Small-scale Fisheries in South Asia

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Chapter 2

Small-scale Fisheries in India: An Appraisal

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The fishing practices followed in India are as diverse and complex as diversity of fishes. On an average 700 species of fishes are harvested annually from Indian coastal waters. Various craft-gear combinations are used for harvesting these resources. The wide variety of fisheries resources are targeted with specific gear and craft unlike monopolized individual species-based targeted commercialized fishing activities practiced globally, especially in temperate and sub-tropical coastal waters. Indian fisheries sector is still heavily relying on less capital-intensive fishing. With the global standards of commercialized fishing grown to much higher proportions, it is possible to address the whole of Indian fisheries as small-scale, except for the few industrial trawlers which operated earlier under the letter of permit (LOP) scheme of the government of India. But with the definitions on small-scale fishery (SSF) reiterated in various fora during different occasions by United Nations, we have tried to define the small-scale fisheries in the Indian context. Further, in this chapter we have provided information based on the prevailing data sets on marine fishery by looking upon the various aspects of SSF inclusive of resources vis-à-vis fleet size, climate related perils, market related issues, its role in poverty alleviation, governance, institutional framework for governance and pertinent issues in SSF.

Artisanal or SSF are traditional fisheries involving fishing households, using relatively small amount of capital and energy, relatively small fishing vessels (if any), and mainly for local consumption. As per FAO (2015), SSF contribute around half of global fish catches in developing countries and employ about 90 % of the world's capture fishers. SSF play an important role in directly increasing the availability of nutritious food for local, national and international markets as well as providing a valuable source of income to those directly and indirectly employed in the sector. The SSF activities, particularly the processing and trading activities adds an important gender dimension to the sector, given that women are usually the

main actors in these sectors. Despite the fact that SSF is a crucial element of the livelihood of the poor and contributes to poverty alleviation through the generation of wealth and income the small-scale fishing communities continue to be marginalized and their contribution to food security and nutrition remains unrecognized.

Defining small-scale fisheries in India

When we try to define SSF in India there are various yard sticks to be explored, including ethnic origin of community in fishing; size and material used in case of fishing craft; fishing gear used; depth of fishing ground and distance from the shore; nature of fish landing; market channels; fishing crew and their remuneration; economics/ benefit-cost ratio of fishing, etc. The mechanized trawlers which mostly have an average Over All Length of over 14 m, which are not that different from the small-scale boats of roughly the same size range and are crewed by the small-scale fishers themselves forms the baseline for exemption when we define 'small-scale fisheries' as everyone in the sector except the mechanized vessels can be brought under SSF in India. Thus, the mechanized marine fishing definitely can be excluded from the purview of the small-scale fisheries. Similarly, the large-sized inboard fishing vessels propelling in the Indian coastal waters can also be excluded from the context of small-scale fishing as they are lengthier vessels, employing 50-60 crew member onboard undertaking deep water fishing operations. Rest of the craft-gear combinations remaining in the fishery *viz.* motorized and non-motorized/non-mechanized fishing all are considered valid in the context of this article considering the technology in use, socio-ecological condition of the fishermen involved and the area of operation. The entire inland fisheries sector in India is operated well under the definition of small-scale fisheries and is fully entitled to be part of this study. Marine fisheries being a major component in this article, greater emphasis is given to small-scale fishing activities happening close to the coastal waters with an idea to intro/retrospect many inter-sectoral issues. At this juncture, the Government of India is promoting deep sea fisheries as an initiative to harness the under-exploited resources from offshore deeper waters and first series of locally designed vessels are getting launched along different maritime states in the country. In this article we tried to visualize the relevance of SSF with almost 70% of total fishing workforce and also crafts harnessing less than 20% of the existing potential harvestable yield which is sustainable in comparison with the capital-intensive mechanized crafts/folks consisting of 30% of total fishers/crafts which churns out approximately 80% of fishery resources.

Managing over-capacity in small-scale fisheries: Resource potential vis-à-vis fleet operations and their contribution in Indian SSF

The fish production levels from the Indian coastal resources has almost plateaued at just above 3.5 million metric tonnes (mmt), with the latest production of the year 2017 being 3.83mmt. When we look into the crafts involved in fishing in Indian Exclusive Economic Zone (EEZ), among the nearly 0.23 million vessels in operation in the country, 30% are mechanized vessels harvesting nearly 70% of resources and the remaining motorized (in-board and out-board vessels) as well as non-motorized/ non-mechanized vessels are harvesting only 30% resources. Often fishing fleets above optimum level are observed in coastal fishing. A consolidation on the potential harvestable yield proposed by working group on revalidation of marine fisheries potential is summarized in Table 1. The NITI Aayog, the major planning body in India, recommended no further registration of mechanized fishing vessels.

Table 1. Revised potential estimate (MSY) from the Indian EEZ (2018)

Attributes	Revised MSY (t)
Conventional Resources	
Mainland	
0-200m deep	4,924,016
200-500m deep	97,461
Sub-total	5,021,477
Oceanic	168,063
Island Ecosystem	
Andaman & Nicobar *(incl. Oceanic 43,794 t)*	47,463
Lakshadweep *(incl. Oceanic 14,490 t)*	73,590
Sub-total	121,053
Total Conventional Resources	5,310,593
Non-Conventional Resources	
Deep-sea myctophids	1,000,000
Oceanic squids	630,000
Jellyfish	200,000
Marine macro algae	17,775
Total Non-Conventional Resources	1,847,775
Grand Total	7,158,368

In contrast to the national scenario, Lakshadweep and Andaman & Nicobar Islands presently contribute only 45,000 t of fish catch, which is about one-third of total potential harvestable yield in these Island archipelagos. The

average landing from these islands, however, is only about 30% of the newly estimated fishable potential (CMFRI & CIFT, 2006; Dam Roy et al., 2009; Vinay et al., 2017). Given that the EEZ encompassing the islands is close to half of India's total EEZ, there is substantial untapped potential that could be harnessed by investing more on island fisheries. Most of the island resources are constituted by high value fishes such as tunas and allied species, barracudas, bill fishes, elasmobranches and squids. The development priorities in fisheries in the islands are quite different from that of the mainland. Islanders are mainly dependent on reef and deep-sea resources for their livelihood.

The fishing craft-gear combinations available in India can be categorized into mechanized, motorized and non-mechanized/non-motorized vessels, basically operating four types of gears, viz., gill nets, seines, trawl nets and hooks & line. All these gear-craft combinations are locally known by different regional/vernacular names depicting the fishery. Our specific interest when it comes to small-scale fisheries is restricted to the outboard motorized/small inboard motorized and all non-mechanized/non-motorized vessels operating the abovementioned gears. The spatial and temporal variations in the marine fishery resources are estimated based on the landing pattern observed quarterly among the resources. Assessment of marine resource potential off Indian EEZ has been a vital task to be carried out before crucial planning interventions of the government. Apart from the finfishes and shellfishes, the marine domain is peppered with many biotas which have direct and indirect role in deciding the potential of the EEZ. As the resource domain and its actual extent of spread is an unknown entity, predictions based on indices obtained on shore have played a major role in reassessing the marine resource potential. Based on theoretical considerations, marine fisheries potential were estimated at the aegis of union government based on the NMFDC data base of CMFRI. NMFDC data base is based on multistage stratified random sampling method which is an internationally accepted estimation procedure for marine capture fisheries of India.

The database evokes regional specific interests to some specific commercially important resources, viz., Hilsa in West Bengal, Bombay Duck in Gujarat and Maharashtra, Oil Sardines in Kerala, silver bellies and lesser sardines in Tamil Nadu, Sciaenids in Gujarat and other similar resources. The major resources landed as the leading species contributing to commercial fishery in these maritime states are also compared on a quarterly basis (Table 2). Since the specific year of study is deficient of some resources, the abundance pattern in the long-term average may differ. For

example, the case of Bombay Duck fishery in Dol nets in Maharashtra which is specifically shown as a case study later in this chapter. The percentage contribution by different small-scale fishery craft-gear combinations are depicted in Tables 3, 4 & 5 along with the actual landing estimates, and their percentage contribution to the fishery in the respective maritime state in the country.

Table 2. Dominant seasonal marine fish landings (kg) during 2018 in 9 maritime states and the major gear used

State	Resource	January - March		April-June		July-September		October-December		Major Gear
		Landing	%	Landing	%	Landing	%	Landing	%	
West Bengal	BombayDuck	2919273	1.82	199140	0.12	2016328	1.26	14125273	8.83	MDTN
	Anchovies	2872453	1.79	146779	0.09	1502475	0.94	14456021	9.04	MBN
Odisha	Lesser sardines	3923668	4.40	3788478	4.25	5889628	6.60	2651774	2.97	MDTN
	Indian mackerel	5577868	6.25	4887156	5.48	412492	0.46	1490216	1.67	OBGN
Andhra Pradesh	Lesser sardines	13395086	6.92	5852062	3.02	4786054	2.47	9869839	5.10	OBGN
	Indian mackerel	6530515	3.52	2977546	1.53	6328725	3.27	5227905	2.70	MDTN
Tamilnadu	Lesser sardines	49464741	7.04	9746475	1.38	20153503	2.87	14187165	2.02	MTN
	Silverbellies	29986188	4.27	7853558	1.12	19166373	2.73	7252468	1.03	MDTN
Kerala	Indian mackerel	9729734	1.51	7307688	1.14	49465789	7.70	14065228	2.19	OBRS
	Oil sardine	29742157	4.63	20444880	3.18	3326170	0.52	23580234	3.67	MRS
Karnataka	Indian mackerel	28256669	6.25	6697293	1.48	20143120	4.46	29277409	6.48	MDTN
Goa	Indian mackerel	3154103	5.34	2003682	3.39	3932623	6.65	5119438	8.66	MPS
Maharashtra	Non-penaeid prawns	8260874	2.80	8583137	2.91	981080	0.33	19295863	6.53	MDTN
	Penaeid prawns	12402454	4.20	5057103	1.71	6100815	2.07	10193407	3.45	MDOL
Gujarat	Non-penaeid prawns	32063224	4.11	33947244	4.35	8674054	1.11	66757569	8.56	MDTN
	Ribbon fishes	26913423	3.45	11882998	1.52	17584700	2.25	30805057	3.95	MDOL

MDTN-Multi Day Trawl Net; MBN-Mechanized Bag Net; OBGN- Out Board Gill Netter; MTN-Mechanized Trawl Net; OBRS- Out Board Ring Seine; MRS- Mechanized Ring Seine; MPS-Mechanized Purse Seine; MDOL-Mechanized Dol

Table 3. State-wise marine fish landings in India by motorized and non-motorized crafts (excluding mechanized crafts) during 2017

State	Motorized landings (t) and composition (%)	Non-motorized landings (t) and composition (%)
West Bengal	30526 (8.4)	939 (0.3)
Orissa	38625 (30.4)	3870 (3.0)
Andhra Pradesh	79008 (39.6)	27997 (14.0)
Tamil Nadu	153009 (23.4)	2437(0.4)
Pondicherry	2882 (10.7)	143(0.5)
Kerala	151332 (25.9)	5354(0.9)
Karnataka	36136 (6.6)	3960 (0.7)
Goa	10408 (10.4)	1861 (1.9)
Maharashtra	3392 (0.9)	993 (0.3)
Gujarat	47864 (6.1)	87 (0.01)
Daman & Diu	4113 (6.4)	0 (0)
All India	557295 (14.5)	47641 (1.24)

Table 4. State-wise operation of different fishing crafts in India

State	Inboard	Outboard	Total Motorized	Contribution (%)	Non-Motorized	Contribution (%)
West Bengal	6564	0	6564	59.38	476	4.31
Orissa	2443	3235	5678	65.40	1256	14.47
Andhra Pradesh	3146	8932	12078	59.74	6965	34.45
Tamil Nadu	8945	22334	31279	72.57	6115	14.19
Pondicherry	387	975	1362	58.73	656	28.29
Kerala	0	13868	13868	63.95	4016	18.52
Karnataka	304	5575	5879	49.47	2225	18.72
Goa	5	937	942	47.53	182	9.18
Maharashtra	5979	809	6788	43.72	2865	18.45
Gujarat	3541	7582	11123	43.01	756	2.92
Daman-Diu	95	301	396	19.88	177	8.89
Total	31409	64548	95957	58.40	25689	15.64

Source: Marine Fishery Census 2016 by ICAR-CMFRI

Table 5. State-wise and gear-wise catch (t) (excluding mechanized crafts) in 2017

State	Type of Craft	Total yield from different gears					
		Bagnet	Gillnet	Hooks & Lines	Seines	Trawls	Others
West Bengal	MOT	14741	12780	1048	1957	0	0
	NM	16	611	0	312	0	0
Orissa	MOT	0	32964	2640	3022	0	0
	NM	0	3302	26	542	0	0
Andhra Pradesh	MOT	0	41256	8056	29696	692	0
	NM	0	21843	981	5162	0	11
Tamil Nadu	MOT	2147	103978	17757	26059	2743	324
	NM	0	2308	43	57	22	7
Pondicherry	MOT	0	2436	310	137	0	0
	NM	0	143	0	0	0	0
Kerala	MOT	0	42909	8528	94891	4846	157
	NM	0	4901	46	361	0	46
Karnataka	MOT	0	15126	9	20527	474	0
	NM	0	2553	0	1407	0	0
Goa	MOT	0	2213	0	8195	0	0
	NM	0	8	0	1853	0	0
Maharashtra	MOT	0	674	20	2698	0	0
	NM	80	228	3	606	0	77
Gujarat	MOT	3753	41345	851	0	0	1898
	NM	0	79	0	0	0	6
Daman& Diu	MOT	0	4113	0	0	0	0
	NM	0	0	0	0	0	0

In India we are carrying out stock assessment of 52 stocks of various marine finfish and shellfish species based on the biology data collected from landing centers across peninsular India during 2012-16 (CMFRI, 2017). The report indicates that 55.77% of the marine fish stocks are being harvested within biologically sustainable levels i.e. harvests from these marine fish stocks are yet to reach Maximum Sustainable Yield (MSY). The National Policy on Marine Fisheries 2017 of the Government of India, which was formulated based on scientific inputs, gives priority to fisheries management in India (Sec. 10.0). Sections 12.0 of the Policy vividly reiterate that MSY will be an input for framing marine fisheries management measures to ensure sustainability of fishery resources. In India, fisheries is a state subject. The respective State Governments in the country accomplish their territorial fisheries management through the Marine Fishing Regulation Acts (MFRAs). However, most of the MFRAs do not mandate the use of MSY or scientific stock assessments protocols for managing the fish stocks rendering most stock assessment outputs as least effective.

Presently, ICAR-CMFRI carries out stock assessments based on data collected from commercial landings. Exact information on where the fishing operation was carried out and the specifics of the fishing operation including fishing time, fishing gears, *etc.* is not available. For further accurate stock assessments these inputs are also required which can be provided only by fishermen. Thus, linking fishermen in the data acquisition system is important. Further, the use of non-commercial data would increase the accuracy of stock assessment models. Fishery Survey of India (FSI), a body under the Ministry of Agriculture and Farmer's Welfare, Govt. of India, regularly conducts surveys of marine fish resources of the country in deeper waters. Use of FSI's survey data along with the data collected by ICAR-CMFRI and inputs from fishermen produce accurate stock assessments (Table 1).

Thus, we can conclude that there are fishing operations in the country which are near to their sustainable limits but still with a looming possibility for expanding it to the deeper waters. But the resources which are controlling the livelihood of SSF in coastal Indian waters are not only dependent on the fish harvesting operations or fleet size but largely on environment related factors also. With the severity of climate being impacted on the ambient water conditions, climate change is being looked upon as a major external driver affecting fisheries and the challenges of SSF with respect to climate change is discussed in the following section.

Climate change and other external drivers in small-scale fisheries: practical steps for responding

Almost all fishes, except a few, are adapted to certain level of change in their environment parameters. However, beyond a particular level, almost no organism can withstand their environment without changing their habitat or by acquiring special adaptations. The major amplifying problems in marine ecosystems due to climate change are warming and acidification of seawater, salinity variations, eutrophication and near-shore changes of current. The primary productivity of marine ecosystems depends on the biophysical and chemical interactions in the aquatic environment. Environmental variables such as sea surface temperature (SST), wind, currents, rainfall, sea level anomaly (SLA) and chlorophyll- *a* highly influence the fishery and primary productivity of the coastal waters. Variations in these environmental variables have a specific influence on fishery and optimal condition of these environmental factors would help to provide a better ecosystem for the marine organisms.

Climate change induces profound influence on biological and physical characteristics of fish *viz.*, migration pattern, life cycle, behavioral changes, feeding, and reproduction, and the fish catch of a region. Life history of small pelagic fishes which are highly mobile, having short lifespan and plankton-based food chain makes them more responsive to environmental perturbations. The catch statistics of Indian oil sardine and Indian mackerel are highly fluctuating since 1985. Since this period, Indian Ocean faced many climatic events and extreme events, which have influenced the pelagic fisheries. According to the Intergovernmental Panel on Climate Change (IPCC, 2014) Synthesis Report, since the times of pre-industrialization, the average global sea surface temperature of total land and ocean increased by 0.85°C (0.65°C to 1.06°C). In addition, the report summarizes that the ocean will continue to warm, acidify and global mean sea level (MSL) will be in rise. By the mid-21st century, increase in 2°C of temperature will cause species richness and higher fishery catch potential at mid and higher latitudes and a decrease at tropical latitudes and semi-enclosed seas (IPCC, 2014). The biological impacts are ranged from shifts of fishes and microalgae, increased coral mortality and bleaching, increased primary productivity at high latitudes, changes in species richness, regional species abundance changes and changes in fishery yield. Coastal water quality is deteriorating day by day due to anthropogenic interferences from industry, terrestrial nutrient inflow, organic compounds, oil, toxic chemicals, thermal inputs from anthropogenic sources, radioactive materials, hazardous chemicals and others.

The small-scale fisheries in the country is largely dependent on the coastal productivity. It is a well-known fact that the Indian oil sardine (*Sardinella longiceps*) is the most dominant species that contribute maximum to the small-scale fisheries in the country. Further, the other major contributors are also small pelagic in nature. The fishery is largely dependent on the coastal productivity, and the productivity related phytoplankton biomass is concentrated all along the near shore coastal waters (Figure 1), which clearly depicts that the fish catch and ultimately the income of small-scale fishers are based on this chlorophyll rich coastal waters. Indian oil sardine catch is subjected to high inter-annual fluctuations. These fluctuations are primarily dependent on the ambient oceanographic conditions that control productivity of coastal waters. With the fluctuations of Indian oil sardine touching the extremes, the low productivity of sardine has been attributed to the temperature pattern of coastal waters. In the recent decade, we observe that the years with El Nino southern oscillation (ENSO) events had remarkable impact on the oil sardine fishery. This was evident by higher Sea

Surface Temperature (SST) of the coastal waters during 2015 (Figure 2) and 2016 (Figure 3). Similar to the red colour pixels in Figure 2, we observe serious SST anomaly in Indian waters during crucial southwest monsoon months which is detrimental to dominant small pelagic fishes, viz., Indian oil sardine which contributes maximum to SSF. In 2016, the fish registered the least catch in the decade. The red coloured pixels in the figures are indication of serious temperature anomalies which resulted in one of the low sardine production years and affected small-scale fishermen badly. During these years various small-scale fisherman associations have come together to formulate long-term plans which can support their livelihood. The fisherman associations referred to this phenomenon as 'drought at sea'. They were appealing for livelihood sustenance packages similar to relief packages given to agricultural farmers during extreme drought resulting in crop failure. The concern is very serious from the point of view of small-scale fishers as oil sardine is not only a fish that supports routine livelihood but is crucial in supporting nutritional security of coastal waters (Figure 4). The small pelagic fish which is rich in ω-3 and ω-6 fatty acids serves as cheap quality protein source to the fishing villages. The fishing is very prominent during south-west monsoon season (June-August) which is important from the food security related issues too, as calamities due to the excessive precipitation along west coast of India often result in natural calamities and famines in the coastal villages.

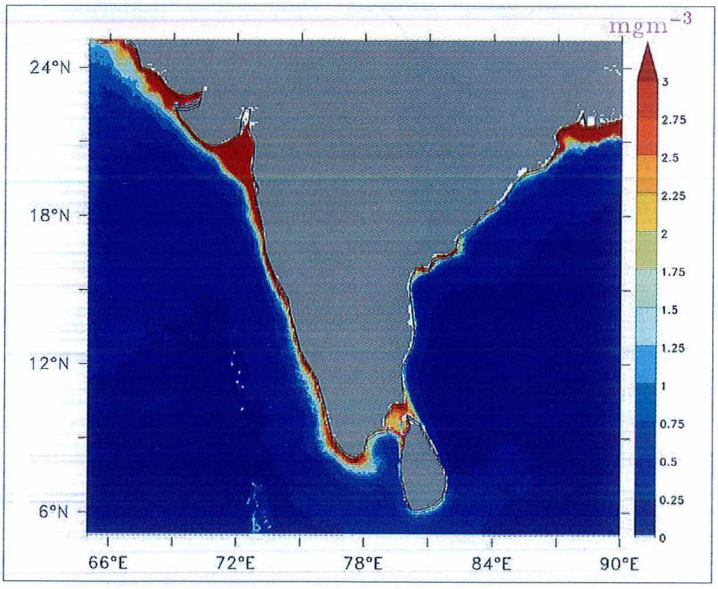

Figure 1. Depiction of coastal phytoplankton composition as a climatology of chlorophyll biomass (The red colour indicate presence of phytoplankton rich waters which will support coastal pelagic small-scale fishery)

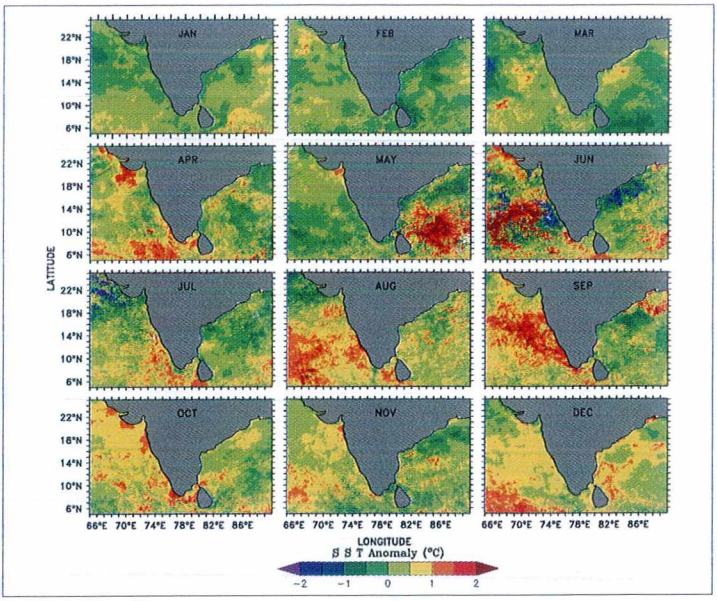

Figure 2. SST Anomaly during 2015 (Red colour pixels indicate serious Sea Surface Temperature anomaly in Indian waters which is detimental to dominant small pelagic fishes such as Indian oil sardine which contributes maximum to SSF. In 2015 the fish registered a poor catch)

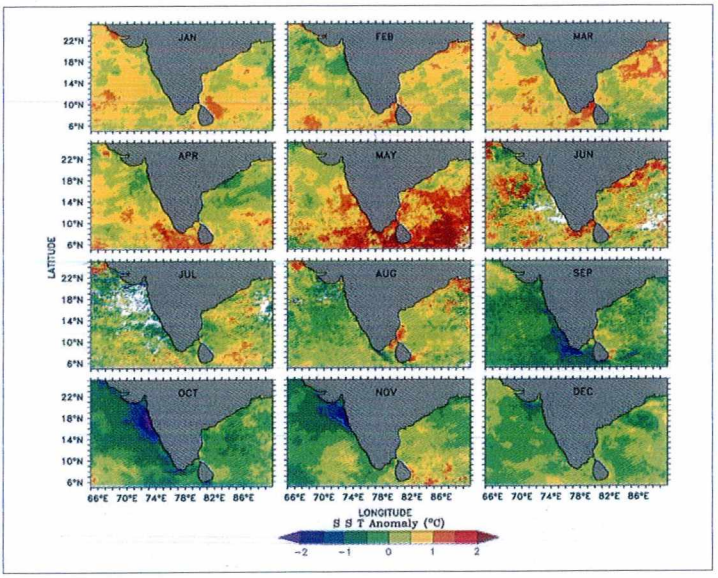

Figure 3. SST Anomaly during 2016 (Red colour pixels indicate serious Sea Surface Temperature anomaly in Indian waters which is detrimental to dominant small pelagic fishes such as Indian oil sardine which contributes maximum to SSF. In 2015 the fish registered a poor catch)

Figure 4. Harvests of Indian oil sardine- the most dominant single species fishery resource harvested in SSF in India

With the increase in frequency of natural disasters which are evident impact of climate change, the SSF is severely affected. The fishermen are the vulnerable group who are always at the perils of disasters. The challenges are severe when the coastal areas are affected with cyclones. The fishing as a commercial activity is seriously compromised resulting in massive losses rendering the already impoverished community into days of famine without income. They realign themselves from the catastrophic losses of infrastructure due to cyclonic winds which devastate coastal dwellings. Recent Ockhi cyclone happened in Kerala can be cited as an example. The coastal dwellings in the southern fishing hamlets of Kerala were severely destroyed and many lost their life. Direct impact of the Ockhi cyclone was reflected on the fishery in the seasonal marine fish landings of Kerala. There was loss of fishing effort (units) to the estimated levels of 56,610 in 2017, i.e. 46% less compared to 2016, which can be attributed to the loss of effort in actual fishing hours to the tune of 5,70,495 i.e. 57% less than 2016. Thus, due to the loss of fishing days during Ockhi cyclone, the landings share during the above period reduced to 13.5% in 2017 from 22% in 2016. The estimated

loss during the above period was 35,465 t valued at Rs.585 crores at landing centre level and Rs.821 crores at retail level. These values indicate that the market potential of SSF is also imperative in the development of the economic system (CMFRI Press, 2018).

Developing markets for small-scale fisheries: utilizing the value chain approach

About three-fourths of total marine fish landed in India is marketed in its internal consumption channel. This, when translated to specific terms, is estimated at a quantity of around 2.7 mmt. The monetary transactions in this domestic market economic system is valued at Rs. 52,431 crores at landing center and at Rs. 78,408 crores at retail level in 2017 (CMFRI, 2018). Wholesale domestic fish markets in India vary widely from 1 to 100 t turnover on daily basis. Private traders completely control this market system with large number of middlemen involved in the process, thereby dropping fishermen's share in consumers' rupee. The domestic marine fish marketing in India is intricate involving multiple stakeholders, middle men and beneficiaries (Parappurathu et al., 2017).

India has access to modern innovative marketing mechanisms, as it has emerged as one among the global leaders in some of the supporting sectors such as information technology, capital generation and infrastructure development in the recent years. The practices followed in domestic channels in India are predominantly with a legacy, and traditional beliefs and values are still accounted in trading systems also. At time this creates a disparity unlike the global marketing channels and creep inefficiencies in the value chain (Kumar et al., 2008; Ravindranath, 2008).

Few factors have been identified as the major deterring ones with the prominent being insufficient landing center facilities, wholesale and retail market infrastructure, deficiencies of cold chain and logistic shortfalls, particularly those associated with small-scale operators in the sector. Public–private partnerships (PPP) following Build, Own, Operate & Transfer (BOOT) model as successfully done in the case of Jeppiar fishing harbor in Muttom, Tamil Nadu can be cited as an example in this background, which needs to be replicated all along the coast.

Dearth of credit and inadequate support from formal financial institutions has remained as the major bottleneck. Middlemen have become necessary evil who are mobile ATMs on the beach to support fishing related credits. Informal creditors playing the spoil sports in fish trading exploiting the perishable nature of fish as a commodity, as government/ developmental

agencies is not able to establish proper cold chain or any viable measures which can support buy back at the time of crisis. Fishing harbors requires amenities such as safe berthing, utilities like food, water, fuel and maintenance of crafts/gears, post-harvest cold chain, fish drying yard, auction hall, and associated services viz., effluent/sewage treatment plant, fire protection, power supply technology unit, ATM, parking facilities administrative building, etc. to ensure efficient fish handling and marketing (Sampathkumar and Vanjinathan, 2015). Similarly, fish landing centres are required to have protected bay, beach landing, freshwater, ice and fuel supply utilities, protected area for fish auction, shore processing and packing facilities, slip ways and road connectivity. Only a handful of the harbours/landing centres, however, have all the above mentioned facilities. Inadequate basic facilities and other modern amenities limits hygienic handing of fish, efficient storage and transportation. Last mile road connectivity and adequate telecommunication facilities are required to be provided in most of the small fish landing centres. Fuel dispensing facilities are often far from the landing centres. Considerable investments therefore are required to plug these gaps, so that fishermen do not have to travel longer distances to ensure efficient marketing of their catch. Further, new harbours and landing centres with modern amenities need to be established in potential areas.

Dol nets are interesting gears operated off Mumbai and Saurashtra coast targeting Bombay Duck and other related resources. The fishermen dire the challenges at sea for implanting lengthier stakes on which the Dol nets are operated. The gear relies on semi-diurnal tidal system to harvest the resources and uses the strength of the tides following the lunar cycle. During slack phases when tidal currents are not strong the fishing cannot be done. So landings are seasonal. The already available amenities are particularly insensitive towards the requirements of women vendors/workers involved in SSF. There are SSF fishermen involved in this when they stake the nets close to the coast for harvesting Bombay Duck. But the highly perishable fish with excess moisture content is often set for drying rather than fresh consumption.

Unlike the marketing channels in seafood export, the quality of fish as a raw material is always doubted. In SSF, this quality concerns are pretty less as the vendors involved in SSF trade are ignorant of the adulterants they are using to improve their profit share. In recent days there have been some concern due to unauthorized preservatives and other harmful chemicals for enhancing keeping quality of fish. Recent episodes of formalin and ammonia presence in domestic markets were curtailed with the intervention

of ICAR-Central Institute of Fisheries Technology (CIFT) which developed and commercialized kits which can easily detect these adulterations. The retail markets are miniature versions of wholesale markets and almost all the constraints mentioned in case of wholesale markets are also applicable for them. Wastage in the fish value chains is very high due to unscientific handling practices, dearth of cold chains and other inefficiencies. In view of this, there is a dire need to channelize capital investments to address the above infrastructure requirements for enhancing efficiency of fish marketing.

The major constraints in the island fishing economy includes lack of skills for hygienic fish handling, proper on-board processing of tuna and other high value fishes for maintaining quality, constraints related to bait fish management, inadequate landing and berthing facilities, meager marketing infrastructure and so on. The islands also lack good processing infrastructure to cater to the requirements of exports and other high-value supply chains. The fishermen fetch low price for the consignments send to mainland due to several intermediaries involved in transportation and subsequent sale of fish. Therefore, separate packages are to be designed for developing island fishery economy giving due regard to the ecological fragility, security as well as special needs and sensibilities of the islanders.

In recent years several initiatives have been undertaken by the government of India. There is a central scheme on 'development of marine fisheries, infrastructure and post-harvest operation'. The main components include development of fishing crafts through technological up gradation; establishment of fishing harbors and landing centers; developing domestic market infrastructure and cold/value chain facilities, and having fishery improvement programs aimed at conservation as well as sustainable harvest.

The centrally sponsored schemes for 'welfare of fishermen' comprises of creation of model fishermen villages which are currently vulnerable to climate and related impacts; group accident insurance for active fishermen; saving-cum-relief programs as well as training and extension programs. Since fishing is professionally one among the most life threatening occupations, the vagaries of disasters such as cyclones have proved to be an eye opener with regard to the need for generous welfare measures among small-scale fishing communities. There is a national initiative on 'strengthening database and information networking for the fisheries sector'. This involves sample survey and productivity based estimation of fishery resource potential. The working group on revalidation on potential harvestable yield set up by the Department of Animal Husbandry Dairying

and Fisheries (DADF) developed the estimates based on catch assessment surveys carried out by national agencies such as Fishery Survey of India (FSI) and estimates released by ICAR-CMFRI. The national marine fisheries census conducted once in every five years funded by DADF is providing the socio-economic data input on marine SSF in India. Further, there are several monitoring, control and surveillance (MCS) programs funded by the Government of India in improving the marine based capture fisheries in India as well as conducting evaluation studies. Besides these, the National Fisheries Development Board (NFDB) facilitates different project in collaboration with research and developmental agencies for developing the value/cold chains of coastal aquaculture, mariculture (emphasis on cage farming), seaweed collection/ farming and marketing, development of landing and market grids, and improving post-harvest infrastructure by up-gradation of existing internal marketing channels starting from the landing centers. India presently possesses 7 major fishing harbors (2 in West Bengal and 1 each in Odisha, Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra); 52 commissioned minor fishing harbors and 181 commissioned fish landing centers. Other than these, there are over 1300 beach landing centers which are seasonal and spatially varying depending on the beach profile that mainly caters to the needs of SSF.

Small-scale fisheries compliance: integrating social justice, legitimacy and deterrence

Fishing in marine waters is governed by United Nations Convention on the Law of the Sea (UNCLOS) and mostly the convention is adhered strictly in most of the countries. But, there are incidences of fishing illegally by 5-9% of the total fishing crafts operating along the India's maritime zone. Illegal fish catching is often observed in island territories, with most violators being foreign vessels targeting sea cucumbers, shark fins and reef fish in the Andaman and Nicobar group of Islands, while shark fins are the target of poachers in Lakshadweep. Both these areas have underutilized fishery resources, which are conserved as protected areas. Fishery related coastal patrolling is found to be insufficient in proportion to the length of coastline in the country. Also, absence of a uniform ban period throughout the coastline has led to fishing trawlers of several states using this legal technicality to fish where fishing ban exists and land in an adjacent state where there is no ban.

Illegal fishing in Palk bay and Mandapam is due to the excess capacity of Indian vessels operating along these coastal waters. The fishing grounds along the Palk Bay and Mandapam region of Tamil Nadu coast can hardly

sustain fishing pressure from one third of the existing fleet. Foreign tuna vessels operating in Indian waters have increased significantly, putting India at disadvantage. A recent press release from Government of India publicized that 116 foreign fishing vessels were confiscated. Majority of them were multi-day tuna long-liners. An ocean governance mechanism of declaration of 5-10 km as no fishing zones on both sides of border along Indo-Pakistan and Indo-Sri Lanka regions can help in preventing accidental intrusion of small-scale fishers into each other's jurisdiction. Also, marker buoys with flags can help in preventing accidental intrusions into sovereign waters of other countries and vice versa. These are in addition to the existing inter-sectorial conflicts between mechanized vessels (non-SSF) and SSF vessels.

A general operational regime of SSF includes coastal water depths up to 50 m, and further beyond, the mechanized vessels are in operation (Figure 6). But the area of operation between 30-50 m depth zones is often contentious as depicted in Figure 4. In a general inference on governance of SSF in Indian context, there is a need for conflict resolution between users of the same gear; between users of different gears; in inter-village disputes; and between small-scale and mechanized fishing. The bathymetry indicated in Fig. 6 up to 30 m depth zone is dominated by SSF. The bathymetry from 50-100 m is dominated by mechanized vessels and there are contentious zones which are usually between 30-50 m depth zones as depicted in Figure 6.

Figure 5. Dol net fishery operations for Bombay Duck along Saurashtra coast

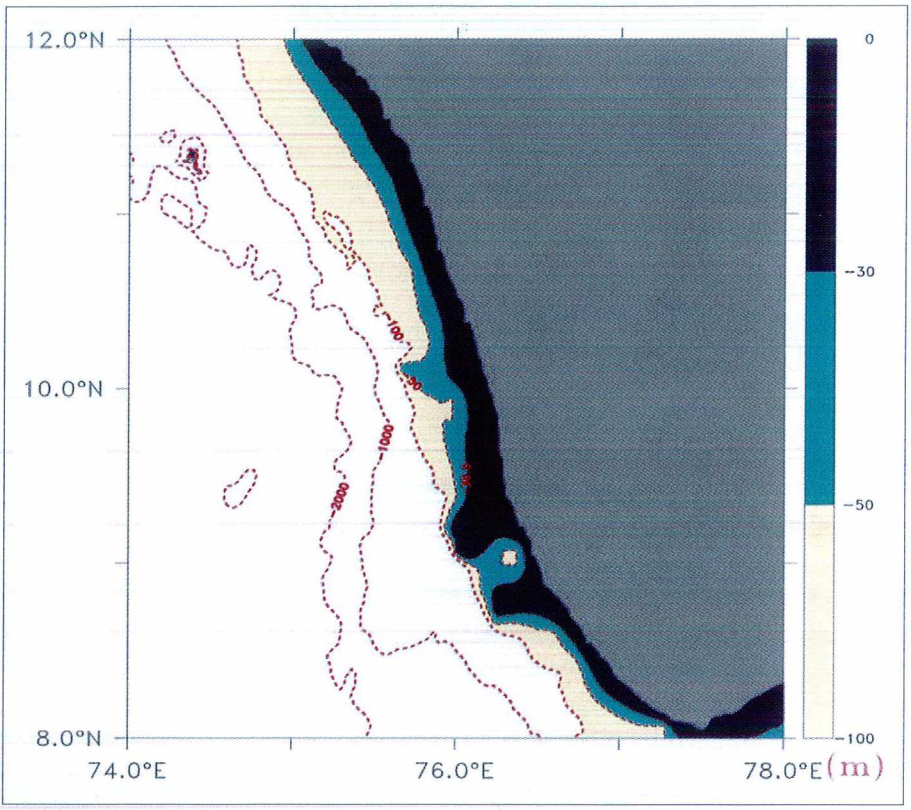

Figure 6. Operational regimes of vessels in southwest coast of India as a pictorial depiction

Poverty reduction as a means to enhance resilience in small-scale fisheries

Regional case studies depicting community based efforts for resilience

There are few interesting case studies in the country. One such case is that of 'thermocol boat' fishery, which a typical case of small-scale regional fisheries is where a small intervention by fishermen helped them to overcome the existing challenges and enhance resilience in fisheries (Figure 7). Thermocol boat fishing is a single fisherman based fishing activity which is clearly an example of small-scale fishing happening in the southern part of India, particularly in Kerala coast. The thermocol boat is a non-motorized craft, locally known as 'Ponth' which is made up of high density polyethylene. The cost of manufacture is comparatively cheaper than the other fishing crafts which empower the fishermen to come up with a less capital intensive fishing vessel. The normal size of the boat ranges between 5feet long, less than 2feet wide and the body of the boat is lined with plastic sheets. The fisherman use thermocol boats to venture into the

sea by them, rowing with a single oar. This is a typical example of green fishing, as there is no fossil fuel involved in this fishing practice. These boats are conveniently operated close to the coastal area with a maximum distance up to 5-7km. The major gear used in thermocol boat is gill net.

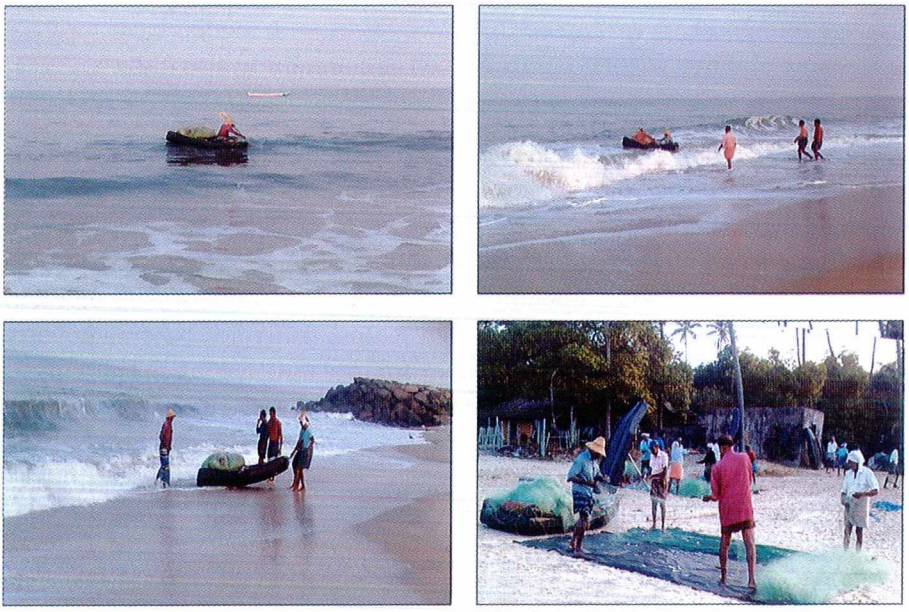

Figure7.Images showing the fishermen engaged in single man operated 'thermocol boat fishery' in Omanappuzha village, Kerala

These thermocol boats are manufactured in large numbers in the Alappuzha district of Kerala, which is famous for mud bank fishery. Mud banks are clearly demarcated areas of calm water adjoining the Kerala coast, during the rough south-west monsoon sea state conditions prevailing in the Arabian Sea. This phenomenon is locally referred to as 'Chakara'. These mud banks are a boon to marginal fishermen of Kerala due to which they can sustain their livelihood too. Thousands of thermocol boats are operating in mud banks, as they can withstand the monsoon related effects such as heavy wind and rainfall. The operational costs are practically less, so that the fisherman can easily access fishes based on the availability.

Contribution of Artisanal and small-scale fishing to food security and poverty alleviation

World summit on sustainable development stated that poverty eradication is the greatest global challenge faced by the world today and there is an indispensable requirement for sustainable development. In addition to

poverty alleviation, food security is another sustainable development goal and nearly 50% of the fish caught in small-scale fisheries is used for food (Venkatesh, 2015). The nutritional contribution which is pronounced in the global community is corroborated with similar estimates in India also with some minor variations in the local areas and fishermen household. Fish as a harvest commodity is consumed directly by fishers on regular basis for their sustenance and that of their family as well as community also (Seema, 2015).

For more than 90% of the fishers, poverty is the major constraint which requires adequate attention. They are largely dependent on middlemen in their operations, as a very few financial institutions have been able to help them in their operations. Middlemen seems to be a necessary evil which sustain the small-scale fishing in the country, as they serve as ATMs on the beach for initiating fishing operations when they have no money to invest in their fishing activities. Often, after a lean season, fishermen become poverty struck and need some operational money for initiating fishing in subsequent fishing season. If they don't operate in time, they miss the chance. Middlemen often looked upon as monsters, who take away chunk of the fishing profits most of the time.

Challenges of small-scale fisheries towards food security and poverty reduction

The main difficulties faced by small-scaled fisheries which restrain their contributions to food security and livelihood are as follows:

Ecosystem related challenges: Faster urban development has been resulting in large-scale encroachment of critical fishing habitats. The destruction of estuaries, mangroves and coral reefs are not only the outcome of anthropogenic impacts, but also resultant of climate change impacts such as greenhouse effect, acidification, *etc.* Further, the destructive fishing methods such as trawling have been identified as anthropogenic driven ecosystem damage.

Fish stock related challenges: Fish being a natural resource, it has been subjected to over-exploitation and related depletion. Over these years there has been excessive bycatch and discards. Being a low capital-intensive fishery, small-scale fisheries have contributed less to this unlike their mechanized counterparts.

Fishing related challenges: Overcapacity and Illegal Unreported Unregulated (IUU) fishing, particularly the unauthorized foreign fleets entering Indian EEZ is a major issue to be dealt with SSF of India. There is a

history of conflicts with large industrial fleets (LOP vessels which is not in operation now) and small mechanized vessels (still continuing).

Post-harvest challenges: Poor handling and preservation methods, and infrastructure issues related to cold chain lead to high post-harvest losses. Low-quality end product due to improper value chain, low prices and greater vulnerability to the creditors/middlemen are often cited as serious issues in SSF.

Fishing villages related challenges: Thickly populated fishing villages are highly vulnerable with low living standards viz., sanitation, health, education *etc.*, displacement and deprivation of land use and access (particularly inshore coastal waters) and various users' conflicts pertaining to the land-use pattern.

Input related challenges in SSF: As discussed earlier, fishermen have less access to affordable credit, poor access to fishing equipment and material and are at the mercy of middlemen who serve as creditors which make fishermen vulnerable to them.

Output related challenges in SSF: Poor access to domestic/ international markets and vulnerability to traders/middlemen who often do under-evaluation of catches. Being a perishable commodity, fish is always priced at the mercy of those who have market control.

Institutional frameworks

There are few inherent advantages for SSF in India. In comparison to other fishing methods, the SSF have fewer negative impacts on the ecosystem. The fishing gears used are mostly more selective and less destructive that renders less by-catch. They have higher dependency due to much lower mobility that leads to a more responsible/ respectful use which can be attributed as cultural ties between land and sea. SSF often have a contribution to the cultural heritage and environment knowledge. There is lower running costs and fuel consumption. The fishing is labor intensive and no way capital intensive. The fishing community shares the benefits of fish stocks with more people and the most needed, while industrial fisheries leads to capital accumulation. SSF are proponents of making it to another day of fishing if there is a community need than prophesying the usual idea of making more money from the existing natural resources for individual benefit.

The SSF system is decentralized and geographically spread out. Therefore, the plans of developing an institutional framework should limit not only on

overall fishing capacity, but also the maximum vessel size for selected fisheries. While developing the institutional framework, there is a dire need to improve participation and transparency by ensuring greater participation of small-scale fisheries stakeholders in the processes of policy development, management decisions and legislation (Mariette Correa, 2015, 2016). There will be a sharing of responsibility to ensure compliance by following co-management/ community-based management. The decisions within the institutional frameworks should upgrade small-scale fisheries within the purview of national agents and implement a pro-poor policy, making sure that fisheries policy development is linked to national strategies to reduce poverty and hunger. Improved fisheries management strategies finally should address the main challenge which is a change of paradigm where we have to transform or move from free/open access fishery where nobody owns, nobody cares for the resources into a community where rights based management which promotes the idea that we own and we care. In India, fisheries being a state subject, formal fisheries management systems are operated under the purview of the state Marine Fisheries Regulation Acts (MFRAs). Indian marine fisheries is managed similar to wildlife with closed areas- 31 marine protected areas and 33 marine national parks & sanctuaries (Singh, 2003) and closed seasons- trawl / fishing ban) being practiced widely for regulating the fishing pressures. But with respect to the gear and craft, there are recommendations for regulating their usage in coastal waters.

The state MFRAs lacked adequate resources, and were unable to cope with rising challenges such as competition from mechanized boats, tourism and industry, lack of capacity to monitor and enforce MFRA regulations, conflict with Marine Protected Areas (MPA) regulations, and limited livelihood options. Therefore, we can say that the MFRAs follow management plans that were not cohesive. When we say MFRA of respective states, the same itself is a misfit for the otherwise sustainable ecosystem based fisheries management proposed as per FAO guidelines. In ecosystem based management, the monitoring and assessment of fishery should not be based on revenue jurisdictions, but ecosystems from where the resources are harvested. Therefore, we have to develop management plans which are integrated in all aspects.

In Indian context, the institutional framework adapted for short neck clam fishery in Ashtamudi Lake can be cited as an example of how we have to develop the institutional framework for sustainability in fishery. The community and administration have come up with the fishery improvement program and has been awarded Marine Stewardship Council (MSC) certification.

Issues and challenges for sustainable small-scale fisheries in the inland fisheries sector of India

India is bestowed with rich inland aquatic resources consisting of wetlands (flood plain and coastal), reservoirs, rivers, canals, backwaters and estuaries. In India, the majority of the inland fishers are small scale in nature who earns their livelihood and nutritional security from fishing in the inland open water resources. ICAR-Central Inland Fisheries Research Institute (CIFRI) studied the socio-economy and livelihood strategies of the SSF of inland open waters such as rivers, estuaries, oxbow lakes or floodplain wetlands, reservoirs and backwaters/lagoons. In recent times, studies were conducted in the rivers Ganga, Mahanadi, Gandak, Bramhaputra, Torsa, Cauvery, Tapti, Siang and Chaliyar; estuaries Narmada, Hooghly and Mahanadi; reservoirs Kangsabati, Chandil, Patratu and Tenughat; wetlands of Assam, Manipur, Bihar, UP and West Bengal; and Chilika lagoon of Odisha. The studies indicated overall poor socio-economic conditions of the fishers' households. Levels of education, operational holdings, family income *etc.* were well below the desired level for a decent living. Fishing is the main occupation of majority of the fishers' households which contributed around 60% of their household income. However, fishing alone cannot provide them sufficient livelihood. Therefore, they engage themselves in different non-fishing activities.

In reservoir fisheries, ICAR-CIFRI demonstrated culture-based fishery taking Fishermen Cooperative Society on board. Cage culture was demonstrated in many reservoirs of Karnataka, Chhattisgarh, Jharkhand, Telangana, Madhya Pradesh *etc.* FRP Coracles and fishing nets (gill nets) were distributed to the tribal fishers. In Karapuzha reservoir of Kerala small-scale culture based fisheries has become successful and the reservoir was stocked with major carps which dominated the catch up to 60%. The culture-based fisheries technology developed by ICAR-CIFRI helped the tribes of Wayanad district in Kerala to earn a decent and sustainable income (Rs. 2,000-3,000/day) through fishing in Karapuzha Reservoir. Cage culture for raising stocking material has been refined for rearing air-breathing fishes such as magur, singhi and koi in deeper wetlands. The commercialized CIFRI-GI cage is a cost-effective and durable ready-to-use cage structure, wherein individual net cage has the dimensions of 5x5x4 m^3.

The present average fish yield in the unstocked beels/wetlands (221 kg/ha/yr) is far below their production potential (1000-1500 kg/ha/yr). Fish stock enhancement protocols have been standardized in the wetlands. Pen culture technology for beels have been refined and demonstrated. Large-

scale pen culture demonstration in 40 beels of Assam in collaboration with the Department of Fisheries, Govt. of Assam has been carried out. CIFRI-HDPE pen is a cost-effective and reasonably durable ready-to-use pen measuring 1,000 m^2. These pens have already been installed in wetlands of Assam and Manipur. High adoption of pen culture technology was observed in different parts of north eastern states.

Inland fisheries in India is often overlooked as they form a small resource group when compared to the marine sector. But all of them qualify to be very much within the ambit of small-scale fisheries. Therefore, in this section of the chapter we are highlighting certain issues those are unique to inland fishing. The prioritized challenges are those which seem to be overlapped with the marine sector, particularly with regard to tenure and access rights. Across India, state laws dictate access to inland waters, similar to the marine fisheries regulation. The inland sector is dominated by SSF which are characterized by highly diverse operations, seasonally and geographically. The various laws governing fisheries in India pay less emphasis on the inland sector as it often overlooked provision under the Constitution of India, Article 262 that assigns to inter-state water-sharing disputes. The scope of such disputes also extended to fish and related resources in the limnological realm.

Various case studies carried out across numerous Indian states by ICAR-Central Inland Fisheries Research Institute (CIFRI) indicate the similarities and disparities in fisheries management (revenue and welfare based models) and socioeconomic and socio-ecological conditions. These differences had important implications for the manner and stages at which interventions that were in accordance with the SSF Guidelines could be introduced. For example, while an inland state in northeast India- Assam defined only a "fisherman" another state in eastern India- Bihar had recognized "traditional fisherman" in its state legislation. The issues confronting the sector included tenure rights to resource access, weak organization in the sector, threats to the resource and thereby to livelihood from outside the sector (pollution, development projects, *etc.)* and the lack of alternative livelihood options. For improvement of SSF in inland regions there is a need of several requirements, viz., establishment of strong policy based governance reforms which may include strengthening of credit systems, encouraging responsible management practices, enhancing income, providing opportunities for alternative livelihoods, increasing consultation and participation in decision making and empowering women to take on leadership and decision-making roles.

Chilika, Pulicatand Vembanad lakes – SSF case studies

Chilika lake fisheries: Fisher folks in this place developed exclusive rights of fishing following a complex management system of partitioning the fisheries of the lake. The resources in the lake are harvested relatively in a sustainable fashion and developed a large range of fishing techniques, crafts and gear. There is a huge support for sustainable fishing in this area under the aegis of Chilika Development Authority. There are fishermen cooperatives who bid for the fishing lease in the area on behalf of fishermen. They work for protecting the rights of fishing for fishermen in a sustainable way. Since the famous Irrawaddy dolphin (*Orcaella brevirostris*) is considered a key-stone species in this area, there are lot of conservation efforts taken for the protection of the same. Eco-tourism, prawn and shrimp farming and related activities also take up a major role in Chilika Lake.

Vembanad lake fisheries: The rich biodiversity and socio-economic importance made Vembanad Lake a wetland of international importance, designating it as a Ramsar site. A unique characteristic of the lake is the Thaneermukkom salt water barrier which divides the lake into two zones, one with freshwater fed by the rivers on the southern side and the other with brackishwater fed both by rivers and by the Arabian Sea on the northern side. Chinese dip nets, coracle fishing, clam fishery, house boat tourism, pokkali farming, sub-sea level farming and related activities make Vembanad a good example of various co-existing livelihood activities based on its resources. But the excess of all these and the dependence of local community on these resources made it highly vulnerable and there are serious efforts to make this ecosystem sustainable through various public private funded packages.

Pulicat lake fisheries: The villages around Pulicat take turns to do fishing using shore seines. Fishing in the Lake is done only twice a week by a village. From one village, on a particular day, few crafts may operate. It may be as less as a single fisherman. They carry out this fishing operation a few times in a day. One or two people do the investment on a particular day for one seine. This fetch them up to Rs. 50,000 during a good fishing day. The returns may vary significantly and there are days without any returns despite the effort. Some days the returns are very poor, as less as Rs.10,000. The fishermen have belief in omens. Getting turtles is a bad omen and very discouraging and they may give up fishing for the rest of the day. Such fishing which sustains an entire fishing village is affecting the survival and sustainability of the entire village when fishing is challenged. There are

instances of serious shifting of occupational pattern among the new generation in the community in search of greener pastures.

Conclusion

Marine fish production in India is catered mostly by the wild caught finfishes which is to the tune of 3.83 mmt as estimated during 2017 (CMFRI, 2018). Small-scale fishers contribute in terms of number of people and crafts involved, but the proportion of fish harvested in SSF is less. A study from CMFRI indicates that the domestic consumption pattern in India is soaring with an estimate of an annual average growth of 3.5%. This domestic demand is coming up when there is already an under-utilization of the existing seafood processing capacity in India for want of raw material. In the country, the seafood processing sector is working to only at 1/3rd of its capacity. Further, there is rising a demand globally for fish and shellfish with more pressure on marine resources. Therefore, there are efforts for augmenting the production of marine fish from Indian Exclusive Economic Zone. Long-term forecasts predict that we have to produce at least 6.0 mmt in the next one and half decades from marine sector alone to satiate the fish demand. But most of these measures are not supportive to the small-scale fishers of the country. Being a leader among the SAARC nations, Indian fishing scenario may be looked upon as an example to project SSF in SAARC. Solutions for the problems can also be similar. This article calls upon the need for a larger regional cooperation to alleviate the poverty among SSF population.

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Chapter 3

Small-scale Fisheries in Nepal

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Nepal is a landlocked country with an area of 147181 sq km; having tremendous geographical diversity; altitude ranging from 60 m in the Terai to the highest peak of the world, Mount Everest, 8,848 m. The climate of Nepal is greatly influenced by altitude as well as the latitude of the location, and the country exhibits every kind of climatic zones (arctic, alpine, temperate, sub-tropical and tropical) within its small area (Rajbanshi, 2012). Nepal has no marine resources. Nepal's aquatic resources are based on inland fresh water. Rivers, lakes, reservoirs, swamps and irrigated paddy fields are the major source of fresh water in Nepal. Approximately 5.5% of the total area of the country is known to be occupied by different freshwater aquatic habitats where around 232 fish species (Gurung, 2018) are reported to thrive. In general, aquatic habitats and fish species can be viewed as prospects for fisheries and aquaculture development of the country. This also implies that aquatic resources located at a different altitude and the climatic zone can offer different fisheries and aquaculture activities in Nepal.

Status of aquaculture development

As a landlocked country, Nepal depends only on inland aquaculture with finfish farming and climatic condition favors cultivation of both warm and cold-water species. Aquaculture practices are a quite new trend in Nepal and it was started in the early 1950s (Gurung, 2004). Afterward, several attempts have been made for the gradual improvement in technology, but its pace of development was slow till the 2000s. Aquaculture practices that contribute to fish production in the country are, pond fish culture; fish culture in swamps; rice-fish culture; cage-fish culture; pen-fish (enclose-fish) culture; race-way culture (trout culture). Majority of cultured species are exotic.

Nepalese aquaculture is in a growing stage and the amount of fish production is too low compared to the world aquaculture production; however, the progress achieved in recent years is highly encouraging. The pond aquaculture with common carps, Chinese and Indigenous Major Carps significantly dominates aquaculture with average production of 4.91