culture technologies is emphasized.

5.4 Institutional Management

To promote the effective functioning of primary fishermen co-operative societies (PFCS), preference is given to register the PFCS or authorized SHGs for leasing of fishing rights of all lakes, reservoirs and wetlands. In the absence of a lessee from PFCS and SHGs, a reservoir can be leased to private entrepreneurs, individuals, public sector undertakings and registered companies through public auction. However, with recent increasing prices, the leasing process is suffering tremendously, further burdening fishers and PFCS.

5.5 Governance of estuarine fisheries

In estuarine waters, suitable restructuring of land lease policies would be done. Government owned brackish water areas are leased out to PFCS, SHGs, unemployed youth and private entrepreneurs for a minimum period of seven years following the Guidelines of the Coastal Aquaculture Authority. The co-existence of private entrepreneurs and small-scale fishers will be smoothened through the development of coastal aquaculture clusters with basic infrastructure. In the allocation of land use rights for shrimp aquaculture, the rights of traditional local communities will be protected. Strict restrictions need to be followed regarding the collection of fish and shrimp seed and brood stock from the wild through appropriate legal measures.

All the farms, hatcheries and support facilities need to be compulsorily registered with the competent authority to adopt the Code of Best Management Practices. The adoption of Better Management Practices (BPM) which ensure efficiency and productivity by reducing the risk of shrimp health problems needs to be popularized among shrimp farmers in the long run. Regular monitoring and control of major pathogens in farmed and wild stocks and their reporting measures should be done to prevent disease outbreaks. Testing and certification of mother shrimp and brood stock, hatchery seed and location requirements will be given due consideration. Regular impact assessments of shrimp culture on the ecology and economy of estuarine waters will be carried out to ensure sustainability in its development and management. The sale and use of antibiotics and chemicals in coastal aquaculture systems also need to be prevented through strict regulatory

mechanisms. Maintenance of the quality of fish feed in such waters should be carried out in accordance with BSI standards and Governmentof India orders.

5.6 Hilsa fisheries: the state fish of West Bengal

Hilsa fisheries is the most important and crucial fisheries in the state of West Bengal. Considering a sharp decline in the catch during the past years, special efforts are undertaken for its conservation and propagation through Hilsa Conservation and Research Centre. Since hilsa fisheries provides livelihood to thousands of fishers in the state, wanton exploitation, pollution and habitat destruction has led to an alarming decline in the catch of Hilsa (Roy et al., 2016) both from rivers and estuarine zones. Co-management and community-based management is encouraged for hilsa conservation. Monitoring and surveillance are being carried out to stop the exploitation of juveniles and destructive fishing. The policy emphasizes collaboration with ICAR-CIFRI for cutting-edge research in this aspect.

5.7 Ornamental fisheries

Ornamental fisheries have been given primary importance since the state of West Bengal in India was the first to introduce ornamental fishery in the country (e.g., for aquarium keeping). The oldest ornamental fish hut in India is located in Kolkata. Since the climate of the state is suitable for the breeding and culture of more than 180 ornamental fish species, priority-setting will be made for the setting up of large-scale ornamental aqua-hubs to provide employment to rural women and promote national export of ornamental fish. Special thrust, in this case, is given to small-scale fishers and entrepreneurs.

5.8 Climate change

With regard to vulnerabilities arising from climate change, more heat and less rain impacting fisheries would have to be mitigated through culture-based fisheries in irrigation water canals, recirculatory systems, aquaponics etc., to develop sustainable food production systems.

5.9 Marketing and trade

With respect to fish marketing and trade, the 2015 fisheries policy emphasizes that for low-income groups of fishers, promotion of the marketing of low value fish through SHGs and establishment of wholesale and retail fish markets will be done. The involvement of the private sector is underlined to set up supermarkets and ultra-modern fish retail shops and fish boutiques to provide hygienic fish and fish products.

5.10 Aqua-tourism

Fisheries-based tourism has been emphasized to be promoted through joint ventures in Public-Private Partnership (PPP) mode. PPP is the partnership between government agencies and the private sector with the objective to deliver goods or services to the public. Providing additional employment to fishers and ancillary activities, water sports, landscaping, sale of fish and value-added fish products, and residential facilities for tourists is also planned to be enhanced. These PPP modes have to bring in equity for the most

vulnerable section of the small scale fishers of the state. Community-based private enterprises are also encouraged.

5.11 Capacity building and awareness

Data collection and management for capacity building and awareness would be performed. Informal and formal literacy programmes would be initiated to improve the literacy levels of fishers. It has been proposed in the Policy that during November-December every year, Fisheries Week or *Meen Mahotsav* or *Nadi Utsav* would be celebrated for awareness creation where ranching with certified fish seed would be done in the open waters of the state. The Fisheries Department Officials would be also sensitized to strengthen their bonds with the small-scale fishers.

5.12 Entrepreneurship

The policy also augments entrepreneurship and self-employment through skill-upgradation of potential entrepreneurs with special emphasis on unemployed youth, women and poorer sections of the society. Further, sharing of capital contribution, promoting linkages for adequate finance, linking fish and fishery products with domestic and export markets would be facilitated. Special assistance to the Scheduled Caste and Scheduled Tribe[1] communities of fishers by providing micro-level assistance through identification of progressive SHGs among these communities, registering them under Freshwater Fisheries Development Agencies and Brackishwater Fisheries Development Agencies, imparting training, allotting water areas to them for culture-based fisheries, arranging financial support and inputs, promotion of marketing would be provided. Loans would be disbursed to small and marginal fishers without collateral security. Declaration of aquaculture as an agricultural activity is in the cards in the future to enable easy flow of credit and suitable tax exemption.

6. Conclusion

SSF are highly vulnerable to natural and anthropological changes in inland fisheries causing loss of employment and livelihood to fishers. A need for adequate policy support thus arises. Some of the suggested strategies are as follows. Figure 1 provides an overview of the key dimensions needed to support regulation and policy development for small-scale inland fisheries in India. This framework draws attention to the key dimensions and feedbacks among policy and legislation, different objectives (e.g., management, conservation), and capacity building among other core features. We elaborate on these issues below:

[1] As per Indian Constitution some communities are recognized Scheduled caste and Scheduled tribe. They belong to disadvantageous socio-economic groups.

Figure 1

Proposed framework for inland small-scale fisheries

Note. Prepared by the authors of this working paper.

• Recognition of SSF workers as the largest primary stakeholder and natural custodians of inland fisheries resources in national policies. The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries by FAO is a policy with the unique feature of including human rights and dignity, non-discrimination, equity and equalityas guiding principles (FAO, 2015). With India being a signatory country (FAO, 2014), there is a duty to uphold its indications.

• Sustainable utilization of inland fisheries resources, including a holistic management approach for inland open water bodies, together with the right and entitlements of small fishers and fish-workers for using and protecting resources. Management interventions, such as community husbandry, leasing policy, security

mechanism, resource conservation policy, awareness and sensitization, can ensure sustainable uses of inland waterbodies. There is a need for drawing appropriate guidelines for conservation and sustainable utilization of inland open water bodies and their fish stocks.

• SSF are a key component of the food and nutritional security of India, and better governance and regulatory framework for SSF sector can significantly add to the sustainable SSF in the country. Conflict in water use, siltation, encroachment, loss of connectivity of wetlands with parent river, climate change, loss of biodiversity, over exploitation are emerging challenges of SSF in india. Managing SSF is basically a socio-legal issue and lawmaking reflects the political decision. SSF is highly diverse in nature, as result governance of SSF is complicated. Therefore all the available and fragmented laws on fisheries may be updated, revised and integrated. Valuation of goods and services is may be done to convice the planners and policy makers regarding the inportance of SSF in inland openwaters. People's participation, community husbandry, resource conservation policy, research, capacity building, awareness and sensitization is needed for better regulatory framework to manage SSF in a susainable way.

• Development of SSF is hampered due to the absence of technical education, traditional fishing methods, information gaps, inadequate infrastructure, financial resources, marketing facilities and allocation of negligible funds for its development. Introduction and implementation of governrnment aided schemes may support the small-scale open water fisheries in India.

• Guidelines encouraging community-based fisheries management in inland open water fisheries. These should make the participation of riparian fishers mandatory in both the planning and management stages.

• Finally, since inland operates at widely varying organizational levels, they are not homogenous within and across regions. These conditions need to be considered while formulating strategies and policies for enhancing its contribution to food security and poverty alleviation.

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The Vulnerability to Viability (V2V) project is a transdisciplinary global partnership and knowledge network. Our aim is to support the transition of small-scale fisheries (SSF) from vulnerability to viability in Africa and Asia. Vulnerability is understood as a function of exposure, sensitivity and the capacity to respond to diverse drivers of change. We use the term viability not just in an its economic sense but also to include its social, political, and ecological dimensions.

The V2V partnership brings together approximately 150 people and 70 organizations across six countries in Asia (Bangladesh, India, Indonesia, Japan, Malaysia, Thailand), six countries in Africa (Ghana, Malawi, Nigeria, Senegal, South Africa, Tanzania), Canada and globally. This unique initiative is characterized by diverse cultural and disciplinary perspectives, extensive capacity building and graduate student training activities, and grounded case studies from two regions of the world to show how and when SSF communities can proactively respond to challenges and creatively engage in solutions that build their viability. Further information on the V2V Partnership is available here: www.v2vglobalpartnership.org.

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