Centre for Strategy and Leadership

Role of **IoT** in the **FISHERIES** Sector in **India**

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Introduction & Background

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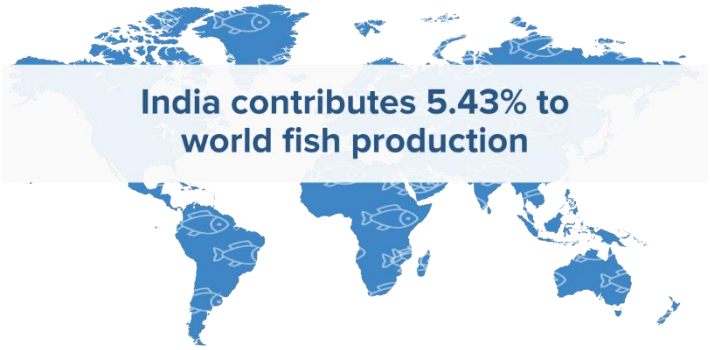
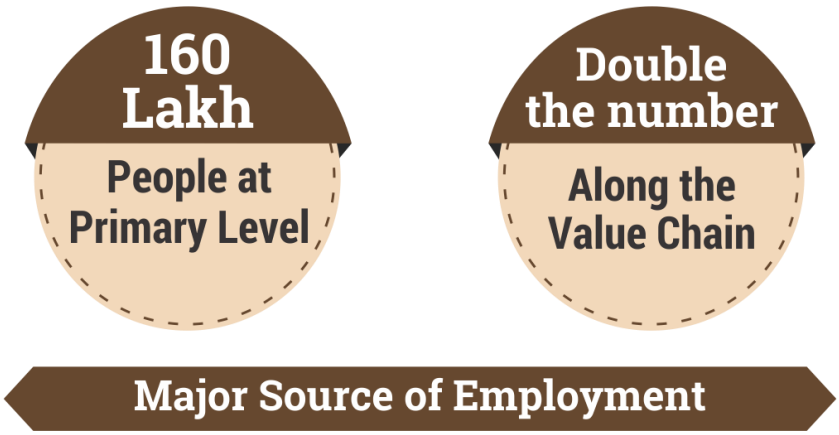
India is the second largest fish producer in the world, contributing 5.43% to world fish production. The country is a major producer of fish from aquaculture and the second largest producer of fish in the world after China. Fisheries is one of the most committed agricultural cooperative sectors in India.



The fisheries sector occupies a prominent position in the socioeconomic development of the country. It encourages the development of several ancillary industries, and is a source of cheap & nutritious food and of foreign exchange; hence, it is recognized as a strong source of income and employment. In the year 2018–19, fish and fish products became the largest group of agricultural exports, accounting for Rs. 47,620 crore. India is the world's second largest fish producer with an annual production of 13.7 million tonnes (MT) in the year 2018, of which 50% comes from the domestic sector. Agriculture accounts for about 50% of the indigenous fish production, which is 6.5% of world fish production. The sector is witnessing steady growth in the total value added, accounting for 5.23% of the total GDP.

India's fisheries sector provides livelihood support to approximately 160 lakh people at the primary level and almost double the number along the value chain. The total fish production during 2017–18 was about 12.59 MT with a contribution of 8.90 MT from Inland sector, and 3.69 MT from Marine sector. A target has been set to enhance fish production to 20 million metric tonnes (MMT) by 2023–24 [up from 13.37 million metric tonnes (provisional) in 2018–19] at an average annual growth of about 9% (up from 7%) (GoI, 2019a).



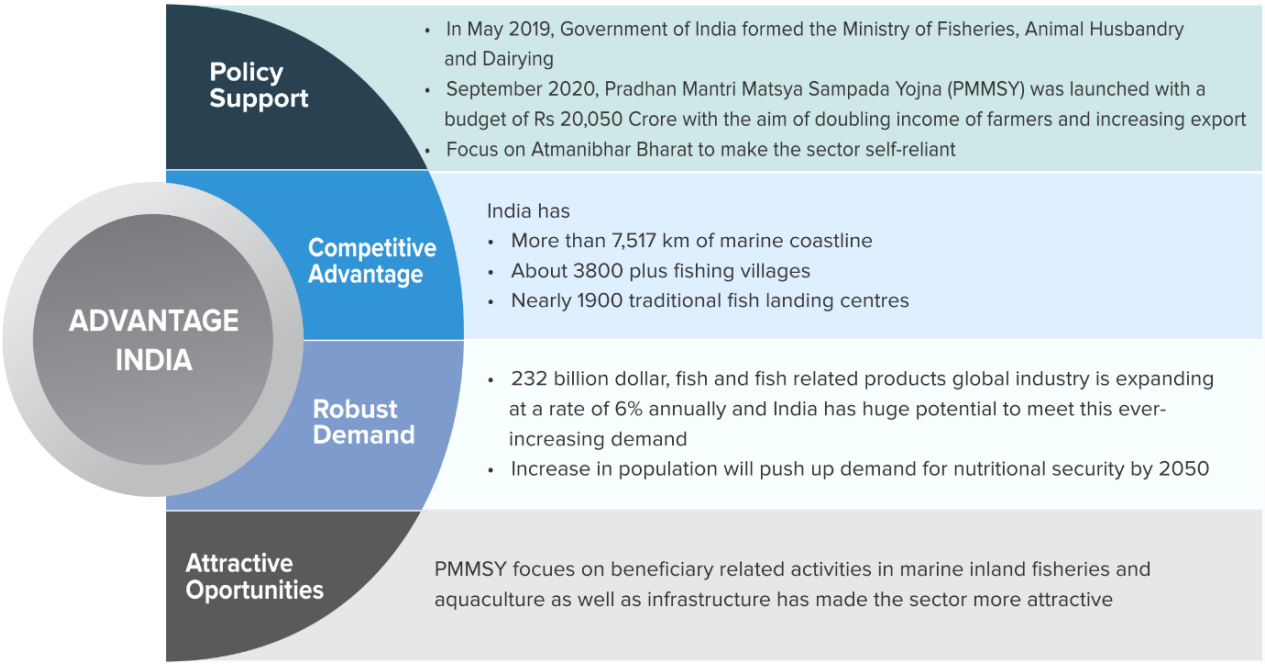
Most importantly, it is a source of livelihood for most of the country's economically oppressed population. The major challenges facing national fisheries development include fisheries resource and fish product evaluation, development of sustainable technologies for fin and shell fish farming, crop optimization, post-harvest and harvest activities, right fishing vessels, and suitable landing & berthing facilities for fishing vessels (Gupta *et al*., 2015).

India's absolute fish production in 2018 stood at 6.24 MMT. This is nearly 66% of the total local fish production from both capture (naturally occurring) and culture (controlled cultivation of fish in water bodies) sources. The primary productivity, however, comes from culture fishing as capture fishing is not practiced extensively. About 12.8% of all animal protein consumed in India is obtained from freshwater fish (Anand, 2019).

Freshwater fish cultivation in India refers to the breeding of multiple aquatic species in water areas such as ponds, reservoirs, and lakes. Natural food organisms are made by adding natural and inorganic compost to the water and numerous species utilize this food, dependent on the supplement arrangement of the lake. The main breeding targets for culture fishing are the huge Indian carp mixes including rohu (Labeo rohita), catla (Labeo catla), and mrigala (Cirrhinus mrigala), as well as a few other species native to China like silver carp (Hypothalamythus multitripon) and grass carp. Culture fishing has quickly become popular because of the importance of

carp as a valuable food item. For a long time, India has not deviated from this type of aquaculture practice. Poor quality or nutrient deficient feed were fed to fish using feed bags. The feed conversion ratio (FCR) in India is 3–4 kg of feed for 1 kg fish production. Fishes weighing 1–1.2 kg are usually harvested after 8–10 months (Anand, 2019).

ADVANTAGE INDIA



Culture System Diversification

For a long time, and in line with the tradition, the Indian fish farmers have habitually used only pond-based aquatic farming methods, thereby overlooking other diversified alternatives that could significantly increase fish production. Freshwater fish farming has recently begun in several states of India.

In fact, until 2008 the development of cage aquaculture was limited due to lack of availability of outdoor floating fish feed. This limitation, however, has now been overcome. In addition to a system based on ponds and cages, more modern measures will be adopted to increase production in India and at the same time optimize the use of land, electricity, fuel, and other inputs besides conserving water (Pillai and Satheeshkumar, 2012).

Impact of formulated Aqua Feeds

India was not on the list of Asian fish producing countries until 2007–08 when the first fish feed plant was set up. A feed-based farm run by the U.S. Soybean Export Council since 2003 has helped provide a number of opportunities to the fish feed industry. Cultivation of pangasius (Pangasius hypophthalmus) has found favour with fish farmers in India with the introduction of scientifically initiated outdoor floating fish feed. The introduction of exogenous feeds has largely supported the growth of pangasius cultivation, adding a new, important species to the country.

The first extrusion feed mill was launched in India in 2008 and since then many feed mills have been built and operated. As of 2013, there are 12 feed plants capable of installing 1.55 MMT of feed per year. In 2013, about 6,83,000 MT of outdoor fish feed was sold, indicating utilization of 44% out of the available capacity of the feed factory.

The demand for extruded mixed fish feed has not increased in proportion to the installed feed capacity. The main reason for this is the narrow range of edible species cultivable in India. The country relies heavily on carp as they can eat compound feeds as well as different feed combinations. If the price of corpus farm gate is economical to the farmer, they are given good quality high-priced feed and when the prices fluctuate and fall, the fish is given low-cost supplementary food material. In addition, the main Indian carp naturally feeds through the feeder slowly. As a result, the current feed capacities remain underutilized (Anand, 2019). Intensive fish farming is high-cost; the purpose of feeding fish is to provide nutritional requirements for health, optimal growth, and optimal yield. India produces large quantities of foodgrain; these include a variety of oil cakes, beans, flour, seeds and grains. In contrast to natural foods, which are a part of the conscious lifestyle and are therefore not biologically stable, artificial feed does not degrade rapidly but cause loss of nutrients in the water (Campling, 2012).

Most of the aquatic production in the country is used to cultivate active feed consumers, pangasius and pacu (Piratus brachiapmas). Tilapia cultivation has not yet been successful in India. Increasing species diversity not only seems to be leading the way in feed use, but also in increasing fish production and stabilizing farm gate prices. This intervention helps provide customers with multiple options and also to produce short-boned fish which is largely preferred by consumers (Anand, 2019).

Impact of Feed-Based Fish Farming

There are many additional benefits of adopting feed-based aquaculture in India. The introduction of mixed feeds has significantly reduced the amount of organic load that contributes to complementary feeds in domestic reservoirs. If about 1.5 FCR (feed conversion ratio) yield was used for fish farming with 1 MMT formula feed in 2019, it obviously replaced the unique fish feed that was driven by 3–4 FCRs and converted into 1 kg fish production (Anand, 2019). Water conservation is unanimous decision because India accounts for only 4% of the world's water resources and 17% of the world's population. Thus, it can be concluded that feed-based systems have made a significant contribution to water conservation, a key national issue (Lopez *et al*., 2014).

It is estimated that Indian freshwater is covered by only 10–15% of feed-based agriculture, and the vast body of freshwater can still be converted into this system. If properly managed, it can increase the production of national fish.

Markets

Most freshwater fish are sold fresh or on ice. Some are sent directly to nearby markets in order to fetch higher prices. There are several large markets like West Bengal, where there is a daily demand for carp. The locals of the state love to eat fish – it is a part of their culture, and farmers and traders try to transport fish to this attractive destination.

In India, fish is usually picked, harvested, and sold at high prices in different markets. Fish is sold either in the morning or evening, limiting its supply to customers. In spite of Indians consuming significant amounts of fish (12.8% of total animal protein supply)—in 2019 it was 20.5 kg per person compared to the world

consumption—the country still does not consume the recommended 5.04 kg per person of fish protein per year (Anand, 2019).

Contributions of the fisheries Sector to India's Economy and Livelihood

The fishing sector occupies a very important position in the socioeconomic development of India. It encourages the development of several ancillary industries, is a source of cheap & nutritious food and of foreign exchange and therefore, recognized as a strong source of income and employment. Most importantly, it is a source of livelihood for most of the country's economically depressed population.

According to the Central Statistics Organization (CSO) estimates, the total output of the livestock and fisheries sectors during 2007–08 was Rs 2,82,779 (Rs 2,40,601 crore for livestock and Rs 42,178 crore for fisheries), which is about 31.6% of the income of Rs 8,44,420 crore from agriculture and allied sectors. In 2007–08, the sector contributed 5.21% to the total GDP (GK Today, 2011). India is now the second largest producer of fish. During the year 2016–17, at current prices, the livestock sector produce stood at 9,17,910 crore, which is about 31.25% of the income from agriculture and partnerships. Fixed-price agriculture and related sector output was about 31.11% of the livestock output. The total fish production in India in the fiscal year 2017 was 12.61 MMT (GoI, 2019b).

Fish trapped in rivers, lakes, canals, floodplains, aquariums, and reservoirs have always been the basis of rural livelihood and food security. At the same time, the degradation of reservoirs due to various reasons has affected the biodiversity, quality, and quantity of fish obtained from them.

In 2007–08, fish seed production was 24,143.57 million fry (Shukla *et al.*, undated). Looking at the contribution of fisheries to income in small states, the data also shows that there is a huge potential for "fish rain" in the agricultural system.

Fishing – A State Subject

Fishing is a state issue and the main responsibility for development lies with the state government. The main objectives of fisheries development are to improve production and productivity, increase exports of fishery products, create employment, and enhance the socioeconomic conditions of the fishermen community. In the Indian context, fish farming is considered a state subject and most of the core support is provided to marine fisheries and central agency management.

At present, the State Marine Fishing Regulation Act of maritime states protect and regulate the fishery resources in the territorial waters that are up to 12 nautical miles from the baseline, while the Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act, 1981 or MZI Act regulates fishing by foreign fishing vessels in the maritime zones of India.

In Andhra Pradesh (a leader in fish production and income generation), the fishing sector contributed 2.33% to the state's GDP in 2008–09. Andhra Pradesh earned about 481 billion Indian rupees in gross value added from fish products towards agriculture in the fiscal year 2018. The gross value added from this state made up about 35.6% of the fish products nationwide. Fishing was valued at over 1.3 trillion rupees in gross value added in the Indian economy during the same fiscal year. The gross state domestic product at constant prices for the year 2018–19 (advance estimates) is estimated at Rs 8,50,000 crore. At the state level, inland fisheries development programmes rely heavily on the central region. Almost all states see the fisheries sector as a source of income, but aquatic investments and subsidies are not promoted as policy guidelines.

The Madhya Pradesh government implemented a Fisheries Policy in 2006. It included subsidies and assistance to farmers, raising aquaculture to the same status as agriculture. However, the implementation of the policy at the field level is a question mark. Central assistance alone is not enough to meet the needs of aquatic operators.

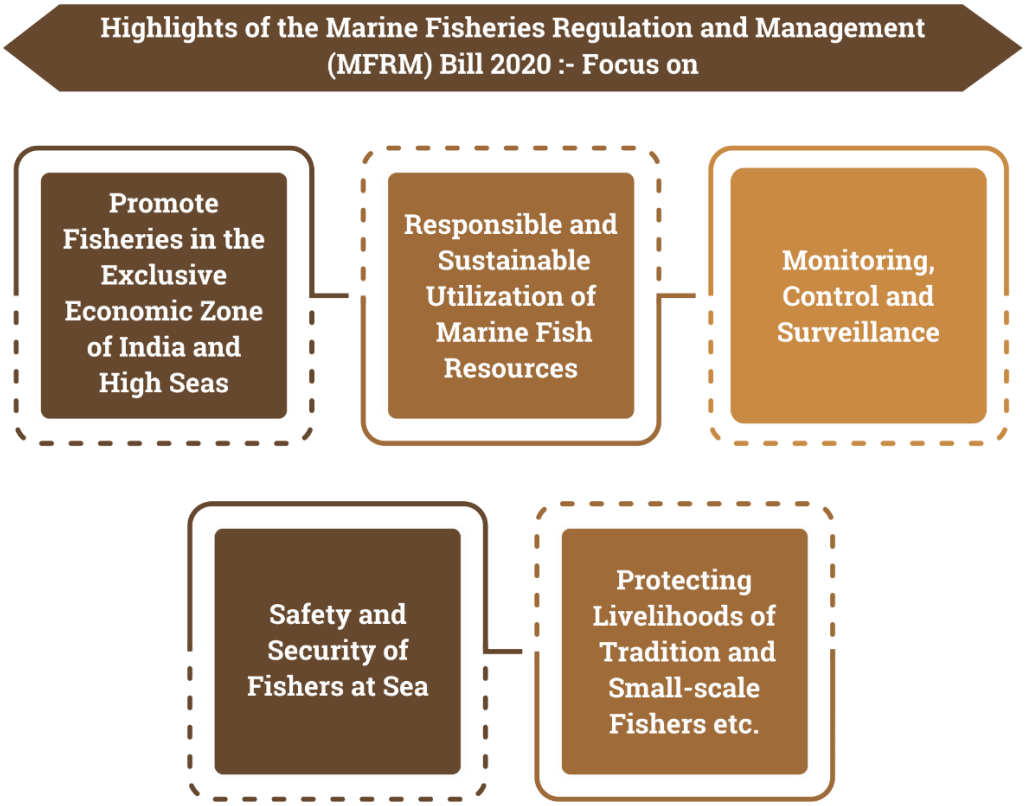
Marine Fisheries Regulation and Management (MFRM) Bill 2020

Highlights

To provide for:

- regulation and management of fisheries in the Exclusive Economic Zone of India and high seas,

- responsible and sustainable utilization of marine fish resources,
- monitoring, control and surveillance,
- safety and security of fishers at sea, and
- protecting livelihoods of traditional and small-scale fishers, etc.



Highlights of the Marine Fisheries Regulation and Management (MFRM) Bill 2020

Improve productivity and production

Development plans of different states give top priority to increased production and productivity through aquaculture by way of supplementary collection in reservoirs, beels, ponds, etc. In each case, the Indian main carp and the three exotic carp are not preferred.

Although little is said about the conservation and growth of other endemic species, there is no policy to advise the indigenous people to consider the inland fishing sector for socioeconomic and environmental development. To this end, government input and investment has not been taken seriously. Nevertheless, market facilities and market development in the domestic fisheries sector are directly controlled by the middlemen and traders. Full value chain management, transportation and supply of seeds up to deciding the market price of fish need to be assessed. Neither the central government nor any state government is discussing how they can free the fish production system from the cooperative sector (Vivekanandan, 2011).

Impact of Covid-19 on the Indian Fisheries Industry

The Covid-19 shock unsettled the world, cutting down both demand and supply, thereby resulting in an economic downturn. The problem in India could be chronic as the Indian economy deteriorated significantly after a few years of poor performance during the pre-Covid period. Fish production in India in 2018–19 was 13.34 MMT, i.e. about 6% higher than the year before. It is a matter of concern that the country is the fourth largest exporter of seafood in the world. In 2018, India exported 13,77,244 tonnes of seafood, which fetched $7.08 billion. From 2011–18, Andhra Pradesh was the top fish producing state in the country, followed by Gujarat and West Bengal, producing 34.5, 17.42 and 8.35 lakh tons of fish respectively. In terms of domestic production, Andhra Pradesh now ranks behind Uttar Pradesh and West Bengal. Notably, Gujarat was the first state to begin marine fish production among all maritime states of the country (MSSRF, 2020).

Some of the major marine fishes are the Indian oil sardine, hilsa, lizard fish, sea catfish, sear fish, silver belly, barracuda, anchovy, mackerel, clupeid, yellowfin tuna, skipjack tuna, penaeid, crust crab, and non-penaeid prawn. In domestic fish production, Indian major carps are the most cultured species followed by catfish, exotic carps, murrel, and minor carps. According to the percentage share of disposition of catch, the market share of fresh fish was 78%, followed by 4% as curring, and 8% as freezing. India produced 52,262 million fry in 2017–18 where West Bengal was the key contributor.

Fisheries sector is an important part of the food and nutrition security worldwide as well as the main source of manpower for rural coastal communities. Fish and seafood products are the best-selling food products, accounting for 38% of the global trade. The 2019 Covid-19 lockdown dealt a huge blow to the fisheries sector, particularly the post-harvest and harvest stages.

Declining consumer demand, low supply, and disruption of supply chain will have a direct impact on fish processing plants, fishermen, fishmongers, suppliers and transport labourers. Moreover, the postponement of several research & development programmes and of the science & management meeting will lead to the slowing down of this sector. In addition, lockdown in the harbours and landing centres has severely affected fishermen in all four coastal union territories and nine coastal states in the country. Fishermen have not been able to enter the sea since March 24, 2020. Meanwhile, a ban was imposed on fishing from April 15 to June 20 on the east coast. For the west coast, it was from June 1 to July 31 (Dry Cargo International, 2020). Therefore, marine fishermen were not able to go fishing for about 75 days on the east coast and 130 days on the west coast. Thus, there is no

doubt that because of this epidemic, the fisheries sector will face severe repercussions even in the post-lockdown period.

In addition, the rise in agricultural labour wages in rural area was depressed both in real and nominal terms from the pre-Covid period. The prevalence of coronavirus further disrupted the fishery activity as well as the supply through various aspects such as crop harvesting, procurement, marketing, and processing. Labour movement restrictions and transportation hurdles directly affected the agriculture and processing industries. March to June is the final season for fish farming as well as shrimp farming which became a barrier for migrant workers (*The Economic Times*, 2020). Crisis of fish seeds, fertilizers, and other inputs also hampered the demand for fish production.

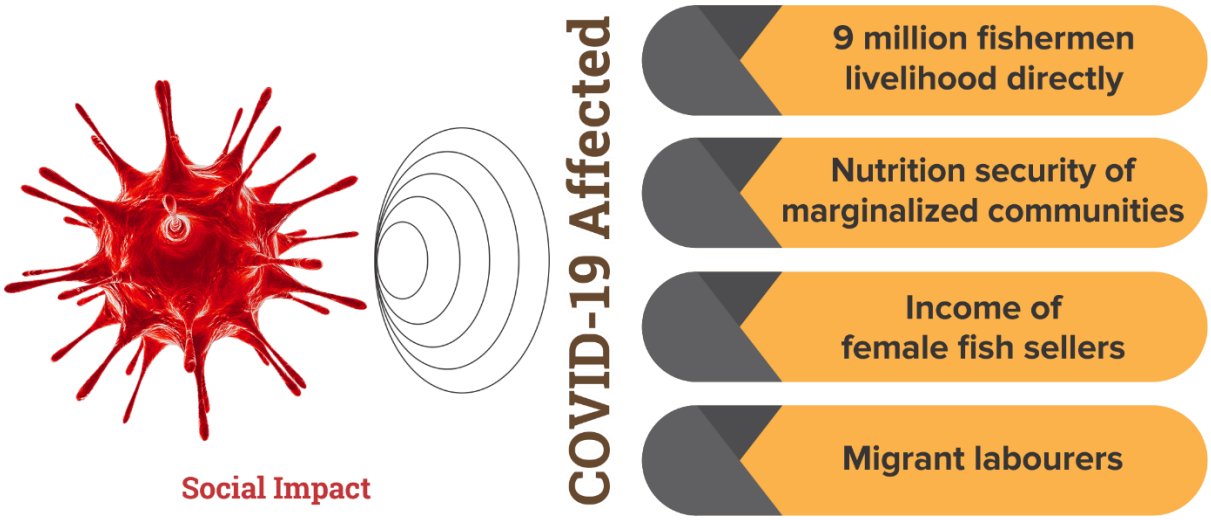
Suppliers and manufacturers were seen to suffer greatly from the declining demand, transportation restrictions, and the closure of various restaurants and retail stores. Many farmers were not able to sell their produce because of supply chain disruptions, incurring huge losses. Despite having the necessary services, the fish and food supply chain still faces many problems in marketing. Some people are not purchasing fish for fear of infection. In India, seafood exports may get retarded as the sector is likely to miss the $7 billion target because of the impact of Covid-19 outbreak on international demand (Kumar, 2020a). However, most export markets, such as the United States and Japan are purchasing selectively and the European market is completely closed off. Therefore, this sluggish farming sector and stagnant exports are going to put the fisheries industry of the country in a severe crisis (Chohan, 2020).

Social Impact

The complete lockdown was expected to help contain the spread of coronavirus. Instead, the outbreak of Covid-19 and the total lockout in India caused severe damage to the livelihoods of the fishing community across the country. Hence, immediate and effective intervention by fishermen is needed to reduce the disruptive impact on the lives of the vulnerable populations, especially on food systems, storage and market chains, both regionally and logically.

In India, fisheries is a major sector for food and nutrition security. More than nine million active fishermen depend directly on it for their livelihood, of which 80% are small-scale fishers. Also, it employs more than 16 million people and contributes 1.1% of India's GDP. Additionally, the east coast of India comprises four maritime states, i.e. Andhra Pradesh, Tamil Nadu, West Bengal, and Odisha, as well as the union territories of Andaman and Nicobar Islands and Puducherry. Fishing is mostly

done using traditional fishing crafts, small mechanical crafts, and motorized boats. In general, the east coast region accounts for 25% of the total Indian marine landings (Chinazzi et al., 2020).



In India, small-scale fishermen face problems in three areas: organization, pricing, and marketing. Most are long-term needs but there are some that are directly related to the coronavirus. A complete lockdown at the landing centres and harbours has affected the daily income of the fishermen across all coastal districts of India.

Moreover, small-scale fishermen are especially responsible for supplying fish (which is a major source of protein) to buyers at low cost. It is a very important source of subsistence and livelihood for the marginalized communities; hence, lack of fish in the diet will have a significant impact on the nutrition security of the populace. In a few villages near Chennai, small-scale fishermen find it difficult to sell their catch. Because of physical distance rules, only few fisherwomen at the landing centre can purchase fish from the fishermen. The time spent on selling fish is limited, so they are forced to sell fish at low prices. For example, before the Covid-19 lockdown, if the rate of fish was INR 500 per kg, the prices were pushed down to INR 300 to 350 (MSSRF, 2020).

Due to the lockdown, female fish sellers have been significantly affected either because there are no fishing activities, or in some places there are only a few fishing boats. Also, the low catch brought to the landing centre is subject to high demand. Although some women buy reasonable amounts of fish from the landing centres for selling in the streets, because of the epidemic, people are not purchasing fish. Besides, customers bargain for lower prices. As a result, their incomes have reduced drastically, making it difficult for them to manage their families.

Workers working in the sector are suffering huge losses. Typically, fishing workers earn money from ship owners during the ban/lean fishing period. However, the boat owners are also facing economic problems because of the lockdown. As a result, workers are having difficulty in meeting their living expenses. Moreover, people who migrated from Tamil Nadu to other states such as Karnataka and Kerala for fishing activities have nothing left because of the national lockdown. Besides, some fishermen reported that their families were having only one meal each day (MSSRF, 2020).

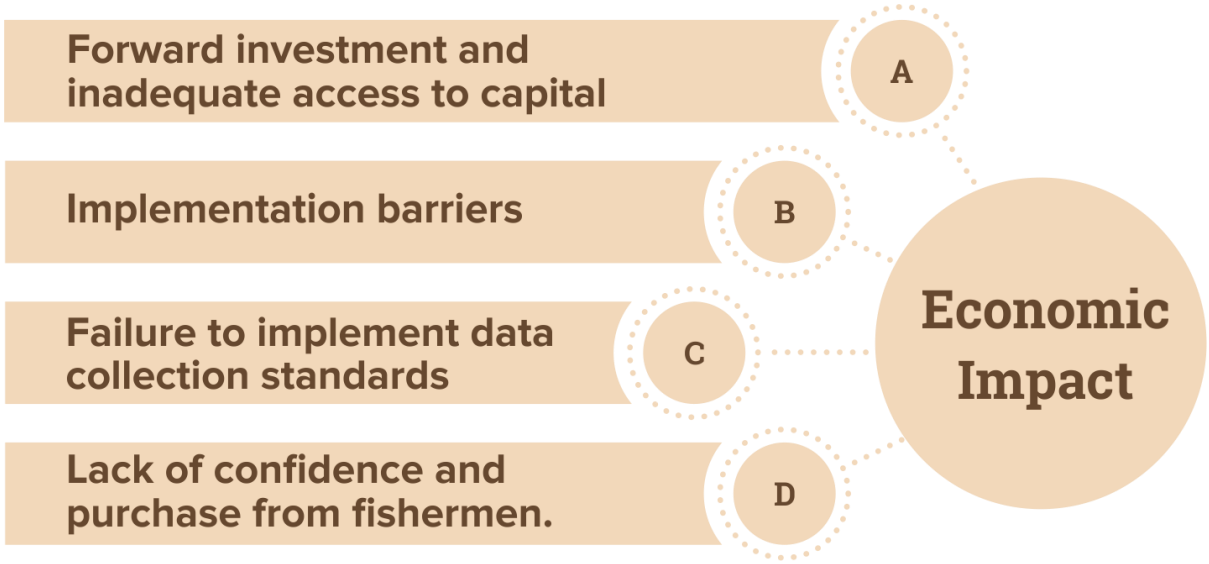
Prior to the lockdown, the trawler operators/fishermen who had been at sea for a long time had to return to the shore. To make matters worse, the fishermen faced difficulties in marketing their catch because of the lockdown restrictions. Only fishermen who were equipped with storage facilities were able to save and market their catch. There is another section of fishers whose catch was severely damaged due to lack of storage facilities. It may be mentioned that huge quantity of tuna fish was discarded in Chennai due to shortage of storage facilities (Dev and Sengupta, 2020).

Due to the stagnation of the export market, fisheries as well as its allied sectors have been severely affected. For a long time, fish traders were not able to procure fish due to the lockdown. As a result, the seafood exports market shrunk considerably. Only fishers were allowed to enter the harbour and that too only for short a period (not more than half an hour). Moreover, the supply chain was severely disrupted. Diesel workers, ice-plant workers, and young people were left jobless. The daily loss ranged from INR 500 to INR 2,000 (MSSRF, 2020).

In short, the lockdown has affected other fish related activities such as net mending and boat maintenance. It also caused great damage to valuable assets such as fishing crafts and gears. Many fishing families reported that besides loss of income, the lockdown disrupted the premeditated jobs such as construction of boat, net and boat repair, and repayment of loan taken for various fishery-related purposes.

Economic Impact

According to the report of the Central Institute of Fisheries Technology (CIFT), the Covid-19 lockdown has put the marine fisheries sector of the country in deep sea, inflicting a daily loss of Rs 224 crore and a monthly loss of about Rs 6,838 crore. The loss to the mechanized sector was estimated at Rs 6,008 crore and that to the non-mechanized sector at Rs 830 crore. But the loss experienced in exports, fish processing, and other nodes of the values chain are not considered (Kumar, 2020b).



In 2017–18, the fisheries sector contributed about Rs 1.75 lakh crore to gross value added. Marine products are the major agricultural commodity exports, accounting for nearly $6.7 billion, and are increasing by 10% each year. But due to the lockdown, some fishing activities became non-operational. Moreover, fishermen who were at sea prior to the lockdown, were not able to sell their catch. Also, the distributional impact of this was felt more by children, women, families, and coastal communities that include migrant workers, wage earners, and regular fish consumers (Kumar, 2020b).

Also, fish processing and export activities are influenced by maritime countries. The economic downturn due to the epidemic in major export destinations including the United States, the EU, the United Kingdom, and China is expected to dampen India's export performance in the coming days.

This could ultimately affect India’s marine life. Besides, fishing and related activities in Gujarat—the first state to complete production of 8 tonnes of marine fish in 2018—have been severely damaged. By January, China had become Gujarat's main export market; however, trade was affected when the Covid-19 virus infected China. Many importers affected by the epidemic canceled orders, creating uncertainty in the export market. Prices were expected to fall by 20–40%. The report suggested the formation of a committee that will include stakeholders to study the problems faced by the fisheries industry and to take corrective action. Keeping in mind the financial needs of the fisheries sector, the government must devise a comprehensive economic package which may include relief packages for fisherfolk as well as processing factory owners containing financial components, such as subsidies for fishermen, deferring of loan installment, and loan waiver (Kumar, 2020b).

Challenges in the Fisheries Sector

The first five-year plan identified priorities for the modernization of India's marine fishing sector. These included mechanization of national technology or introduction of new mechanical boats, port facilities, marketing development, ice management, and refrigeration and transportation facilities.

The plan highlighted the need for human resource development, particularly cooperative advertising, mechanization to avoid looting, efficient marketing, proper land consolidation, middle class elimination, and fish management after harvest. The development of diesel engines, drilling materials, powerful hydraulic and deck equipment, and electronics have improved efficiency and accelerated the mechanization of domestic fishing vessels. Technological advances in boat and gear design, the use of new hull materials such as steel, engines and equipment, storage and processing, and the increasing use of GPS (Global Positioning System) at hand in recent years have provided access to all marine fishing companies in exclusive economic zone (EEZ).

Although much has been achieved over the years, the overall progress has been slower than what was envisioned. Fishing practices have largely remained unchanged over the centuries. Besides, lack of modernization and non-adoption of new technologies are the core issues responsible for the slow pace of development.

Lack of Modernization

The application of new data technologies that fishermen rely on in the fisheries sub-sectors has proven that innovation can improve the efficiency of fisheries management processes. However, their inclusion in the sector has been slow. With the fishermen at the waters, lack of modernization is not only a risk to their own safety, but also it can become a national security issue.

Four key challenges that have hindered the use and integration of new fisheries-based data technologies across all fisheries sectors are: (i) forward investment and inadequate access to capital, (ii) legal and bureaucratic barriers, (iii) failure to implement data collection standards, and (iv) lack of confidence to purchase from fishermen.

First, the resources required to acquire new hardware and software for data collection have been identified as a new impediment to the adoption of new technologically advanced fishery-dependent data systems, including the need for new human resources. Despite potential long-term savings, the cost of switching to new technology is high (Bradley *et al*., 2019).

Second, long drawn legal and bureaucratic processes have at times led to delays in projects, leading to slower adoption of modern technologies.

Third, failure to implement data collection standards is another impediment to the inclusion and adoption of new technologies. Unless industry standards are set, data discrepancies will act as a barrier to effective data collection and interpretation as well as to its effective use.

Fourth, lack of confidence to purchase from fishermen is another barrier to the inclusion of modern technologies in the waters. While fishing techniques are important, the safety of the fishermen and their boats is of equal importance. A fish farmer can be taught how to adopt modern fishing technologies and include these techniques in his day-to-day work, and at the same time stressing on the importance of installing safety equipment in his boat.

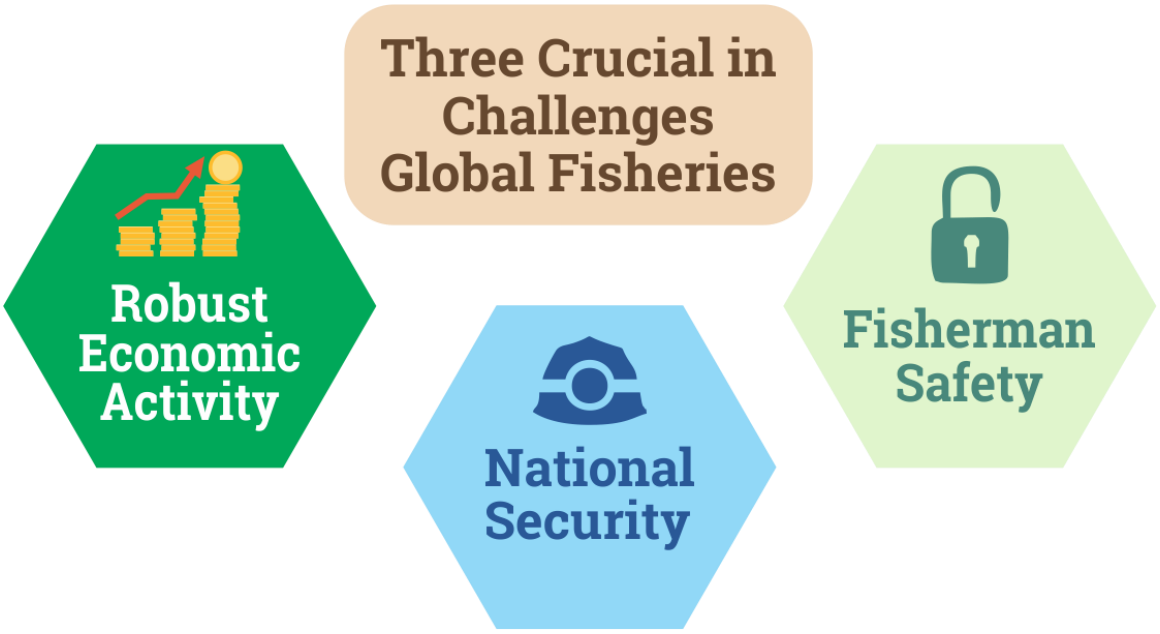
It has also been found that the available devices are complicated to use and require signification space for installation, which discourages the small and medium fishing boats from using the devices.

Safety equipment, such as from Skylo Technologies, which has been in the market for some time, need to be incorporated which will not only provide early warning in

terms of the ever-changing climatic conditions in the water, but also will be central in locating the boat during a mishap as well as keeping a tab on new and unregistered entities in the water.

Robust Economic Activity, Safety & Security – Three Crucial Challenges

Global fisheries face three major challenges: (i) making fisheries a robust activity, (ii) ensuring safety of fishermen, and (iii) national security. Unless digital & technological advances and innovative monitoring tools are employed in a robust and mandatory manner, loose ends will not be gathered, thereby leading to a slowdown in fishing activities.



Three Crucial Challenges

Modernization is the process by which countries transform into urban and industrial societies from traditional societies. But the fishing community of the country has been largely left out of the overall development process. The main reason for this is the rapid marginalization of communities in the markets and in the coastal waters, following the government-initiated steps taken by the state in the early 1960s to improve modern practice.

Further, the opportunities provided by the "development" programme led to free entry of rich "outsiders" into what was a coastbound sector. The new entrants took on the role as boat owner, moneylender, employer, and middleman-trader; as a result, the fishermen were not able to free themselves from their domination. In addition to this development came the competitive use of fish harvesting methods,

encouraged in both the traditional and mechanized sectors by a preliminary spurt in profits and productivity. Given this, it will lead to a decline in resources in the fisheries sector and damage the marine ecosystem (Vollen and Haddara, 2019).

River and lake fishing is common in India. However, more than 70% of India's total fish production comes from the sea. While it is an important activity from the economic and food security perspective, the safety of the fishermen and national security are central to the activity.

Many fishermen feel that the IoT equipment installation is expensive due to which fishermen with low incomes are not able to afford it. Some also feel that satellite providers are ridiculously expensive and only add up to cost to the fisherman. In addition, the cost of using cloud records for storage and extracting data is high for the fishermen. Unless these are addressed, it will be difficult to further accentuate fishing as a robust economic activity, thereby keeping fishermen's safety and national security at stake.

Impact of Modernization on the Fisheries Sector

As stated by Jothiswaran *et al*. (2020), modernization has been very good for human beings in terms of social and economic development, but it also has a few negative effects. In the fisheries sector, it has resulted in most marine fishing fields being severely overexploited for human consumption – for vitamins, fish meal, and various other uses. Because of this, over 8% of marine fishery is exhausted, 16% over-exploited, 3% under exploited, 21% moderately exploited, and 52% fully exploited. It has become a serious threat to the sustainability of the marine resources.

In addition, aquatic habitats have been destructed or altered hugely for the construction of embankment for drainage, irrigation, and flood control. Besides, the pollution caused by the use of fertilizers & pesticides, indiscriminating release of industrial wastes, and unintended construction of rural roads and tunnels hinder uptake of fishing and related activities and also destroy marine life.

Vollen and Haddara (2019) confirmed that fish catch has declined radically in India, China, Japan, Thailand, South Korea, and New Zealand. Because of the decline in fish production, fisherfolk have ventured into disputed offshore waters of their country as well as into the waters of other nations to catch fish. It is also a big challenge to not only protect the marine resources, but also maintain the security of the country. Moreover, China is the largest exporter of fish and fish products in the world for the past 12 years. However, China faced criticism for offshore fishing, the export value of which was US$20 billion in 2013. According to the Institute of Oceanology in China,

30% of the fishermen had distorted the marine resources while 20% over-exploited it. As a result, the impacts of pollution and overfishing are worse than seen in the previous decade.

Other negative outcomes are: (i) polarization among fisherfolk, (ii) end of traditional skills, knowledge, and processes leading to deskilling; (iii) increased capital investment, and centralized ownership where the decision-making power is confined to top management; (iv) increased indebtedness; (v) extreme energy intensity as well as greater dependence on fossil fuels; (vi) make the source of revenue of fisherwomen precarious; and, (vii) increase in exploitation to an unstable level (Vollen and Haddara, 2019).

Challenges in the Revival of the Fisheries Sector

Fisheries and aquaculture play an important role in the economic development of India. Today, fishing is a bright field in Indian agriculture – the backbone of the Indian economy. To assess the future challenges for the fisheries sector, a number of key issues have been identified that cover all sectors and which will help formulate effective policies (FAO, undated). These challenges include:

- Maintain the contribution made by fisheries and aquaculture to food security, national economic development and recreation, and employment. Based on geography, market access, and affordable technology, contribution of fisheries to food security comes not only from fish products for direct domestic food consumption, but also from marine products of every kind that can be sold nationally or exported for funds, and those which make revenue through employment, recreation, and tourism. Also, to determine whether or not access to all potential contributions is automatic and whether special intervention is required to achieve full access.

- Strengthen the fundamentals of fisheries management and aquaculture through improved data collection and scientific evaluation so that decisions about management and development options can be made more rationally and information can be provided. It needs a variety of approaches: (i) consult with the data user to obtain the data they need for their work, (ii) have appropriate data collection and data management systems, (iii) have national commitments to provide information, and (iv) engage non-FAO (Food and Agriculture Organization) and FAO regional fisheries agency and other related organizations and agencies in regional assessment relating to trends in fisheries.

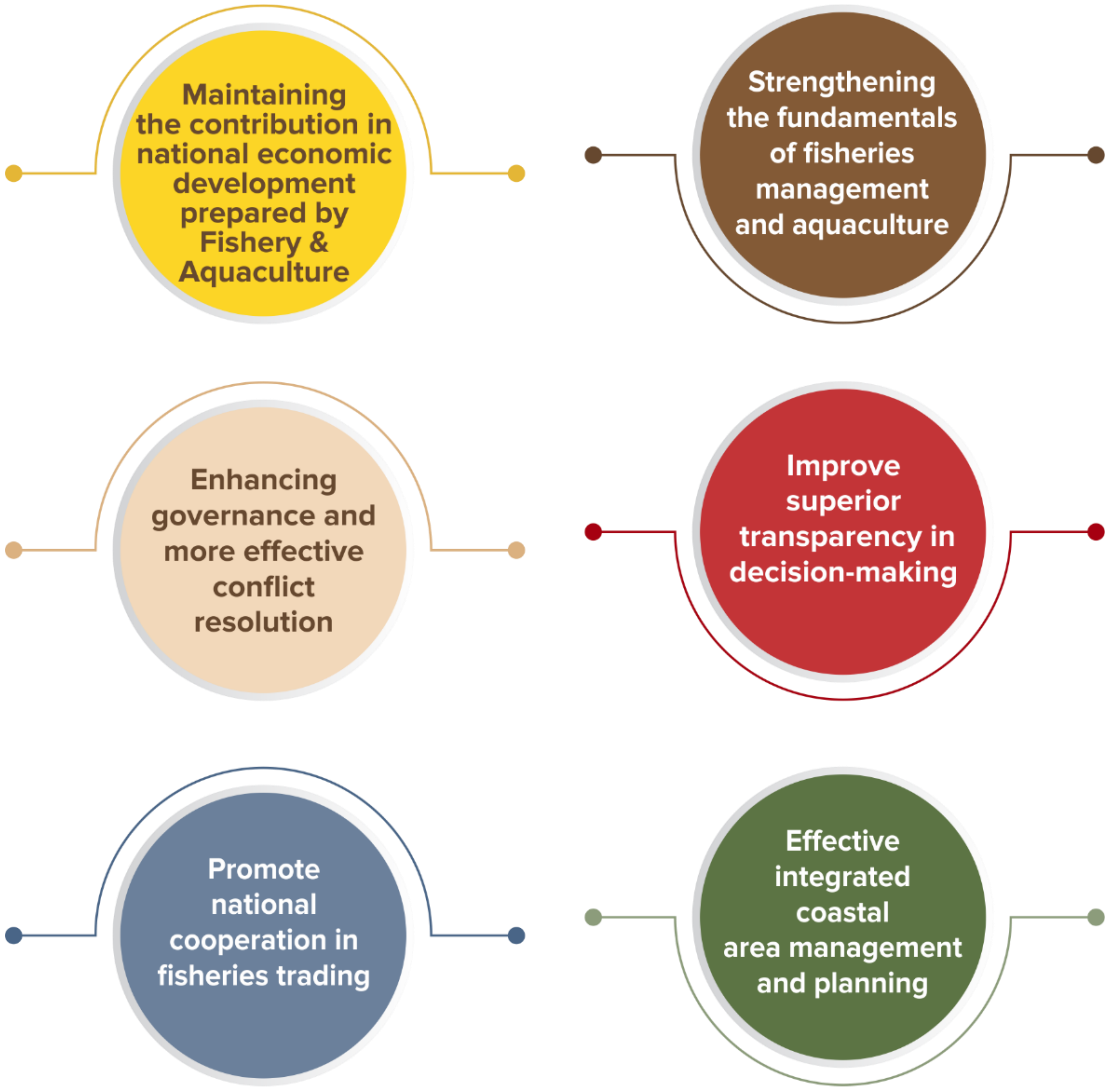
- Enhancing governance and more effective conflict resolution. Intensification of regional fisheries conflicts should be expected as fishery resources become scarce; increase national capacity and strengthen regional institutions; make objective performance indicators related to administration; and, encourage harmonious management and better cooperation among regional agencies in addressing the issues of general concern.

- Improve transparency in decision-making at each level of fisheries industry through larger stakeholder participation in regional and national

processes. This kind of transparency is essential when consulting and working with teams on a project.

- Promote cooperation in the fish trade to avoid conflicts and sanctions; reduce the impact of the international fish trade on those at risk; i.e. victims of food insecurity.

- Integrate coastal area management and planning more effectively. The management of facilities for improved and protected production of rare resources can increase long-term small-scale marine fish production and assure the primary goal of deep-sea fishing in the medium term to ensure global food security.



To address these challenges, the fisheries sector needs to improve its efficiency in creating and managing effective, quality assurance systems to expand its domestic market by matching international standards. Along with this, a Code of Conduct must be implemented for fishermen to enable the responsible use of marine resources in a sustainable manner to help overcome the aforementioned challenges. However, development of national and regional fisheries mechanisms is needed to ensure logical and effective fisheries management in the region in the long run.

Importance of Technology in the Fisheries Sector

Digital and other electronic technologies are changing our economy, society, and people's lives. Technology has had a particularly significant impact on information and communication activities, which have always been at the centre of sustainable development. Information and Communication Technology (ICT) uses technologies that support electronic communication and information processing, including all information relating to telephones (fixed and mobile), computers & the internet, and radio & television.

Be it giving a boost to economic activity or ensuring safety and security, technology needs to be at the helm to ensure an all-inclusive growth of the fisheries sector. It is important to take note that several new technologies, such as the internet of things (IoT), big data, sensors, data storage, robots, and transmission will be cheaper and more compact to run. However, in the fisheries sector the extensive use of such technologies is still restricted because of its cost, ever increasing data requirement, the challenge in sharing that data between the fisheries management authorities, and the restricted number of people trained to use these tools.

Technology allows small-scale fishers to not only gather information on fisheries and aquaculture, but also enables them to make better business-related decisions, which shows their commitment to marine conservation. For example, the fishers and the authorities have access to daily information about catches and prices because of the use of digital technology. However, the use of technology is still not as widespread as it should have been.

ICT for Development

The use of ICT for development is beyond direct support for revenue-generating activities. For overall development, ICT is a powerful way to reduce people's vulnerabilities, bring about fairness and social inclusion, and hold communities accountable for their own development.

Basic Requirements for Information Sharing

Information and communication technology is a primary tool for developing information sharing, collaboration, communication, and ownership.

Problems relating to food and livelihood security and lack of publicity for fishermen can be solved through information networks. The combination of mobile and new networking technologies can create new opportunities.

Programmes and policies that support further development of ICT across the fishing community and the fisheries sector are localized—in accordance with the relevant rules of international law—to address the needs of the poor by helping them learn more about responsible fishing.

Benefits of Technology in the Fisheries Sector

Information and communication technology is being used in the fishing sector from asset valuation, capture or culture farming to processing and commercialization. There are specialized applications like Sonar for tracking fish. Other uses include Global Positioning Systems (GPS) for navigation and location tracking, business mobile phones, data exchange and emergencies, wireless programming with the fishing community, web-based information and networking resources (FAO, 2007).

The introduction of mobile phones in India has brought big changes in the fisheries sector; the sector's efficiency and profitability have improved dramatically. As mobile phone services became more widespread, fishermen were able to land on catches that wholesalers were ready to buy.

Various communication technologies are used by fishermen, entrepreneurs, aquatic experts, extension workers, etc., while many farmers use community radio to either share or gather information relating to the market. Information on various innovations in fishing technology is disseminated among farmers to raise awareness and stimulate discussion on various issues relating to fisheries and aquaculture.

The internet has emerged as a potential tool to contribute to rural development. It helps local people get information and support from other development agencies and also establish a two-way, horizontal communication between the local community and development agencies. It facilitates conversations within the community and with government planners, development agencies, researchers and technology experts. Besides, it encourages public participation in decision-making.

Coordination between local, regional, and national development efforts is essential to maximize the effectiveness of the development programmes. Therefore, the internet helps share information with agricultural researchers, engineers, farmers, and many others. It can provide a wide range of global information. In developing countries like India, the internet has proved to be valuable for the development of the fisheries industry.

Balancing fisheries and environmental interests is not easy, but advanced analytics (the use of advanced methods for collecting, processing, and interpreting big data)

could be a possible approach to the problem. Currently, when fishing agencies, regulators, and environmentalists apply these tools, their use is usually limited to small-scale pilots. However, advanced analytics may have reached the stage of entering the fisheries sector. Apart from the development of new technologies to support analytics, both policymakers and fishing company leaders are feeling the urgency to increase the stock of fish (Christiani *et al*., 2019).

Also, those who enter the fisheries industry or participate in regular development have greater technical knowledge of advanced analytics and a deeper understanding of other digital tools than their predecessors.

Even in the emerging markets, fishermen can access information about these technologies and their benefits through a simple smartphone search. The increase in advanced analytics can improve the use of fishing-enhanced tools and techniques suitable for optimization of fishing operations.

If large fishing companies around the world adopt this model, they could reduce their annual operating costs by about 1.11 billion, and in turn consumers could benefit from lower prices for fish and seafood. A better fishing strategy could help improve marine resource management, increase industrial profits by billions of dollars by 2050, and double the total biomass of fish from the current level (Christiani *et al*., 2019).

Challenges of Technology in the Fisheries Sector

As mentioned earlier, many fishermen feel that the IoT equipment installation is expensive because of which low-income fishermen are not able to afford it. Some also feel that satellite providers are ridiculously expensive, which adds up to cost to the fisherman. In addition, the cost of using cloud records for storage and extracting data is high.

Technology needs to be made affordable along with minimal cost of maintenance. Unless this is backed by proper training, the use of technology will remain limited in the fisheries sector.

Role of IoT in the Fisheries Sector

Technology plays an important role in the fisheries sector, particularly IoT-based solutions for improving safety, security, productivity, and efficiency of the sector through the following:

Real-Time Tracking and Monitoring of Vessels

With a boost in technological advancement, breeding and rearing of fish in tanks, ponds, and artificial enclosures have emerged as the principal form of aquaculture across the globe. Natural fish stocks in lakes and reservoirs are cultured and treated in order to replenish and maintain a continuous batch of fresh catches.

However, the ever-increasing influence of industrial contamination has inversely affected the health of the marine ecosystem. The rigorous exploitation of the natural water bodies near a commercial setting adds adulterants of major value. These pose as a threat to the semi migratory (carp, roach) and the migratory (sturgeon, beluga, atlantic salmon) category of fishes that inhabit the seas. Seafood is one of the most traded items of primary import and export to traders across the globe for unlimited profit.

Pursuing a sustainable business master plan is imperative to carry out beneficial trade in the market. Tapping the right means to seize the best sea catches in desired quantities is all about securing the right target for long term success in conservation of the valuable resources. The future of the retail sector rests on the quality of the catch and more viable trawling services.

There has been a worldwide speculation that in order to obtain the necessities of life, the amount of fish that should be farmed is enough to feed millions which would turn the ocean into a bed of resources (Shyam, 2016).

The aquatic ecosystem is bearing the brunt of excessive farming of fishes due to an increased demand. As overfishing (the practice of catching fish faster than they can reproduce) takes over, a gap begins to develop in the entire biological community that necessitates a focus on fishing down the food web. It causes irreparable damage to the entire marine environment, thereby affecting the fish rearing business.

In respect of floating vessels (ships, boats, and other major vessels), the distance is monitored in nautical miles through artificial tracking devices that observe the tracking and logistical programming of vessels carrying sea produce or otherwise. This tool narrows down operation by real-time fleet tracking, using geological data from maps and charts for navigation surveillance of the fisheries sector (Maksimovic, 2018).

This time-tested technology monitors fish farmers and seamen working on their catch in the port or even offshore through constant display of data. One can get detailed updates about the marine weather conditions and the position of the vessel in the live navigation chart. It helps in filtering out global lanes and routes of ships that ferry across borders determining the real-time update on traffic volume on water. Skylo's cost-effective, ubiquitous, and reliable platform allows large-scale positioning of satellite connectivity to provide real-time alerts as well as actionable data for maritime operations.

Inadequate interoperability is restricting the use of technology to its true potential. There is a need to establish a common framework and standard for the IoT devices. In the absence of a standardization process, the interoperability of IoT with legacy devices should be considered critical (Geeks for Geeks, 2019).

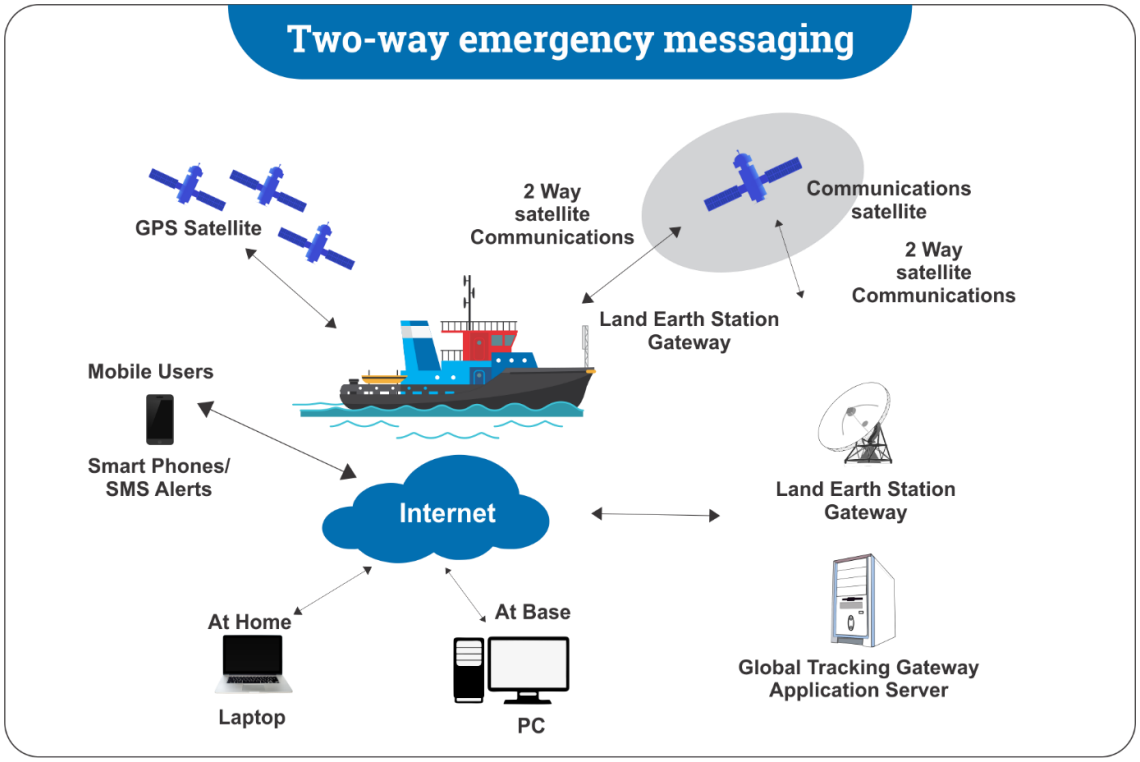
Early Warning and Distress Alert Messaging

The Skylo platform helps remain 100% connected, even when there is no cell coverage for miles, and to send and receive alert notifications to the crew regarding any impending danger caused by an upheaval in climate, maritime boundary regulations, fuel levels, and other issues the boat may encounter. It allows crews to provide immediate SOS and warnings about weather and give regular updates back and forth to both the crew and the operator with messages in actual time to avoid distress. Skylo communicates the current location and productivity reporting all the

time, giving peace of mind to people working in dangerous and remote (and traditionally analog) environments.

Two-Way Emergency Messaging

Two-way emergency messaging for dead ships, critical weather and disaster response can be achieved using Skylo's end-to-end platform. With the help of Skylo, regular location and productivity reports allows ship monitoring and offshore alerts. Skylo provides fishermen with fish market data, real-time messaging, location data sites for catch reporting, marine reserve management, and more efficient fish management.



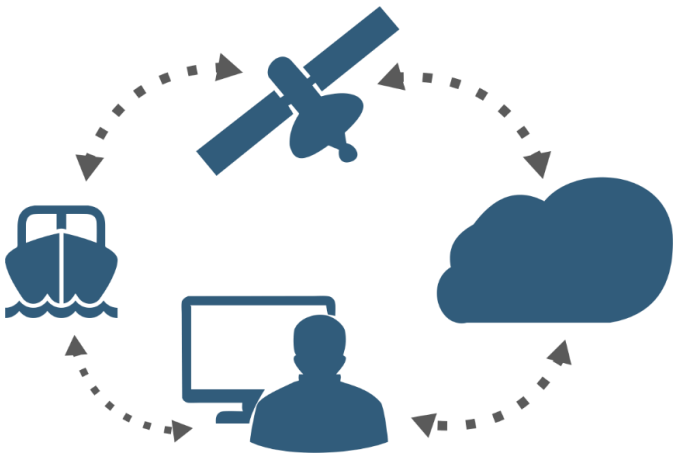
While technology cannot solve the global fisheries crisis on its own, it can be a catalytic component for the transformation of fishery policies and practices. A systematic approach to create sustainable technological innovations – where the current requirements are met without risking the resources of future generation – can help improve the management of the fisheries business. Alaska's cod is an example of how new technology is supporting the fisheries industry to become more sustainable and efficient. In addition, cod fishery is examining the electronic monitoring systems, combined with machine learning and computer vision technology (the applications of artificial intelligence that allow systems to learn from their own responses), to evade overfishing Pacific halibut, the high-value species in the area frequently found with cod (Ortiz, 2019).

In addition, technological innovation provides opportunities to enhance fisheries management and marine business, while at the same time not compromising the safety of the fishermen and national security.

This technology can be used to digitize the fisheries industry. There are currently about 4.6 million fishing boats that can benefit from the "always-on" connectivity. The Skylo Hub, the Skylo Network, and the immersive Skylo Platform can be accessed on Android devices and desktop PCs via bluetooth or Wi-Fi, allowing fishermen to access life-saving two-way SOS communications and connect anytime, anyplace with fleet operators and their families back on shore. Fishermen can report their catch prior to landing at shore to ensure a full sale of their catch. Skylo transcends the definition of disruptive innovation, affordably connecting millions of devices, and enabling many industries to transform their businesses through constant connection. Customers have already reported lucrative successes, from lives saved to increased productivity.

Currently, there are about 4.6 million fishing boats, and Skylo's Hub connects to existing Android devices via bluetooth or Wi-Fi, allowing fishermen to access life-saving two-way SOS communications and connect to fleet operators. Using Hub services, fishermen can also access the market to sell their catch while still at sea. Being submerged in the sea, Skylo transcends the definition of disruptive innovation, allowing millions of connected devices at low cost to transform their connections, save lives, make a living, and connect wherever possible. This technology can be used to digitize the fisheries sector.

Ship to Shore Communication & Messaging Systems

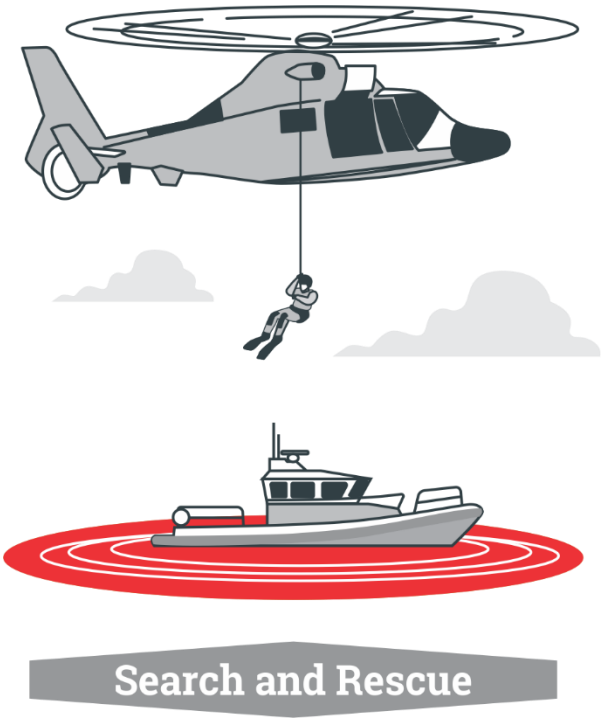


There is a world of possibilities for the marine sector to tap and exploit the radio and telecommunications sector. The use of unconventional mechanisms of radio

telegraphy using Morse code can help bring relevant changes in marine communication. In earlier centuries, communication between two ships or from the ship to shore was acted upon through the use of automotive technology.

Search and Rescue

One of the major undertakings by the coast guard development boards across borders is the use of more reformed and advanced devices that can help locate and rescue people stranded due to bad weather and rough seas.



These devices help track missing persons through clip sensors attached to the user's wearable, even in deep waters. It helps detect bodily injuries as well. Internet connectivity along with an LTE (Long-term Evolution) chipset is imperative for providing superior connectivity powered by radio frequency identification chips (Probst, 2020).

To put such mechanized installations to use, proper government supervision is needed to ensure proper management of the vulnerable species. For the fisheries sector, in order to scale up and boost per area culture, the vitality and health of these ponds, lakes, and seas should be expanded (Coronado *et al*., 2020). This would rule out the increasing demand for illegal fishing. Thus, a governing body should be put in place to enforce regulations that will encourage ethical and sustainable fish farming.

For example, Skylo Technologies' wearable devise is fundamentally a GPS tracker that allows machine technology with LTE chipset. The chipset helps the search and rescue diver to locate the lost person with maximum accuracy, thereby increasing the chances of survival.

Traffic Management and Just-In-Time Operations

In a bid to optimize safety and viability of traffic management in the seas, entrepreneurs across the globe are bringing more innovative standards for information exchange. The abundance of information out there is startling. It helps the industry plan better ideas and thus carefully work around designating resources or determine factors like short, long or in-time arrival routes within the fisheries sector. This helps reduce the threat and challenge of an impending accident. Proper knowledge and awareness about the structures of routes and infrastructural setups are important to bridge the gap between knowledge and planning.

This optimizes the working capacity within the maritime sector. It provides a competitive edge over other companies in the same category. In order to maintain flexibility and order, work is divided into verticals but all are controlled by a central administration (Coronado *et al*., 2020).

A few notable characteristics of maritime voyage pertain to identifying each voyage through a unique referral code. The code records vital data relating to the operation of a vessel; for example, it records the sea route taken to help avoid heavy marine traffic. Effective prediction about the supply route chains and thereby sharing information on marine transport boosts competitiveness. This helps the vessel cross its mark without the fear of accidents or dense traffic.

This explains by data how shores and vessels interact with each other in areas of heavy traffic. Complex traffic routes and complicated areas of travel are examined so that goods are ferried across shores efficiently with the least amount of fuel consumption and hassle. Lesser fuel consumption stems from lower infrastructural cost per unit, thus reducing emissions. Sharing Split Benefits by Halves, a research conducted by a University in Russia, says that the world consumers saved 1 billion pound per year in Europe by just taking shorter routes.

Coastal Security

An overview of the wireless remote-control application of IoT based tools is given out to plug loopholes inside the security enforcement activities of the Coastline. Coastal surveillance and other administrative security enforcement activities are

controlled via the application of sensors that bind the entire security processes together.

All seaborne machines are registered under one name. It improves the quality of the coastal traffic system alongside registering vehicles under the same. Real time data on the plying and ferrying of registered vessels is tracked through AIS (Automatic Identification System) databases. This works on the principle of a nodal emergency centre called Emergency Operating Centres spread across four layers. The first layer of sensors consists of compact yet long range of network of sensors (Coronado *et al*., 2020).

- The L/S band radars are often used to track tides along the coastline. These radars are placed 50 metres apart.

- Sonar radar is a network of passive rays. These are fastened with sonobuoy which are placed 10 kms apart from each other following the coastline.

- Surveillance receiver – spaced at a distance of 100 kms from each other; the surveillance receiver might as well be placed in the same plane as the radar, which monitors data transmissions.

A network of thermal imaging cameras is stationed 10 kms apart in the second layer along the coastline that can detect objects even as far as 5 kms. Based on the needs of the user, mid to high resolution images are captured with the help of this camera. A broad range of PTZ (pan-tilt-zoom) cameras are used that are placed 5–10 kms apart.

- Active illumination camera is used majorly at night when the thermal imaging camera is non-operational due to its inability to capture proper data. It works

as a supplement to the thermal imaging cameras and can be proactively used alongside the thermal imaging camera when the entity gets closer at night.

- Complimentary optical cameras are used during the day when shots are taken with mid resolution. These work on the principal of a variety of PTZ cameras.

The third layer of the unit runs on the abled application of C4SIR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) of the Nodal Command and Control (Nodal C&C) centre, integrating the sensor feed from sensors in layer 1 to layer 2, thereby planning a response. Then there is a 2 megabits per second (MBps) wired data link with wireless backup. When a crises situation emerges, these data repository units act as an immediate backup from where we can gather data. Also, it shares data amongst the nodal centres in times of grave crises (Mistral Solutions, undated).

The fourth layer is compounded after joining multiple Nodal C&Cs together by the Emergency Operating Centre (EOC), forming the next level in decision-making in the coastal surveillance system. Also, it depends on the range of surveillance as to how many Executive Oversight Councils (EOCs) need to be set up.

With a speed of 10 MBps, it allows multiple C&C's to transmit nodal data either wirelessly or with the help of wires. As mentioned before, a C4ISR application helps integrate data from other Nodal C&Cs to present a common operational picture to top-level decision makers in the fisheries sector (Mistral Solutions, undated).

The most cost effective and pragmatic in design, Skylo Technologies is instrumental in significantly designing safe procedures for a more functional coastline activity that does not pose a threat to adventurous people partaking in activities of the fisheries sector. Real time governance and monitoring activities along the borders are carried out with the help of these data chip driven machines that help detect and drive away unethical actions along the coastline.

Maritime Disaster Management in The Context of Skylo

Natural disasters in India are a major challenge leading to widespread loss of life, infrastructure, economic activity, impacting all sectors both vertically and horizontally. Poorly designed infrastructure along with climate change, extreme weather, natural disasters and other factors represent a significant risk to human life and communities. In the context of the marine industry, new investment is needed to manage disasters more effectively. Disaster management projects have long lifecycles because of huge financial investment, multi-year building efforts, and

government approval process. We now need to think creatively about how to extend the process (Seto, 2019).

India is a country prone to natural disasters of all kinds. Such events make us realize that there is a need for preparedness, which needs planning, coordination, and putting the various systems in place to prevent losses. The Coastal Disaster Management Plan targets all parties (governments) involved in local, regional, maritime disaster management in India. The Plan includes operational sub-plans that describe operations and effectiveness at the management agency and operational level (SCTIMST, 2005).

If Skylo is integrated into the infrastructure, it will be possible for development planners and public safety officials to monitor real-time data on roads, buildings, bridges, public transportation, and energy grids. It may prioritize preventive care & improvement, and ensure that the structure can avert future weather disasters while continuing normal activities. Sudden failures such as bridge collapses and life & mobility related to chokepoints will become a thing of the past.

Government agencies and regions can implement artificial intelligence (AI) and machine learning to predict catastrophic impacts on IoT data sets, giving them the opportunity to know the location of the stage, the path to the ground, and flood zones. As a result of this critical information, many a mishap can be averted.

Skylo helps safety protection officials refine strategies over time, devising smarter plans and responses. Skylo can be used to examine event data to identify current regions and populations and analyze patterns based on growth, development, and climate change among other things. Government leaders can use this insight to create policies that mitigate the impact of disasters on communities, such as designing new buildings in low-risk areas. Not all crises can be avoided, but we now have the technology to predict and prevent disasters such as oil spills or building collapses. When an unforeseen natural disaster occurs, respondents can gain access to real time data to minimize damage (Seto, 2018).

Improved Connectivity in Remote and Rural Areas

The IoT has a wide range of connectivity even in the rural and remote areas with bleak to zilch scope for connectivity. Terrestrial services have been augmented with the recent innovation, the 5th generation satellite constellation which integrates the advantages of 5g technology with a prospective system that can provide enhanced domestic services like fire alarm, anti-theft bell, and spoilage tracking to eradicate chances of damage within the fisheries sector.

These are done by fixing tiny sensors on drones that fly across AI enabled permitted territories to monitor data. This is a highly analytical model useful for the village setting where high-tech drives are not a regular phenomenon. However, proper advisory bodies are required to supervise the entire working process (Vollen and Haddara, 2019).

To achieve a true digital platform around the world, numerous communications channels will be required. For utilization cases with high correlation to human populations (retail, smart cities) cellular connectivity will meet these requirements. LEO CubeSat constellation is a perfect match for applications with high latency tolerance in remote and rural regions, such as non-emergency scientific data collection at the poles or at sea, or some agronomic data collection. For carrier-grade narrowband IoT applications that also require cost effective, ubiquitous, and reliable connectivity, the fisheries sector should anticipate Skylo's GEO satellite option that provides the Skylo Hub for receiving/transferring data, the Skylo Satellite Network in partnership with BSNL for reliable connectivity, and the Skylo Platform to better communication from sea to home base (Trivedi, 2019).

IoT Solutions for Managing Security, Improving Safety, and to Fast-track the Modernization of the Fisheries Industry

With so many technologies being used by fishermen, it is difficult to focus on a few key technologies that have played a critical role in modernizing the fisheries sector. The application of IoT has transformed the commercial fisheries industry. The IoT enabled devices can withstand high temperatures and mechanical stress during commercial fishing activities, and can analyze whether using a camera or matching a product specification.

Organizations such as Indian National Centre for Ocean Information Services (INCOIS), Central Marine Fisheries Research Institute (CMFRI), and Bharat Sanchar Nigam Limited (BSNL) have been doing great work at the ground level and have over the years brought in innovative technologies to ensure the safety of fishermen and vessels along with national security. However, involving private and small fishermen is an ongoing process, and given the speed of technological innovations there is a need for the private players to adapt to the new technologies for the benefit of the community at large.

Big Data Technology for Fisheries Monitoring

To manage the increasing data on fishery monitoring and management including other activities within the sector, big data can help organize incoming data from new technological tools. It provides alternatives to traditional theatre databases and on-demand tools. Today, data is created and processed in the cloud and displayed on mobile devices in near real time. Big data includes customer transactions, production databases, web traffic logs, automation, satellites, sensors and IoT records (Eigaard *et al*., 2014).

On-Board Survey Camera and Electronic Monitoring

Electronic surveillance consists of a separate "closed" video or photographic system integrated with a sensor system that can be used to view changes in fishing activity and to describe or adjust details. Both record and display are "closed systems." Camera and sensor systems do not allow external or manual input or data manipulation. On-board survey cameras can detect interactions with bycatch species and provide a secondary source of data. The camera can take up alternative space depending on the needs of the observer (Gilman, 2011).

Smart Weighing System at Sea

The marine smart weighing system calculates the weight of the catch. Data is regularly sent to fish markets and ports to support data to update landing forecasts. Some of these weight systems integrate RFID (Radio-frequency Identification) 21 tags attached to fish boxes to improve traceability. The new RFID tags allow fishermen to read and write ship ID, travel, location, weight, size, shooting date, presentation, and much more. The tags also allow fisherman to respect quotas and control fishing bans during biological rest periods (Girard and Payrat, 2017).

Government Initiatives and Policy Interventions

Fisheries is a state subject, and the coastal states have been for years developing and implementing policies that are not only economically beneficial to the fishermen, but also are improving the state's GDP, taking into consideration illegal and anti-social activities as well as safety of the fishermen and the seas.

In West Bengal, several agencies are working together to develop different coast guard systems. These measures include joint regional patrols by state maritime police, customs and the Indian Coast Guard (ICG). In 2015, the Department of Home Affairs of the Government of West Bengal submitted a proposal to set up a Naval Police Battalion alongside the Indian Reserve Battalion to strengthen security and surveillance in the coastal areas.

The state government decided to set up a radar to bring about 104 Sundarbans islands under the advanced security mechanism. A joint strategy was also planned by carefully monitoring the entire Sundarbans to keep a close watch on various destructive activities, including terrorist modules, arms smuggling, wildlife poaching, and pirate movement (Bhabani, 2015).

The Gujarat government was also working on setting up satellite-based tracking and alert systems on about 12,000 fishing vessels at a cost of Rs 95 million to monitor the movements of the Indian fishermen. The system would track and alert fishermen when they cross international waters and send warning messages during natural disasters such as tsunamis and cyclones. Through this system fishermen can also send distress signals.

A central command and control centre is planned at Gandhinagar in Gujarat to enhance coastal security and provide 24-hour surveillance for the state's non-major ports. The centre is connected to the port via various alarms and CCTV cameras. It includes a sea-based thermal imaging camera to monitor the wide sea around the port and a night-vision device to monitor all movements (FICCI-PWC, 2017).

The state also conducts semi-annual simulated coastal protection exercises in collaboration with various organizations involved in coastal protection. These exercises help assess the effectiveness of existing coastal protection structures. A combination of different security agencies in the coastal protection network assess the effectiveness of the fishing community in dealing with seaward threats, the level of communication between conservation agencies, and the readiness of coastal protection personnel to deal with potential threats (FICCI-PWC, 2017).

To enhance coastal protection, the government is taking various steps to update the technical monitoring unit along the Maharashtra coastline. An idea being discussed is to install a high-resolution surveillance camera in Mumbai's skyscrapers to monitor the coastline. Moreover, in order to prevent the boat from crossing the internal maritime boundary with Pakistan, state governments have started registering the ships with the customs department and plans to equip it with a GPS as well as a very high frequency (VHF) wireless set (FICCI-PWC, 2017).

Pradhan Mantri Matsya Sampada Yojana (PMMSY)

Prime Minister Narendra Modi in September 2020 launched the Rs 20,050 crore Pradhan Mantri Matsya Sampada Yojana (PMMSY) to increase production and exports in the fisheries sector with the aim of doubling the income of farmers. This scheme aims to increase fish production to 220 lakh metric tonnes (LMT) by 2024–25 from 137.58 LMT in 2018–19 at an average annual growth rate of 9%.

Shri Giriraj Singh, Union Minister for Fisheries, Animal Husbandry and Dairying, stated that this ambitious project would increase the export rate in the fisheries sector to Rs 1,10,000 crore and create about 55 lakh direct and indirect opportunities for employment in the fisheries sector in the following five years. PMMSY's services are dedicated to fish farmers, fish vendors, fishermen, fish workers, and other stakeholders related to the fisheries sector. Under this scheme, insurance coverage in support of fishing vessels has also been started for the first time.

The PMMSY will focus on the development of fish production and productivity, quality, sustainability, technology planting, post-harvest infrastructure, modernization & strengthening of value chain, and standards & traceability in the fisheries sector from “catch to customer.” This will help establish a robust framework and increase export competitiveness, which in turn will improve the welfare of fishermen. The PMMSY will also create an environment conducive to private sector partnerships, entrepreneurial development, business models, and innovative project activities for newcomers including incubators within the fisheries sector. The PMMSY is a fisher-centric umbrella scheme and the main stakeholders are the fishermen, fish farmers, fish workers, and fish sellers in development activities. The core objective of this scheme is to improve their socioeconomic conditions (PIB, 2020).

This scheme will generate “Blue Revolution” through responsible and sustainable development of the fisheries sector in India and establish India as the leading fish producing nation.

Implementation Strategy and Activities

The PMMSY will be executed as an umbrella project that includes both Centrally Sponsored Scheme (CSS) and Central Sector Scheme (CS) components. This will focus on the development of the fisheries sector through a group of various interventions, and the development of the fishery value chain from production to consumption. The PMMSY recognizes the roles of the states and UTs in ensuring effective implementation of the scheme for optimal outcomes. Although most projects will be implemented in partnership with the union territories or states, all funds will be given by the central government in some areas of national importance. Moreover, this scheme could help maintain a good balance between production and productivity activities with technology infusion. The post-harvest infrastructure includes establishment and modernization of the fisheries value chain as well as a strong management and regulatory frameworks.

As mentioned previously, the project will create an environment conducive to private sector partnerships in the fisheries sector, entrepreneurial development, and innovative activities in the fisheries sector. Under PMMSY, “cluster or regional based approach” will be regularly adopted to increase the competitiveness of the fisheries sector, facilitate scale economy, achieve higher income incentives, accelerate growth, and expand thee sectors. Different connections and integrations of groups/regions and different types of meat, seed and feed; complex infrastructures, processes, and marketing networks; and, necessary interventions/activities, will be identified to develop fishing and aquaculture. The government will be assisted in projects aimed at consolidating, expanding and conserving the resources of the communities. Some of the central projects identified for connectivity and transformation structure are the "Sagarmala Project" of the Ministry of Shipping, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and National Rural Livelihoods Mission (NRLM) of the Ministry of Rural Development, Pradhan Mantri Krishi Sinchai Yojana (PMKSY) of Ministry of Food Processing Industries, and Rashtriya Krishi Vikas Yojana (RKVY) as well as other schemes of Ministry of Agriculture and Farmers Welfare.

In contrast to the Blue Revolution, for the first time a well-organized implementation framework will be created within the PMMSY for effective implementation at the district and sub-district levels through institutional management. State programme units and district programme units will be created in several potential fishing districts based on a few parameters. It is anticipated that this arrangement would provide the focused attention and the mission mode direction to PMMSY. This scheme predicts the development of Fisheries Management Plans and Integrated District Fisheries Development Plans under the

leadership of Deputy Commissioner/District Collector through the District Level Committee that will be consolidated into State Fisheries Development Plans at the UT/state level for effective planning, and ideal consumption of resources as well as for integrating with other programmes and schemes (GoI, 2020).

To put it simply, thrust will be placed on water management and spatial planning reinforced by the regulatory framework. Adequate allocation will be made for production and productivity, quality, productive use, and development of new and innovative technologies such as biofloc, regenerative systems, recirculating aquaculture systems, aquaponics cage cultivation, and more. To this end, the PMMSY, in close collaboration with the Marine Products Export Development Authority (MPEDA), will focus on species diversity, value addition, infrastructure development and modernization, traceability, brand promotion, certification, etc. It will also promote startups as well as encourage innovations and entrepreneurial models. Besides, it will focus on fisheries development in Ladakh, Jammu & Kashmir, Islands, and North-Eastern states through region-specific strategic development plans.

In northern India, especially in the alkaline and salt regions, the promotion of large-scale aquaculture is central to PMMSY, which is an adequate source of funding. The PMMSY envisages minimal financial allocation based on activities with quantifiable physical goals. It provides guaranteed investments in a variety of large sub-sectors, including thin and extensive financing under the Blue Revolution (GoI, 2020).

For the first time, the use of blockchain technology, global standards and certification, end-to-end traceability from "catch to consumer," promotion of good aquaculture practices, hatcheries, accreditation of brood banks, and farms are included as a part of the scheme with the satisfactory financial allocation. These measures will bring higher productivity, quality, increased export competitiveness, and higher prices to fishermen and farmers to ensure that aquatic health management is supported by an integrated laboratory network that can deal with diseases, antibiotics and residue issues. The plan is to create a universal coastal fishing community through integrated modern fishing villages. The main strategy of PMMSY is to bring together fishermen and fish farmers through fish farm producer organizations to increase their bargaining power (GoI, 2020).

For the first time under PMMSY, aquaparks will be developed as fisheries hub while the aquaculture activities will be one stop "parks" with affordable, assured, and quality inputs under one roof. The aquaparks will house modern aquariums, business incubation centres post-harvest infrastructural facilities, etc. In addition,

insurance coverage for fishing vessels will be introduced for the first time under PMMSY besides insurance for fishermen.

For the first time, the PMMSY envisages structural expansion support services to provide the necessary services to fishermen and fish farmers. The youth will take part in fish expansion through 33474 *Sagar Mitras* within coastal fishing villages. Also, many Fisheries Extension Service Centres will be set up in private places to create job opportunities for young professionals. Mega investments have been proposed to build and strengthen fishing ports and landing centres for healthy fish management, reduction of post-harvest erosion, high cost, etc. Operational reforms will also be adopted under PMMSY. In addition, there is also a thrust on urban marketing infrastructure to provide affordable and quality fish (GoI, 2020).

As an illustration, technologies such as Skylo offer the best tech support to the PMMSY programme, as this scheme assists fishermen in the acquisition of technologically innovative fishing vessels for the development of deep-sea fishing and for improving export competitiveness.

Experts Speak – Inputs and Recommendations

Dr. Balakrishnan Nair
Group Director, Indian National Centre for Ocean Information Services (INCOIS)
Ministry of Earth Sciences

UNI Panel Discussion on PMMSY: Role of Ocean Information Services

Theme: Geo-Strategic Security and Stakeholder Perspective

Empowering India's large fishing communities with appropriate technologies wherein their role as crucial watchdogs for geostrategic security along the nation's long coastal fault lines must become a key area of focus for policymakers in the security apparatus. It is critical for India to have a robust tracking system for all fishing vessels.

Key challenges being faced by fishermen vis-à-vis policies that will encourage improvements on ground zero and also promote technology innovation for community growth and development in the long term are:

- It is not forgotten that the 2008 Mumbai attacks were carried out using a fishing vessel. We have robust systems in place for checking entries into our country via land and sea, but even after more than a decade of an event of such scale, there is no system that can tell us if the boat in our waters is Indian or foreign, until the officials board it and inspect the documents. This should be unacceptable in the year 2020.

- Episodes such as the Ockhi cyclone has taught us that our fishermen – who ensure the country's food security – should themselves feel secure when venturing into the sea. GEMINI (GAGAN Enabled Mariner's Instrument for Navigation and Information) is a hand-held system that receives signals from GAGAN satellites and passes it on to any mobile via bluetooth. An App developed by INCOIS, if available on the mobile, will translate and display the information in the required text and map formats recognized by fishermen. The expected cost of GEMINI device with three-day battery backup with marine grade casing is approximately Rs. 8700/-.

- As an outreach of GEMINI, we conducted user-interaction workshops in multiple states and union territories. Contrary to layman's belief that fishermen would not want to get tracked, we have ample feedback that the boat owners all along the coastline are rather ready to pay for tracking facility of their boat, with account-based access. In return, they are comfortable if agencies such as INCOIS make use of their location for providing fisher advisories and alerts.

- It is a fact that no country has a friendly neighbourhood when it comes to shared resources. India in particular does not have many friendly neighbours, and the sea-going fishermen – due to their numbers and presence over vast areas – are at first line of vulnerability, being captured at will on the grounds of intrusion into another country's EEZs. Without tracking data, India is helpless at international forums. If India has a reliable tracking system, our boats will not be easy prey. Further, it will strengthen India's stance on responsible fishing practices for the shared stocks.

- Numerous examples from the world wars to the present situation in the South China Sea tell us that the presence of fishing boats can be rather advantageous if tapped properly. Each boat can virtually be the eyes and the ears of our security agencies against any unwanted activity within our waters.

Presently, Indian fishermen are mainly active within a portion of the Indian EEZ. Beyond that, fishing in international waters by other Asian and European countries is a norm. As India evolves its leadership in the Indo-Pacific, a multilateral tracking system becomes an even more pressing need.

Dr. A. P. Dineshbabu
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Challenges in the Indian Fisheries Sector

I would like to share information based on trawl fisheries in India which contributes about 90% of the marine fish landing in India.

- In-depth analysis of fisheries development in India necessitates the protection of the traditional sector and the protection of fishermen rights to keep them in the fisheries sector. From a subsistence vocation, marine fisheries developed into an industry with huge investments. For the fisheries industry, there is no restriction on who ventures into sea; they may or may not be fishermen. So, anyone having money can invest in the fisheries industry. As a result, the fisheries industry becomes the investor and most of the fishermen become the employees in the industry. Competitions for higher profit lead to many unhealthy developments such as unscientific modifications in vessels, vessel speed, and nets operated. This results in the collapse of the fishery – many commercial species, environmental degradation, bycatch, high discarding, and juvenile fishery.

- Technology is being extensively used, such as GPS, fish finders, satellite phones, and identification of fishing grounds of different fishing groups, intensification of the speed of the boat, as well as operational modification to catch bottom fishes, column fishes, and pelagic fishes along with technological support to catch targeted species. Now, boats are capable of fishing a targeted fish alone from a fishing ground by changing their operation mode.

- Presently, the electronic systems in many of the boats are sufficient to monitor the operations in the sea. However, the fishermen are not interested in being a part of the monitoring system, claiming that the information on fish abundance found by them is their intellectual property and by sharing that information they will have to compete in the same fishing ground. Basically, they don't want to be a part of the monitoring system because they will lose financial freedom if all catch and profit come under the scanner which may have income tax-based repercussions in future.

- Over the years, trawling has grown both in terms of technological intervention and improvement in capacity to capture fish from extended fishing grounds far and deep. Nevertheless, all these developments were economic oriented and ignored scientific instructions now and then. Hygienic working and living conditions were highly compromised in almost all the trawlers to accommodate more fish hold. Similarly, major fishing harbours also do not maintain hygienic standards as instructed by scientific organization.

- While considering the doubling income from fisheries, doubling the fish production may seem a distant possibility. We need to adopt best practices in fish handling, fish preservation, and suitable fish marketing techniques which could double the income from the present catch without exerting much pressure on the environment. The improvement of conditions in fishing vessels and fishing harbours is the prime requirement to achieve this goal.

IoT – A Solution for the Indian Fisheries Industry, and Maritime Security and Safety

- Fishing and operational areas have undergone phenomenal changes in the last few decades and fishing activity is now generally extended to 200 metre depth zone. So far, no agency is involved in the extension of fishing activity in the sea, which is found to be a shortcoming in terms of sending alert notifications for to ships and other big vessels at sea.

- The CMFRI, with its Geographic Information System (GIS) mapping of fishing activities in the sea, has come out with protocols for mapping fishing activities in the sea with seasons and methods of operations.

- The CMFRI has demonstrated its capabilities by successfully mapping the trawl operational area around the Indian coast in GIS format and also demonstrated the mapping of all gears operated along the Indian coastline. Since fishery is a highly dynamic system, time series updating is needed to make it as much up to date as possible.

- The database and maps can be used for alerting the ships about other activities in the sea to protect the fishermen from accidents at sea (being hit by ships, etc). The CMFRI has come up with the mapping of fishing activities in the sea, incorporating all possible information on the seasonal changes in fishing area, and the activities in the sea ranging from unnoticeable, gillnet, and long lines to active trawlers and purse seiners operation. This scientific

information and maps of the activities of fishermen at sea can be an efficient tool to alert the ships in different seasons and CMFRI is capable of taking up the work for any state.

- Ensuring safety of life and implements of fisherfolk can be achieved through marine spatial planning (MSP). This requires methodical recording of the activities of fishermen and extension of fishing activities in space and time. In light of intense multi-sector activities in the sea like shipping, national security & defence activities, oil exploration, mining, and tourism, most government bodies face extreme difficulty in striking a balance between conservation concerns and economic development needs. MSP in GIS platform can be used to address safety issues of fishers and local communities by bringing their operations in the coastal and marine zone in a transferable format.

- Maritime ship collisions involving fishing boats have often been reported in many countries, and MSP is becoming an increasingly important tool for ensuring safety in the navigation route. The Ocean Council has instructed maritime professionals to collect information on other users of waterways space, from both sea and shore, and to take part in international, regional, national, and local MSP debates. This was suggested to ensure understanding of the needs of other marine users and resources. In the Pacific and Oceania, such experiments proved successful with fishermen voluntarily supplying data for ensuring their security.

- There are different kinds of monitoring mechanisms available around the world which, along with vessel movement monitoring, ensure the safety of fishermen at sea. Vessel monitoring systems (VMS), automatic identification system (AIS), long range identification and tracking (LRIT), space system for the search of vessels in distress-search and rescue satellite aided tracking (COSPAS–SARSAT) system, and global maritime distress and safety system (GMDSS) are some systems suggested by USA for ensuring the safety of vessels in the sea. VMS is extensively used by most of the countries to track vessel locations.

Recommendations for the Government

In India, from a legislative point of view, fisheries is a “subject” under the state list according to Article 21 of the Indian Constitution, and the management and control of coastal fisheries is vested in the maritime states and union territories. The Comprehensive Marine Fishing Policy 2004 of the Ministry of Agriculture,

Government of India reviewed the present status of fishery regulation in coastal waters. It recognizes that though the Marine Fisheries Regulation Acts of coastal states and union territories have adequate provisions for management of resources and fishing operations, they are often found falling short of effective implementation. It also raised concern that the exploitation of living resources within 50 metre depth zone is showing symptoms of depletion and in certain belts in the inshore waters it tends to cross the optimum sustainable levels. One of the most promising suggestions in the Policy is to introduce MSP and ecosystem-based fisheries management. With spatial analysis of catch and effort data, it is possible to point out some of the inherent difficulties in the implementation of fishery-related policies, and to review the present allocation of judicial powers along the Indian coastal waters to solve inter-sector and intra-sector conflicts. Territorial waters, which were considered as a state fishery administrative boundary, lack legislative significance since fishing operations in most of the states extend beyond their territorial waters. Regional marine spatial planning with regional cooperation of different states coordinated by a body governed by the central government is suggested as a probable option for effective implementation of policies in the marine sector, and also to reduce inter-state and inter-sector conflicts. Adding spatial dimension to the data collected will help in regular updating of information for strengthening fisheries administration.

Marine fishing activities are highly dynamic with seasonal changes in areas of operation and depth of operation. Real-time documentation of such information from India was thus far considered impossible and the meagre data available were found to be poor or insufficient (due to lack of spatial dimensions) to be accepted in policy decisions. In the present fishing scenario, the installation of satellite-based equipment in trawlers and other mechanized vessels enables them to collect data on distribution and abundance of marine living resources in spatial format and the expertise in the use of GIS tools helps process these data for decision support in fisheries management. This could be one of the inputs for MSP, which would enable policymakers to suggest suitable decisions for marine zone management.

Fishermen on board and working in the fishing harbour and allied industries need to be organized with employment benefits under labour ministry so that their livelihood will be protected during difficult conditions arising from climatic vagaries and disease outbreaks. Health checking of the labourers should be made mandatory for keeping fish hygiene and labourers heath. Trawler operators are sacrificing basic facilities like on-board toilets. The space in the trawlers should be allocated taking into consideration basic human needs. The Scientific Organization working on fishing technology has come out with model trawler cabins, which can accommodate all basic needs of the labourers on-board. While registering the boats or during the

time of renewal of registration, physical verification should be done to ensure that all basic facilities are complied with before the trawlers get ready for the voyage. Lack of hygiene on board will increase the risk of disease outbreaks and the lesson learned from Covid-19 demands a rethinking on hygiene, fishing operations, and better implementation of human rights as part of the best practices in trawling.

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Challenges in the Fisheries Sector

1. Coastal and Marine pollution micro plastics
2. Increasing competition for coastal resources by non–fishery and non-coast dependent sectors
3. Absence of deep-sea environmental governance system
4. Increasing share of non-edible fish landings and diversion of edible fish for non-edible products indicating marine bio-diversity loss
5. Absence of community engagement in fishery plans and Blue Revolution programmes

IoT – A Solution for the Indian Fisheries Industry, and Maritime Security and Safety

- Develop strategies to mobilize coastal communities against destructive fishing practices
- Marine litter policy and make Coast Guard accountable for increasing plastic pollution
- Incentivize fishing for litters

Recommendations for the Government

1. Take necessary steps to strictly implement sustainable development goal 14 and related goals as recommended by state and central plans.

2. Develop the concept of "no-go zone" to rejuvenate fish catch areas. Those fishing grounds with ecologically sensitive areas and threatened species should be protected from trawling and other forms of fishing methods. All trawlers and other gears should be fitted with GPS which can be tracked by satellite and registered. Identifying and administering marine protected areas is a major strategy for protecting marine resources, conserving biodiversity and ensuring the well-being of people dependent on them for livelihood. The Sea Bird (Naval) project, claimed to be the largest in Asia, has already displaced 4779 families from 13 villages of Karwar, and 8423 acres of prime coastal/marine areas has been acquired for the project. Similar land

acquisition has happened in almost all coastal states such as Maharashtra, Odisha, Andhra Pradesh, and Tamil Nadu. We suggest that a certain percentage of the area could be notified as marine protected area (marine sanctuary/marine national park) under the Wildlife Protection Act since fishing is already strictly prohibited in these areas due to security reasons. Thus, there will be no further loss of livelihoods and conflicts with fishing communities.

3. Ocean dumping of about 0.6 MT of plastic waste annually is a fast-growing concern for India. A Marine Litter and Microplastics framing the National Marine Litter Policy and action programme as per the National Green Tribunal judgment should be implemented. Regular monitoring of the coastal water quality in real time and assessment of the health of the coastal ecosystem is important.

4. In India there are only regulatory controls to protect wetlands and there is no scope for market-based approach within the existing legal framework. It is important that the existing regulatory system should incorporate rules to introduce market-based approaches. In this regard regulating the access to marine biological resources including fish by imposing a cess based on the net value realized by the users is a significant step. The products can be listed by their manufacturing industries and fees could be levied under the Access and Benefit Sharing Regulations 2014 issued under the provisions of Biodiversity Act 2002. The Biodiversity Board could also start a marking system like a green line/triangle for bio-products & fees paid, red/orange if unpaid. A bio-declaration form may be introduced for export at airports/ shipping ports at airports/flight, to declare bio-goods and determine if ABS fee is paid. The Export Inspection Council under the Ministry of Commerce & Industry and relevant export promotion boards could join the National Biodiversity Authority/state biodiversity boards and begin to screen all bio-resource products exported/processed for its contents to check if any bio-resource has been used. If any bio-resource elements are found, the royalty payable could be some percentage of the market value of the product. The Board could insist on all processors/exporters to execute an agreement/declaration that the product does/does not consist of any bio-resource before it was shipped out of the country. The Board could also finance laboratories to detect the contents of the bio products at a few selected ports and also enter into an agreement with Export Inspection Council.

5. Shrinking coastal space for fishing related activities was one of the main concerns of the fisher groups. New claimers such as tourism, housing,

infrastructure, and industries have alienated the land and resources transfer hitherto available for fishing related activities. By using the existing legislations such as Coastal Regulation Zone (CRZ) 2018, areas currently required for future expansion by fisher groups should be protected. The beach space along harbours, jetties, and beaches are mostly under ports departments. The port areas are being permitted to be used for bus shelters, roads, ship building/breaking companies, pipelines for petroleum, etc., on the ground that they are all shore-based activities. The space required for fish drying, net mending, marketing, and storage activities are not allowed by the port departments. Hence, those land areas customarily used by women for their livelihood activities should be permanently leased for specified purposes.

6. With an increase in the number of extreme weather event forecast under the IPCC (Intergovernmental Panel on Climate Change) models, mangroves as coastal defences are often cost-effective solutions with biological benefits. They would help with freshwater eutrophication being passed to the marine environment and also capture carbon. The mangroves are unpopular with shrimp farmers as they encourage wading birds that may transmit disease, may reduce Ph required for growth of shrimp, and may increase crab population which will borough the bunds of shrimp ponds. These issues could be addressed through management measures and education/information in fishing villages.

7. All the west coast states should have uniform fishery management rules and regulations such as control on fishing intensity, eligibility for fuel subsidy, sustainable fishing practices, zoning regulations, and closed seasons and areas. The fuel subsidy may be linked to the adaptation of the existing management regulations as per the Karnataka Marine Fisheries Regulation Act. Thus, those fishing boats which adopt management regulations such as mesh size, zoning of fishing areas, closed seasons (monsoon ban), and strict adherence to limits to fishing capacity (HP and size) may be given incentives and subsidies rather than giving subsidy to each and every licensed boat.

8. The existence of a large number of fishmeal companies shows the destructive fishing practices followed by the deep-sea fishing vessels by harvesting non-target species and bycatch. Therefore, the government should impose restrictions on the expansion and starting of fishmeal companies through a system of progressive taxation of turnover of such companies under the Biodiversity Act 2004.

9. The Roadmap for the process of MSP may be designed and created involving all relevant stakeholders, focusing on generation of data and sharing of data information; implementation and enforcing the plans; monitoring and evaluating performance; and, adapting the spatial planning process.

10. With growing affluence, particularly in urban areas, people tend to buy clean, ready-to-eat and ready-to-serve fish products from supermarkets than buying raw fish. By designing a suitable business model for women involving mobile kiosks for value added fish products, capacity building of fisherwomen through preparation of value added fish products, establishing mobile market units for promotion of the enterprise, exposing SHGs to various market and credit opportunities, and providing basic entrepreneurial knowledge and skills to the fisherwomen would lead to women empowerment. This project could be a partnership venture of NETFISH, NGO, and Central Institute of Fisheries Technology (CIFT) for piloting the value-added fish product promotion through Designer Mobile Fish Kiosks as one of the income generation activities for fisher women.

11. Development of "accelerated technology including AI, automation, robotics and digitalization" for exploiting a state's EEZ in a sustainable way, which may contribute to economic development of the country and enhance societal benefits.

12. We need insurance mechanisms that pay out quickly to the victims from fishing and other coastal communities who incur financial and physical losses due to erosion, cyclones, and other climate related disasters. Such insurance mechanisms should be funded by imposing taxes and penalties on those who contribute to climate change as measured by the stock of greenhouse gases they have produced. A Catastrophic Risk Insurance Facility could be established to pay and undertake immediate relief efforts.

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In India, fisheries provides livelihood to at least 16 million fishermen and fish farm workers. At the primary level, there are more than 32 million workers in the value chain across fisheries. The sector has huge potential to more than double the incomes of fishermen and fish farm workers provided there is technological upgradation. Across all functionalities of fishing process from growing of fish to catching, to processing and scientific & efficient post harvesting, we need to keep in mind the sustainability of fisheries resources because without sustainability, we cannot meet the needs of the present, without compromising the ability of future generations to meet their own needs.

As a sector, it contributes 1% to GDP, showing a steady and continuous increase in gross value added, and has approximately 6.6% of agricultural GDP. The sector is a major contributor of foreign exchange earnings, has more than 5% of total exports, and constitutes 20% of agricultural exports.

With 10% of global biodiversity of fishes being in India, 2 million sq km of exclusive economic zone, 0.5 million sq km of continental shelf area, and huge inland water resources like ponds, lakes, rivers, brackish water, saline water areas, tanks and reservoirs, the total fisheries potential of India is around 22 MMT, out of which only 13 million has been exploited so far, leaving a huge potential. It is not that over the years technology upgradation has not happened in fisheries sector, but it is a fact that the marine fisheries sector is still dominated by socioeconomically backward artisanal and small-scale fishers, despite the fact that as of now, 75% of marine fish production comes from mechanized sector, 23% from motorized sector, and only 2% from artisanal sector.

Technological upgradation started in this sector with the Indo-Norwegian project in Kollam region of Kerala in 1953, where the primary objective was the mechanization of fishing crafts. It took some years before the benefits of mechanized and trawl fishing were appreciated over non-mechanized fishing. Further development happened under the FAO/EPTA (Expanded Programme of Technical Assistance) programme, which led to the making of medium and large fishing vessels, indigenous engines for these vessels, alternative materials for boat building, new and efficient designs for fishing gears, and new methods of fishing. All this resulted in changes in craft movement, development of new gears, and new tackling

techniques. It raised the productive capacity with the use of machine power that enabled fishermen to reach the fishing ground early and spend more time fishing. It helped them increase the range (distance) of fishing operations. Fishermen could also now catch bottom-dwelling species because of the increase in the depth range of fishing operation.

Due to mechanized fishing and improved crafts, there are newer and more efficient methods of fishing which have come into vogue like gillnetting, boat seining, bottom trawling, pelagic trawling, long lining, lift netting, and fish pumping. Technological upgradation was primarily based on R&D for fisheries resources, fishing crafts, fishing gears, fishing techniques, and CMFRI played a big role in that. Thereafter, upgradation also happened in the landing process, and the first sales and preservation processes, although there is still a huge potential for improvement in this area.

Technological upgradation is a blessing, but also has its share of problems. For example, it has brought the problem of overcapitalization and over exploitation of fisheries, so much so that in many areas there is a huge depletion of natural resources. There was marginalization of traditional fishermen who could not cope with or afford the new advances.

It also led to underemployment in the non-mechanized sector. Further, it led to intense competition for limited resources and to lower per capita production, juvenile fishing, large level discards. All this resulted in sustainability issues.

In terms of preservation, in earlier times, mostly freshly prepared fish was consumed, and preservation was generally done by salting or smoking or sun drying. Later on, fish canning became popular and much later icing and then freezing. Later on came special freezer carriers and factory freezer ships but freezing fish at sea is usually a very costly option.

As the National Fisheries Policy 2020 notes, there are major constraints impacting the growth of marine capture fisheries such as limited scope for expansion due to overcapacities in territorial waters; weak regulation and inefficient management; inadequate infrastructure, especially fishing harbours, landing centres, cold chain distribution systems; poor processing and value addition, wastage, traceability and certification; and, non-availability of skilled manpower. For inland fisheries, some of the constraints are the seasonal nature of fishing operations, depletion of stocks in natural waters, tenure and lease rights issues, use of obsolete technology for harvesting, and low capital infusion.

So, while the national policy rightly visualizes the need for creating a conducive environment for attracting investment into the fisheries sector, delegating powers to states and union territories to grant marine fishing licenses for EEZ s and high seas, empowering traditional and small-scale fishermen and fishing groups to undertake resource specific deep sea fishing for harnessing the untapped potential of high value resources like tuna, tuna like species, and oceanic squids. Deep sea fishing will require the development of an optimum fleet size of modern fishing vessels capable of undertaking extended time voyages of 3 to 6 months at high seas, modern technology, and capacity building.

There is also a mention of suitable conservation measures like ranching, temporary ban period, and creating suitable at sea and on shore alternative livelihood activities. While all this is clearly visualized, nothing will happen without proper and fast implementation of these policy prescriptions.

Last but not least is the need for measures to ensure safety-at-sea for fishermen and fishing vessels. For this there is a need for immediately providing low-cost NB (narrow band) IoT small satellite terminals which should be capable of providing reliable and instantaneous data communication both ways at a fast speed, also with the facility of two-way text communication. It seems that state owned public sector undertaking BSNL has probably developed such transponders and have demonstrated their working and effectiveness to various states or users. This needs to be immediately adopted by users and provided by coastal states/UTs.

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Challenges in the Fisheries Sector

- Overcapacity is a most frequently raised problem in India's fishing sector. At the same time, we have underutilized potential. So, overcapacity might be more relevant for specific fishing zones where large numbers of fishers compete with each other for limited fish stocks.

- Depletion in stocks of several commercial fishes is another problem; sardine decline in southwest coast due to overfishing/juvenile fishing, and environmental factors such as El Nino and rising sea surface temperature are excellent examples.

- Destructive fishing practices such as juvenile fishing, pair trawling, and light fishing.

- Lack of a central act that governs the area between 12–200 nautical miles is another major issue. Due to this, most of the mechanized fishing in this zone is technically illegal, unreported and unregulated.

- Fishing is generally profitable, but due to the excessive number of resource fishers/fishing labourers depending on small-scale fishing, fishers remain generally poor with low living standards.

- Occupational hazards and low coverage of risks and uncertainties. Majority of the fishing vessels in India are uninsured. Also, many fishers do not have accident insurance coverage. Also, the coastal assets of fishers have no risk coverage from cyclones and tsunamis.

- Formal credit availability in fisheries is extremely low, with high dependence on expensive informal loans.

- Limited communication facilities (VMS/AIS) that could help fishers engage in multi-day fishing in case of extreme weather events.

- Limited amenities in most of the fishing vessels (no specific vessel standards).

Recommendations for the Government

Some recommendations for the government for further development of the fisheries industry and improvement of maritime safety and security are:

- Use of space technology and ICT for fool proof sea safety and communication systems which are affordable to fishers (subsidies might be important here),

- High priority for maritime safety, especially to prevent chances of infiltration and illegal activities,

- Strengthening welfare measures for fishers, and

- Strong priority for developing fish value chains with better infrastructure, market intelligence, and database systems in place.

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M2M/ IoT Enabling Smart Infrastructure

M2M/ IoT is one of the emerging technologies as on date and is being used to create smart infrastructure in various sectors, namely automotive, power, healthcare, smart homes, intelligent buildings, environment monitoring & pollution control, water management, waste management, and agriculture, fisheries. IoT will revolutionize and change the way all businesses, governments, and consumers interact with the physical world.

As per the recent projections by Ericsson, there may be around 24.6 billion connected devices across the globe by 2025. Out of this, around 21% will be on cellular technologies.

In India, an ecosystem is to be developed for connecting five Billion devices by 2022 as envisaged in National Digital Communication Policy (NDCP) 2018.

1. Machine to Machine (M2M) Communication/Internet of Things

1.1. M2M Communication

M2M refers to the technologies that allow wired/wireless systems to communicate with devices of same ability. M2M uses a device (sensor, meter, etc.) to capture an "event" (motion, meter reading, temperature, etc.), which is relayed through a network (wireless, wired or hybrid) to an application (software programme), that translates the captured event into meaningful information.

1.2. Internet of Things

Internet of things is a bunch of technologies and is benefitted by a number of technologies such as M2M, AI, machine learning, edge/distributed computing, big data analytics, blockchain, and 5G. The IoT is one of the most disruptive technologies as on date across the globe.

1.3. International Telecommunication Union-Telecommunication standardization Sector (ITU-T)

The ITU-T in its Recommendation ITU-T Y.2060 (06/2012) has defined IoT as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

The enabling technologies for M2M/IoT are sensor networks, RFID, mobile Internet, location based services, augmented reality, AI, wired & wireless communication network, internet protocol versions IPv4/IPv6, etc.

M2M/IoT will have a large number of communication technologies such as RFID, NFC (near-field communication), BLE (Bluetooth low energy) working in very short range, low power wireless, cellular (2G, 3G, 4G, 5G), fixed line broadband, power line communication, cellular low-power wide-area network or LPWAN (EC-GSM, NB-IoT, LTE-MTC), and non-Cellular LPWAN (LoRa, Sigfox etc.)

5G will provide enhanced mobile broadband with peak data rate of 10 gigabits per second, mission critical services (Ultra reliable & low latency communication or URLLC) with RAN latency < 1ms and Massive M2M/ IoT services. URLLC will be quite useful for self-driving vehicles, drones, robotic surgery, and vehicle to vehicle (V2V) communication.

2. Standardization work in M2M/ IoT domain in Telecommunication Engineering Centre (TEC), Department of Telecommunications (DoT), India:

TEC formed multi-stake holders working groups and released Technical reports, available on TEC website (www.tec.gov.in/technical-reports/). These are:

1. M2M Enablement in Power Sector
2. M2M Enablement in Intelligent Transport System
3. M2M Enablement in Remote Health Management
4. M2M Enablement in Safety & Surveillance Systems
5. M2M Gateway & Architecture.
6. M2M Number Resource Requirement and Options
7. V2V / V2I Radio Communication and Embedded SIM
8. Spectrum requirements for PLC and Low Power RF Communications.
9. ICT Deployments and Strategies for India's Smart Cities: A Curtain Raiser
10. M2M/IoT Enablement in Smart Homes

11. Communication Technologies in M2M/IoT Domain
12. Design and Planning Smart Cities with IoT/ICT
13. M2M/IoT Security

3. Several actionable points emerged from these technical reports, which are important for the development of the ecosystem in M2M/IoT domain. Some important actionable points are as given below:

3.1. Based on TEC (Telecommunications Engineering Centre) Technical Report, 13-digit M2M numbering plan for SIM based devices/gateways, which will co-exist with the existing 10-digit numbering scheme, was prepared.

3.2. M2M SIM/Embedded SIM and remote subscription management: In view of technical report released on this subject, interface requirement (IR) was prepared in TEC.

- DoT has approved the use of Embedded SIM with over-the-air (OTA) provisioning.
- Ministry of Road Transport & Highways in India has issued a Standard [AIS-140] which mandates the use of embedded SIM for commercial passenger vehicle tracking.
- The Bureau of Indian Standards (BIS) has released a new Standard for automotive tracking device and integrated systems (IS 16833: 2018) which mandates the use of the embedded SIM as per the standards/specifications of TEC, DoT.

3.3. Any device/gateway having direct connectivity with public switched telephone network (PSTN) or public land mobile network (PLMN) will be required to have static IP. As IPv4 is about to exhaust, adoption of IPv6 at device, network, and application level will be necessary. Therefore, such devices/gateways should have IPv6 or dual stack.

- BIS has mandated IPv6 for Smart meters (IS16444).

3.4. Multi-protocol gateways

3.5. Common service layer: It is important for sharing of data across verticals and between platforms. oneM2M Rel2 standard has been adopted as a national standard. It will be quite useful for the development of a standardized ecosystem for IoT domain, especially for smart cities.

Shri Parthsarathi Trivedi
CEO and Co-Founder
SKYLO Technologies

Digitization and Connectivity holds the key to a sustainable and profitable future for every sector to grow. Also, it is an integral part in achieving Prime Minister Shri Narendra Modi's vision of true Digital India.

For centuries, industries like agriculture, railways, and fisheries have been operating offline, and have not had the opportunity to take full advantage of the latest advancements in AI and IoT.

With continuous research and advancement in technology, the ability to connect anywhere at any given point of time across India is possible. Utilization of the latest technology will boost productivity and optimization of resources across sectors.

The challenges faced by the fisheries sector include unreliable, unstable offshore connectivity, inconsistent visibility into precise locations of ships, lack of reliable real-time alerts for adverse weather events, unpredictable information about regulations, international borders, unsafe environments, and inability to sell catch before they reach the shore.

In the fishery sector, optimum use of technology can transform the sector in three main ways – safety, productivity, and sustainability. A robust IoT ecosystem provides with connected data, devices, business applications and communication networks to exchange information in a seamless yet secure manner.

All these challenges can be addressed only with affordable real-time two-way connective and communication solutions. With advanced IoT real-time alerts and GPS tracking, we can reduce the economic burden and enhance the security of the fisherman. It will improve productivity and reduce maintenance costs and help in making informed and better business decisions. However, this technology movement has to be a pan India process.

Shri Vikas Sharma
Director & Chief Executive
Centre for Strategy and Leadership

Fisheries is the world's fastest-growing food-production market, accounting for nearly $160 billion worth annual output. India is the world's second-largest fish producer, contributing 5.23 per cent of the global fish supply. It has assumed an increasingly prominent role in the country's socioeconomic growth by offering low-cost, high-nutrition food as well as a strong source of income.

Technological advancement is necessary to optimize the ability to harness the full potential of the Fisheries sector. Specifically, fostering IoT-based technologies can help improve the sector's security, safety, productivity, and efficiency, as well as maximize the management of scarce resources, protect fishermen, and increase the overall productivity of the Indian Fisheries industry.

While technologies such as IoT and ICT are available in the market, the major obstacle that the fisheries sector encounters is a lack of advanced and affordable technologies. Many fishermen, particularly the low-income fishers, are still using old fishing tackles as they cannot afford expensive equipment.

Hence, we need technology that is advanced and affordable with minimal cost of maintenance. The availability of more advanced and low-cost equipment in the market will help in economic and social development of the fishermen and also facilitate the development of the Fisheries sector and its auxiliary industries. Also, harnessing the IoT will help generate employment opportunities and contribute in taking forward the vision of Atmanirbhar Bharat.

Innovative and cost-effective alternatives are the need of the hour to boost productivity and efficiency in the Fisheries sector. Startups such as Skylo Technologies offer advanced security equipment and enhanced disaster management solutions such as two-way emergency messaging, immediate SOS and weather forecasts, and back and forth notifications to both the crew and the operator with messages in real time to avoid distress. It facilitates continuous location and efficiency monitoring, giving people peace of mind when operating in dangerous and remote environments.

The platform ventures beyond the concept of disruptive innovation by linking millions of devices at low cost, thereby allowing multiple industries to transform their businesses through constant connectivity.

Thus, producing advanced and affordable IoT solutions as key part of the sector's growth model should be made a priority. There is a need to adopt innovative monitoring tools and apply the advances in digital technologies in a robust manner to tie up the loose ends for better development of the Fisheries sector.

The Way Forward

This study considers new technologies such as ICT and IoT as important tools for realizing green growth in the fisheries sector based on the development of new technologies and their contribution to improved management of the fisheries industry and the organization of the food supply chain. To this end, many initiatives are being taken by institutional organizations and government bodies in the field of the best fishery management practices.

Organizations such as the Indian National Centre for Ocean Information Services (INCOIS), CMFRI, and BSNL have been doing great work at the ground level. Over the years it has brought in innovative technologies to ensure the safety of the fishermen and the vessels along with national security. However, involving private and small fishermen is an ongoing process, and given the speed of technological innovations there is a need for the private players to adapt to the new technologies for the larger welfare.

Skylo Technologies is a great example of best practice and fortified data sharing because it allows the development of new concepts in the implementation of marine protected area and proper stock management.

In addition to value chain, stakeholders need to be involved in the decision-making process to improve scientific data and knowledge required for management and governance. Besides, the fisher community should be helped in developing technical knowledge so as to better adapt to the new technologies, especially fishermen working in vessels of less than 12 meters which are difficult to espy.

The future of fisheries management depends on technological innovation. A complementary new technology will help create a tool box for the ecology and communications policymakers to manage fish stocks. Moreover, technological and digital improvements now allow the use of innovative monitoring tools to better manage fish stocks at each level of the value chain. The use of technology in such situations is still largely limited by the cost, challenges facing the fishery management authority in data sharing, ever more complex data requirement, and few people being trained to use the device. The challenges in the fisheries sector can be overcome through the uniform use of technology across fisheries development boards for which the fish farmers need to be engaged on a regular basis.

Special Report on E-Conclave: *New India @75 – IoT and the Changing Face of Fisheries Industry*

India is the second largest fish producer in the world, contributing 5.43% to world fish production. It has earned a very important position in the socioeconomic development of the country as it provides low-cost, high nutrition food.

In 2018–19, the country earned Rs. 47,620 crore in foreign exchange through the export of fish and fish products. The sector is showing steady growth in the total value added with a share of 5.23% in total GDP. Therefore, fish production is recognized as a strong source of income and employment.

A major milestone for the nation is August 15, 2022, when independent India will turn 75, and the Hon'ble Prime Minister of India has given his clarion call for establishing a New India by 2022.

To celebrate this momentous occasion, Centre for Strategy & Leadership (CSL) is organizing a series of events, discussions, and conferences to showcase the growth, achievements, and milestones of key sectors, as identified by NITI Aayog.

Shri Pratap Chandra Sarangi, Hon'ble Minister of State for Fisheries, Animal Husbandry & Dairying, and Ministry of Micro, Small & Medium Enterprises, Government of India.

In this backdrop and with regard to the potential opportunities in IoT in the fisheries sector, CSL successfully organized the series' first E-Conclave "New India @75 – IoT and the Changing Face of Fisheries Industry" on November 20, 2020. The series was inaugurated by Chief Guest Shri Pratap Chandra Sarangi, Hon'ble Minister of State for Fisheries, Animal Husbandry & Dairying, and Ministry of Micro, Small & Medium Enterprises, Government of India.

The distinguished speakers for the programme were:

- Lt. General (Dr.) Rajesh Pant, National Cyber Security Coordinator, Prime Minister's Office, Government of India
- Shri Raj Nehru, Vice-Chancellor, Shri Vishwakarma Skill University (SVSU), Government of Haryana
- Lt. Gen (Retd) P.J.S. Pannu, PVSM, AVSM, VSM, Former Deputy Chief of Integrated Defense Staff
- Shri Sushil Kumar, DDG (IoT), Department of Telecommunications, Government of India
- Shri Parthsarathi Trivedi, CEO and Co-Founder, Skylo Technologies
- Shri Vikas Sharma, Director and Chief Executive, Centre for Strategy & Leadership

The programme was organized in association with our "Media Partner" *India Ahead News* and Shri Vishwakarma Skill University, India's first Skill University, set up by the Government of Haryana.

Hon'ble Minister Shri Pratap Chandra Sarangi shared that the fisheries sector is growing at a rate of 9.71% through fisheries exports and recent initiatives taken by the government. The contribution of the fisheries sector to the Indian economy was to the tune of Rs 46,662 crores through exports during 2018–19. He talked about the Blue Revolution and the PMMSY scheme – launched by Hon'ble Prime Minister Shri Narendra Modi – which focuses on sustainable development of the fisheries sector in the country with an estimated investment of Rs 20,050 crores, the highest ever for the five-year period FY 2020–21 to FY 2024–25 in all states/union territories, as a part of Aatma Nirbhar Bharat Abhiyaan. Out of this, an investment of about Rs. 12,340 crore is proposed for beneficiary-oriented activities in marine, inland fisheries and aquaculture and about Rs. 7,710 crore in fisheries infrastructure like deep-sea vessels, and developing integrated laboratory network for diagnostic and quality testing through mobile labs/clinics. This will pave the path for overall development and upliftment of the standard of living of fishermen.

General Rajesh Pant emphasized the use of IoT not just for the security of the nation (to avoid and fight terrorist attacks), but also on how it is an asset to the fisheries sector. He mentioned that there are nearly 17 billion IoT devices in the world. By 2025 there will 30 billion IoT devices and this figure is projected to reach 50 billion by 2050. He further mentioned that the biggest challenge is that there are no cybersecurity standards for IoT devices in our country. However, the Ministry of Electronics and Information Technology, the Department of Telecommunications, and NITI Aayog are all working on it, including the Bureau of Indian Standards.

Skylo Technologies co-founder and CEO Mr Parthsarathi Trivedi said that digitization and connectivity are actually going to be the key to achieving the prime minister's goal of doubling our fisheries production under the blue revolution. Technology can transform the fisheries sector in three main ways: safety, productivity, and sustainability. However, affordable two-way connectivity at sea for the lack of fishing vessels, that remain unconnected and unserved, needs to top the agenda. Skylo has successfully reduced the cost of satellite connectivity by more than two orders of magnitude, essentially shrinking it into a portable, a transponder, making it possible for every fishing vessel at sea to be connected, no matter where in the Indian waters it goes. Furthermore, with their standard mobile phones paired with Skylo transponder over bluetooth or wifi, fisherman now have access to life-saving two-way connectivity, the ability to stay close to their families while being anywhere in the waters, and also remote access to markets. But rolling out IoT

should to be a pan India movement. This will help fishermen to connect to the wholesale market through digitalization. Digitalization will be key to achieving the goals, and technology will transform fisheries in a big way.

Mr Vikas Sharma stated that 65% of India's population under the age of 35 years makes it a robust workforce pool. As per studies, the IoT sector will be a booming sector with more than $20 billion market by 2022. Therefore, harnessing the IoT through public and private partnerships will help in creating millions of job opportunities, thereby facilitating the development of in fisheries sector as well as its auxiliary industries.

Mr Raj Nehru added that given the huge surge in demand, more than 150 million new technology-oriented jobs will be generated in the IoT sector as it shows cumulative annual growth of more than 20–25%. To yield benefits, and for the sector to continue growing, more technically skilled workforce is required in each level of the pyramid.

Lt General Pannu said that the 7,000 km plus coastline throws up many challenges for the country; for example, the security of technologically under-equipped, low-income fishermen who go beyond 200 nautical miles in unmarked marine borders. Internet of things will help bring these fishermen into the mainstream industry, and make them economically stable and secure. Moreover, the fishermen will not fall into the trap of invaders, making India's marine waters more secure and protected.

Mr Sushil Kumar emphasized the need for the certification of IoT devices. He said only the certified devices should be allowed to connect in the network. New vulnerabilities may be discovered in the already certified devices. Therefore, a central mechanism like a National Trust Centre (NTC) is required to ensure the deployment of the certified devices and addressing the vulnerabilities. He mentioned that TEC is already working on it. Standardization is a continuous activity. Standard-based solutions will help in the development of sustainable smart infrastructure, which will remain smart not only for the present generation but even for the future generations.

Conclusion

The E-Conclave concluded with clearly establishing the importance of IoT in enabling the fisheries sector to reach its full potential. Information regarding the various funds and support schemes was shared, which helped understand the government's future plans and investments in the fisheries sector.

Linking schemes such as the PMMSY with IoT will facilitate the development of the fisheries sector as well as its auxiliary industries. Moreover, it will help bring fishermen into the mainstream industry, making them economically stable and secure.

However, unless digital & technological advances and innovative monitoring tools are employed in a robust and mandatory manner, loose ends will not be gathered, thereby leading to a slowdown in fishing activities. To this end, available technology can be provided at an affordable price tag. It can be inclusive regardless of the economical weight of an individual pocket. At the same time, it can be effective, profitable, and sustainable.

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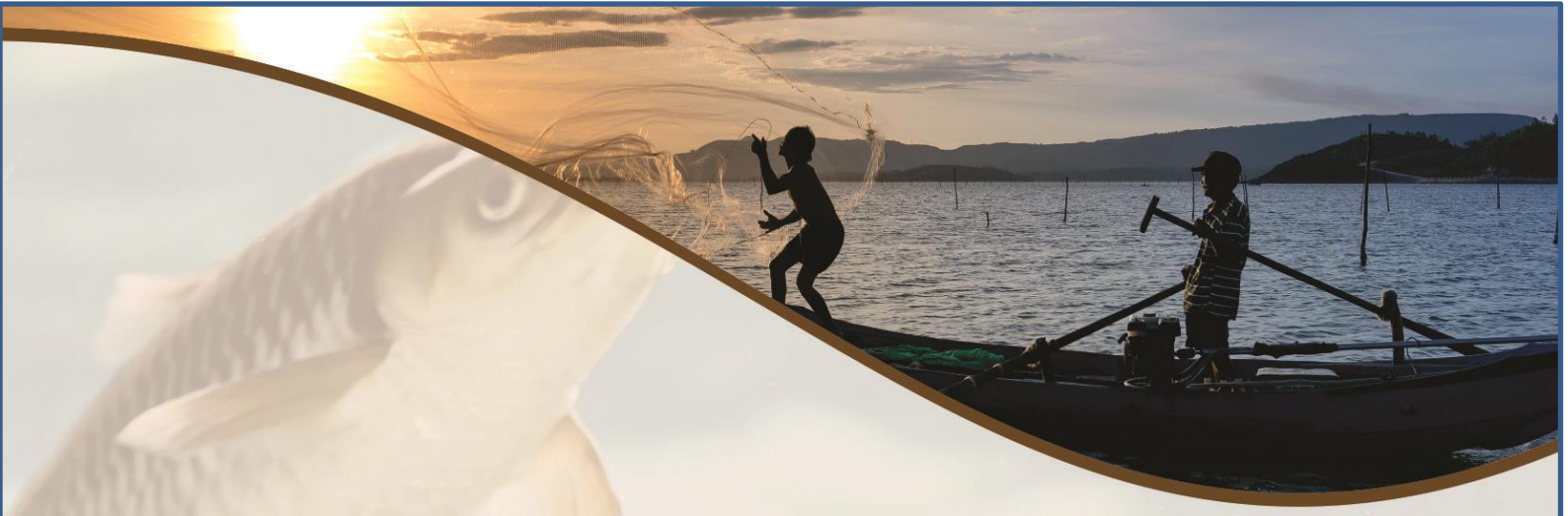

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