

Fisheries and Aquaculture for Food Security and Nutrition: Global and Indian Perspective

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Abstract

The contribution of fisheries for food security and nutrition are often not fully recognised and integrated in agricultural and food security strategies and programmes. Aquaculture is the fastest growing form of food production in the world with tremendous annual growth rates of 8.8% per year, having expanded by almost 12 times in the last three decades. More than 120 million people in the world depend directly on fisheries-related activities. Asia has contributed to a steady increase in the world aquaculture production (91.11%) in order to meet the increased demand. It is evident that any decline in Asian aquaculture production will affect the stability of global seafood supply. There is a need for further actively promoting the HLPE report (2014) and the leading nations (both developing and developed countries) must take significant initiatives to implement recommendations of this important documentation. The time is right for India to launch a Fisheries Strategic Master Plan (FSMP) and an associated action program of support where increased fisheries production, both captured and cultured, and improved value-addition in order to drive both domestic and export-oriented growth, while maintaining an ecosystem-based focus for resilience and sustainability. India's "Blue Revolution" potentially will come from underutilised inland resources (reservoirs, irrigation tanks, lakes, swamps, rivers and streams) and aquaculture sector. While freshwater and brackish water aquaculture has more than doubled over the last 10 years, the current overall yield is only about one-fifth of the best performing farms in China and other countries of East Asia.

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Introduction

Aquaculture is the fastest growing form of food production in the world with tremendous annual growth rates of 8.8% per year, having expanded by almost 12 times in the last three decades, providing now more than 40% of the fish consumed worldwide, allowing to keep pace with the growing demand while capture fisheries is stagnating. According to the FAO 2018 report, total fish production in 2016 reached an all-time high of 171 million tonnes, of which 88 percent was utilized for direct human consumption, thanks to the relatively stable capture fisheries production, comparatively reduced wastage and continued aquaculture growth. However, the rapid development of aquaculture has come with associated environmental costs such as habitat degradation, disease and pollution.

It is estimated that more than 120 million people in the world depend directly on fisheries-related activities (fishing, processing, trading), a vast majority of them living in developing and emergent countries. Small-scale fisheries account for 90% of fisher folk. It is estimated that between 660 and 820 million people (workers and their families) depend totally or partly on fisheries, aquaculture and related industries as a source of income and support (Allison *et al.* 2013, HLPE 2014).

In the capture fisheries sector, most of the stocks of the top ten species, which account in total for about 30 percent of world marine capture fisheries production, are fully exploited and, therefore, have little potential for increase in production. According to the CMFRI (2018) report, India's marine fish production shows a sign of revival with the annual marine fish landings in 2017 (3.83 MT) registering 5.6% increase compared to the previous year. India is also an important country that produces fish through aquaculture. India is home to more than 10 percent of the global fish diversity. The

fisheries sector provides employment for 14 million people according to the Fisheries Development Board. Fish and fish products have presently emerged as the largest group in agricultural exports of India.

Fish in aquaculture systems are very efficient converters of feed into protein – more efficient than most terrestrial livestock systems. For instance, poultry converts about 18 percent of the food consumed and pigs about 13 percent as compared with 30 percent in the case of fish (Hasan and Halwart 2009). Production of 1 kg of beef protein requires 61.1 kg of grain while 1 kg of pork protein requires 38 kg as compared with 13.5 kg in the case of fish.

Asia has contributed to a steady increase in the world aquaculture production (91.11%) in order to meet the increased demand. It is evident that any decline in Asian aquaculture production will affect the stability of global seafood supply. Integration of proper technologies and management such as adoption of appropriate regulatory measures, fish health management, and managing external costs in the environment by setting guidelines, pricing mechanisms and fund schemes, will lead to a more profitable, responsible and environment-friendly aquaculture and at the same time protect wild fisheries (Liao and Chao 2009). However, more well-organized research, development, and extension efforts with the support of effective government policy regulations are needed to solve relevant problems and improve productivity. Otherwise, aquaculture production will not be able to meet the increasing demand for global aquatic products when capture fisheries and livestock industry can no longer do so. In both developing and developed countries, action must be taken to achieve the best outcomes for long-term food supply and security from aquaculture.

Indian inland fisheries sector has untapped resources where there is huge potential for phenomenal growth and the country should target this sector for the blue revolution. India is bestowed upon by 3.15 million ha of reservoirs, 0.72 million ha of lakes and 0.5 million ha of floodplain wetlands and the productivity of these water bodies has the potential to be increased up to between 2 to 5 times more. Using waterbody-based production models are the best approach available to utilize the untapped lake, reservoir and wetland resources.

This paper specifically focuses on the key fisheries reforms and management measures required from a Global perspective in General as well as Indian

subcontinent standpoint for sustainable contribution of fisheries for food and nutritional security.

Global Perspective

This description with regard to sustainable contribution of fisheries for food and nutritional security considered several studies and reports by UN and other international agencies and the key areas are highlighted in this paper.

According to the 2014 report High Levels Panel of Experts (HLPE) appointed by the World Committee on Food Security (CFS) for reviewing the Global Food and Nutritional Security issues and propose recommendations, the world (both developed and developing nations) is yet to give a deserving recognition for the important role played by the fisheries in food and nutritional security. The roles of fish for food security and nutrition are often not fully recognised and integrated in agricultural and food security strategies and programmes. Fish being more nutritious than staple plant foods, and provides high levels of animal protein, health promoting long-chain fatty acids (LC-PUFAs) and micronutrients can play an extremely important role in improving the nutritional status of individuals, particularly for those at risk of malnutrition such as children and pregnant women. According to the World Bank (2013), despite projected fish price increases, the world annual per capita fish food consumption is projected to increase by 1.4 kg, reaching 20.6 kg by 2022, up from 19.2 kg in 2012. These global numbers again mask regional differences, with the per capita fish consumption projected to increase in all continents except Africa, with Oceania and Asia showing the highest growth rate. Capture fisheries production is anticipated to be stable at 2010 levels and aquaculture production is expected to exceed that of capture fisheries in 2015 and to reach 53 percent of total human consumption by 2022 and 62 percent by 2030 (World Bank 2013).

As human use of living aquatic resources reaches the limits which natural endowments can sustain, the world needs and seeks better ways of managing the resources and of boosting and protecting their productive capacity. However, the pressures on the resources are mounting as growing numbers of people want food and livelihoods from them and competing activities stress the supporting ecosystems. The fluctuations in the supply, demand, value, management and use of living aquatic resources could threaten the progress towards sustainable food security in many parts of the world, but they could also stimulate improved management and use of the

resources.

An aquatic resource, whether it is marine (sea, coastal lagoons etc) or inland (river, lakes, floodplain etc), management is complex as these resources spread across various administrations within the country and also between countries. Each administration sometimes developed policies with least consideration to the other stakeholders (other states within the country or another country). Many poverty problems of fishing communities have non-fisheries causes, and are often related to institutional issues, requiring broader cross-sectoral support.

In order to reach fair agreements for managing resources within the country and internationally, adequate policies need to be developed based on sound scientific information coupled with strong political will and vision.

According to many studies, the following international initiatives could affect future management and use of living aquatic resources (ICLARM 1994).

- Negotiations of highly migratory and straddling fish stocks.
- The codes of practice on responsible fishing and aquaculture.
- The International Convention on Biological Diversity.
- The General Agreement on Tariffs and Trade ([World Trade Organization](#)).
- The UN Conference on Population and Development.

In 2014, the HLPE report has provided a fundamental but practical documentation which discussed the options for sustainable management of fisheries resources and made recommendations to enhance its contribution to food security and nutrition. This important report served as a guideline for the development of country specific strategic plan and appropriate policy development in order to support in addressing specific issues pertaining to the individual nation. These national strategic plans should include:

- review the governance structures for strengthening fisheries institutions dealing with management, especially in their ability to manage fisheries in a sustainable manner;

- develop of fundamental strategies/policies to maximise the benefits derived from fisheries and reduce the poverty and vulnerability of fishers;
- examine the investment policy regulations of governments in fisheries and aquaculture development and pathways for investment and how the public sector investment relates to/complements private investment in particular small scale in relation to food security; and
- discuss the options to create enhanced awareness of the importance and contribution of fisheries to poverty reduction and promoting their inclusion in national development plans and poverty alleviation strategies.

However, the HLPE report has not yet been taken into consideration by many countries which could be attributed to lack of active promotion at the appropriate level and inability to exercise adequate persuasion by relevant authorities. CFS must take proactive steps to promote the HLPE reports so as relevant administrators and politicians will take serious note of the HLPE findings. According to the report (HLPE 2014) the States should

- a) Make fish an integral element in inter-sectoral national food security and nutrition policies and programmes with special regard to promoting small-scale production and local arrangements (such as procurement through local markets, e.g. for school meals) and other policy tools, including nutrition education.
- b) Include fish in their nutritional programmes and interventions aiming at tackling micronutrient deficiencies especially among children and women, in the respect of cultural specificities, promoting local procurement, and taking into account costs and benefits.
- c) Strengthen international assistance and cooperation to build the capacity of developing countries to negotiate better terms in fishing agreements to protect the food security and nutrition of their populations.
- d) Eliminate harmful subsidies that encourage over-fishing, to make progress toward halting the current decline in global fish stocks. Revenues available to states from foregone subsidies could be redirected towards public good investments that support food security and nutrition in relation to sustainable fisheries (such as infrastructure and capacity development), or to improve the livelihoods and economic possibilities of fishing community residents.

FAO code of conduct must be implemented by all countries. The purpose of 1995 FAO Code of Conduct is to set international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. Implementation of the FAO “Code of Conduct needs to be further improved globally for sustainable aquatic resource management. The 2012 external evaluation of the Code (Williams *et al.* 2012) found that the “Code pays very little attention to either food security or poverty and mentions [small-scale fisheries] only in passing.” The themes were not elaborated further in Code instruments, which have more of a focus on environmental sustainability and technical issues related to aquatic resources rather than on the people who depend on them. The Evaluation Report recommended, among others, that FAO should ensure developmental objectives such as gender equality, food security and poverty reduction. This matter was further emphasised in the 2014 HLPE report.

Climate change impacts are already visible, with modifications of the geographic distribution of species and warmer water species moving towards the poles, ocean acidification and changes in coastal conditions that affect habitat. This has various impacts on production. Inland fisheries and aquaculture may face higher mortality due to heat waves, water scarcity and competition for water. Climate change impacts on fish-dependent populations will depend on the evolution of fishing opportunities (evolution of resources available, entitlements and capacities to fish, evolution of operational costs in production and marketing) and the evolution of prices. Impacts of extreme events are increasing, with more risks of damage or loss of infrastructure and housing. Sea level rise might lead to the relocation of communities. The HLPE 2014 report has recommended the following matters:

- a) Mainstream climate change adaptation strategies relevant to fish and food security and nutrition into all aquaculture and fisheries policies and actions at national and subnational levels, including linking them to climate and weather research and prediction agencies, developing specific studies and introducing, where needed, flexibility in management and governance mechanisms.
- b) Engage in inclusive dialogue and analysis to build scenarios to understand the possible impact of climate

change on the food security and nutrition of most vulnerable zones (for example coastal and small island states) that could be affected and develop and implement the necessary actions through inclusive processes.

Governance: Proper governance is particularly important to determine access to fisheries resources, integrity of fisheries resources and distribution of fish benefits. In most countries, too little attention has been given to the ways different individuals and groups (including poorer and marginalized people in the fisheries and aquaculture supply chains, but also poor consumers more generally) will gain, lose, or be excluded from access to fish resources, to other productive supply chain assets, or to fish as a food commodity. In this regard, evidence suggest that human rights instruments are important effective tools to help ensure that states fulfil their obligations, including those pertaining to the right to food.

Access to resources for aquaculture can be especially contentious given the specific requirements for this activity which needs to take place on suitable lands, in particular those linked to appropriate water resources, in the context of a strong development of the activity, and given competing uses on these specific areas with a wide a range of other activities, including fisheries.

In the aquaculture sector, secured rights to land and water are essential to the development and investments in the sector. Issues of rights are linked to the location of the activity itself.

Governance in fish food chains which involve international trade plays a major role in the orientation of production, both by promoting certain types of organization, such as transformation at sea in big boats and by setting quality standards driven by export markets. These are generally initiated and set either by big private operators or/and by non-governmental organizations of importing countries. Better inclusion of exporting countries and of the interest of small-scale fishers in standard setting bodies, such as Codex alimentarius and private standards organizations would help making them take into account developing countries and small-scale fisheries specificities (HLPE 2014).

In particular, a more inclusive governance of voluntary sustainability standards would enable to make them work better for small fishers and operators, both by including food security and nutrition concerns in the standards and by devising procedures adapted to the needs and capacities of small actors (Mathew 2011, FAO 2014a).

Such certification schemes also play an important role in the determination of Best Management Practices (BMP), for agriculture in general (FAO 2014b), as well as for aquaculture.

Large-scale trawl fishing, over time and presently, continues to be the major source of intense competition and conflict over both the resources and fishing space of the small-scale fishers. Large-scale pelagic trawls straddle temperate and tropical waters to harvest large shoals of small pelagic species within the Economic Exclusive Zones of many countries. These operations also require considerable mechanical power to be hauled on board. Trawls can be technically characterized as active, non-selective, intensive and efficient. This again results in competition with local small-scale fishers, who are also often totally marginalized. In many quota-managed fisheries, these larger species are considered overexploited and hence denied to small-scale fishers; but the “incidental” catch by trawlers is often overlooked or condoned. Large-scale trawling for pelagic species, with notable exceptions, is most often linked to supplying fish-feed for industrial aquaculture (Naylor and Burke 2005). In many countries around the world, large-scale trawling has been banned or severely restricted by the state at various junctures for one or more of the reasons enumerated above. In these countries, the adverse ecological and socio-economic impacts inflicted on coastal small-scale fishing communities by large-scale trawling have led to considerable physical violence and consequently to disruption of their normal livelihood patterns resulting in income and food insecurities.

Indian perspective (Applicable to countries in the Indian subcontinent):

India is the World’s second largest fish producer (at 11.4 million tons), significantly lags China (~50 million tons), but is well ahead of Indonesia, Peru or the USA (~6 million tons). Fisheries contribute about US\$24 billion to the economy (~1.2% of GDP in 2016) and is about 9% of the gross value added (GVA) from the “agriculture, forestry and fishing” sector (US\$274 billion). India also has a thriving seafood export market, valued at US\$ 6 billion y^{-1} - 5% of the global trade. About 13 million people, many poor and historically excluded are directly employed in fishing, and another 30 million in associated ancillary activities. The right measures and policy reforms could unlock far greater benefits. A clear vision, prioritizing resilience and sustainability, strategic investments and improved governance could put the Indian fisheries sector on

a climate-smart and solid development pathway. Urgent action to address overfishing could preserve the productivity of the marine resource for future generations. Improvements to biosecurity and food safety systems could help India gain even greater access to lucrative markets, including international markets, and reduce risks that hold back private investment. Fisheries could also bring considerable benefits for human health, particularly food security and nutrition. Fish is a source of proteins, healthy fats, and essential micronutrients—all extremely valuable in the context of India's high level of malnutrition and childhood stunting from poor diets (World Bank 2013, Global Nutrition Report 2018).

Fisheries Strategic Master Plan: The time is right for India to launch a Fisheries Strategic Master Plan and associated action program of support where increased fisheries production, both captured and cultured, and improved value-addition in order to drive both domestic and export-oriented growth, while maintaining an ecosystem-based focus for resilience and sustainability. Such "blue growth" prioritizes the sustainable management of natural aquatic resources in the delivery of economic and social benefits. It minimizes environmental degradation, biodiversity loss, and the unsustainable use of resources, while maximizing the economic and social benefits that build strong communities. The approach also aims to help workers in fisheries, aquaculture, and along the seafood value chain to act not only as resources users but also to play an active role in managing natural resources for the benefit of future generations (FAO 2015). Increasing fish availability to rural and urban markets is a priority to meet growing demand for more climate-smart animal source protein; However, India’s fish consumption while rising is relatively low compared to other fish exporting nations. Annual per capita fish consumption in India among non-vegetarians is about 8 kg, compared to the global average of 20.1 kg (Bangladesh 19 kg, China 33 kg; France 35 kg; USA 22 kg). Fish has traditionally been the food of the poor, and the cheapest source of animal protein, but in most urban and rural markets in India, it is becoming the costliest due to declining wild stocks (from overfishing) and increasing demand.

Blue Revolution in India: As part of the larger rural economic transformation sought by the Government of India, the Blue Revolution Program was formally launched by GOI in 2017. The Program seeks to double the income of 2.7 million fish-farmers by 2023-24, with further increases in income expected by a

large catalysing effect on the entire rural economy (farm and non-farm). Inland section (capture fisheries and aquaculture) will be the major growth area from the Indian context. Blue Revolution potentially will come from underutilised inland resources (reservoirs, irrigation tanks, lakes, swamps, rivers and streams) and aquaculture sector. While freshwater and brackish water aquaculture has more than doubled over the last 10 years, the current overall yield is only about one-fifth of the best performing farms in China and other countries of East Asia. A four to six-fold increase in yield in the near-term is possible with the adoption of well-honed “best practices”, which takes human and animal health, environmental, and socially sustainability considerations into account. Therefore, India has to focus in transformation of inland resource management and introduction of cutting-edge and climate resilient technology for the “blue revolution”. Climate Change will necessitate innovation and increased investment in adaptation measures to reduce vulnerability to maintain economic growth of the fisheries sector for food, export and jobs. India’s rapid growth has increased its prominence on the global stage and has drawn attention to its climate mitigation and adaptation efforts.

Addressing technology gap is the most important step in the right direction. A large gap exists between the technology available and accessible to farmers. Although scientific knowledge/technology is available with respect to improved production methods, approaches for community-based fishing/farming and resource management, not much of this information is being passed on to the practitioners in the field, including individual fish farmers, small private sector operations and communities. There need to be special focus on strengthening the research-extension linkage. Effective initiatives need to be taken to bring together researchers, extension officers and farmers to demonstrate innovative fish production models. The improvement must be in the following major areas as a matter of priority.

- Introducing updated production technology as a large gap exists between the technology available and accessible to fish farmers.
- Making available genetically superior fast-growing commercial fish varieties to farmers
- Improving accessibility and availability of formulated species-based fish feed at a competitive price.

Cautious approach is warranted for marine cage culture in India. Pollutants from cage culture and its impact on the environment could be significant on productivity if development is not strictly managed. Dense populations of animals such as farmed fish in cages may be a major source of organic and inorganic compounds in water. Such high densities of animals may produce marked changes in the chemical composition of the water (e.g. DO components and N/P ratio), which may subsequently affect populations of phytoplankton. The main sources of pollution are animal faeces and excretions and feed waste. Currently caged culture in India is promoted mainly using trash fish and general formulated feed. Species based floating formulated feed is the suitable one recommended for cage culture activities which is yet to be developed in India. Unlike its land-based counterpart, cage culture relies upon natural water movement to deliver water and oxygen to sustain production and remove wastes. The impact of aquaculture on the surrounding biota has been a growing concern in many Asian countries because of the rapid expansion of cage culture in the past few decades. Uneaten feed and faeces contribute significantly to the overall solid-waste production from cage systems. The limited potential that exists for treatment of the waste material produced is a key issue in the environmental concerns raised against cage aquaculture. The effects on the benthic community structure of organic loading originating from fish farms are most pronounced under and in the immediate vicinity of fish cages. They are less so at increasing distances from the farming operation. Accumulation of waste products in farm sediments usually results in dramatic changes in sediment chemistry and also the macro- and meiobenthic communities (Kumar and Crips 2012). Majority of the Indian marine area are open and the rough sea conditions are not conducive and suitable for cage culture operations. Countries like Vietnam were able to develop a cage culture due to availability of the sheltered water area. However, understanding the environmental impact, Vietnam has cut back the number of operations and also enforced strict environmental regulations. Integrated aquatic resource management, with multiple objectives to meet economic, social and biological goals adapting the ecosystem approach is vital for the sustainable development, equity and efficiency. Ecosystem-based fisheries management (EBFM) is a modern scientific method adopted for sustainable fisheries management. It is a science-based approach to the management of natural resources that aims to sustain health, resilience and diversity of ecosystems

while allowing for sustainable use by humans of the goods and services they provide. It is an integrated aquatic resource management with multiple objectives to meet, including economic, social and biological goals which are vital for sustainable development. As a concept, a stabilised aquatic resource system aims to ensure that resource exploitation contributes to sustainability, inclusive social development and economic growth, while seeking to counter the notion that sustainability and growth are mutually exclusive. Co-management and knowledge management form important tools for implementing EBFM (Fig 1). Improved management of marine resources can help prevent large declines in production. If the current trends continue, India's major commercial species groups, including demersal and pelagic fish, and shrimps, are projected to decline substantially in total stock size, undermining the valuable harvests that they currently support. An increasing proportion of these harvests will consist of smaller and lower-value individuals. A program to reduce the current levels of overfishing could help reverse these trends, helping to maintain current production quantities, and increasing the value of that production. Too many boats chasing too few fish also leads to high costs, and thus reducing overfishing will also increase profits.

(a) Coastal states fisheries forum needs to be created as part of establishing EBFM as a longer term management strategy. Migration in commercially important pelagic fishes (forms a significant income and food for the fisher community), is a part of their life cycle. These fishes migrate across the state and during these periods fishers from respective states catch their share of stock for their livelihood. The management measures and policy reform restricted only to one coastal State will not be sufficient enough to manage the stock. Therefore, creation of Coastal states fisheries forum is essential in order to frame policies which will comply all coastal states with the objective of sustainable fisheries management. In the long term, creation of such coastal state fisheries forum is inevitable.

(b) Establishment of sound database is critical. In order to achieve sustainable fisheries, the focus has to be on the policy reforms and management measures which will lead to healthy ecosystems. Those policy reforms and management measures could only be formulated with the help of biological and ecological information on commercial fisheries. All information related to commercial fisheries

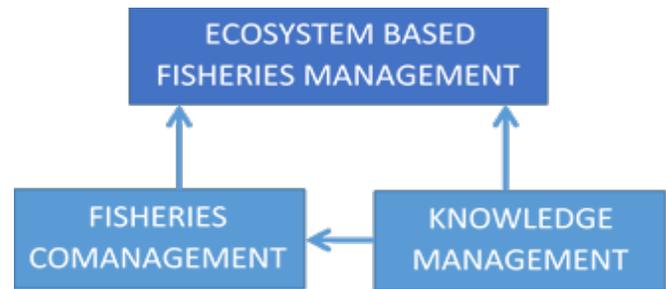


Figure 1. Ecosystem Based Fisheries Resource Management Functional Components

need to be collected and this include compiling data on catching & effort, size distribution, growth, recruitment index and yield along with the information on reproductive cycle. The policy reform should not only be limited to input (fishing equipment and tools) and output controls (legal size of fish caught, species and quantity) but also extend to the environmental protection of nursery areas and breeding ground even if it is outside the marine environment such as river and estuary. Better database means better knowledge and thereby enhanced efficiency in fishery resource management.

(c) Implementation of Marine fisheries co-management: Co-management is a participatory form of management that brings together a range of stakeholders in sharing responsibility for making decisions about natural resources. Fisheries co-management is of increasing interest to governments, the fishing industry, fisheries managers and scientists because of its potential to improve the sustainability and efficiency of fisheries management. Most importantly it is one of the vital tools for implementing Ecosystem Based Fisheries Management (EBM). The mission reviewed progress of this sub-component.

In 2019, The State of Tamil Nadu and Puducherry Union Territory formally established the Fisheries resource co-managment System (TNGO 2019). The Tamil Nadu Co-management Frame Work consisting of the four tier system is described below (Fig 2). This will include the elected village level committee. The District Fisheries Management Committee is elected by the village committee members. The next level is Regional Fisheries Management Council (RFMC). From North to the South of Tamil Nadu, the fisher communities significantly varied culturally, religiously

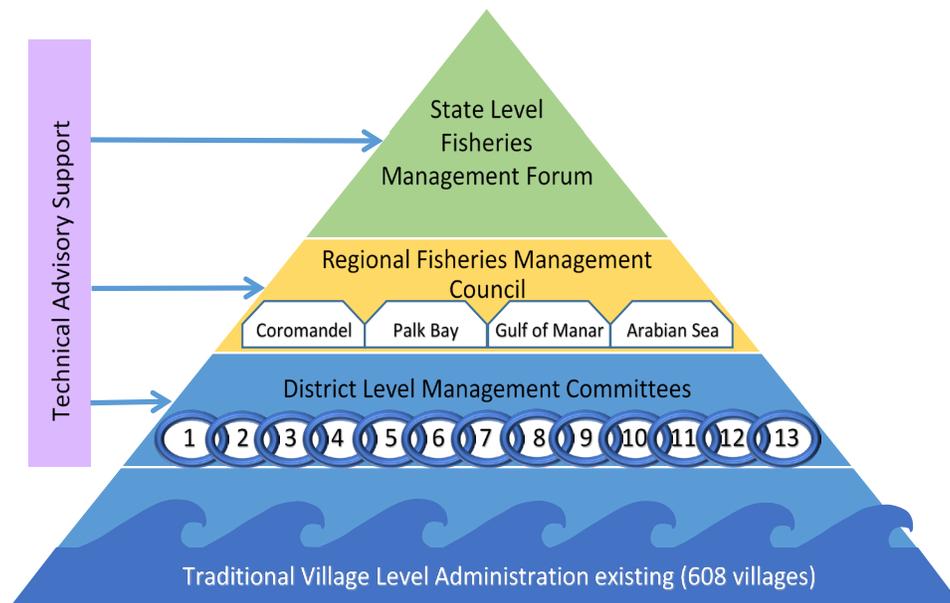


Figure 2. Structure Fisheries Resource Co-management in Tamil Nadu

and geographically. For the same reasons, the issues also deferred region to region as they were different fishery zones. In order to address both regional issues and enforce fisheries management at the same time, it was important to establish regional Councils. Hence, four regional Councils have been established namely: Coromandel, Palk Bay, Gulf of Mannar, and the Arabian Sea. The members of the regional fisheries management council are represented by fishers elected by the District Committee. The regional fisheries management council reports to the State level fisheries Forum chaired by the Commissioner of Fisheries who coordinates the regional councils and formulates the overall state level policy reforms. All three levels of management platforms are supported by a technical advisory committee consisting of qualified Fisheries Management Specialists.

Estuary and coastal zone management plan is a vital step for all state governments to implement. Often called nurseries of the sea, estuaries provide vital nesting and feeding habitats for many aquatic plants and animals. One of the key factors contributing towards the sustainability of fisheries resources is the health of estuaries which provide critical habitat for 75 percent of the species that are valued commercially (Walsh 2011). Since most marine pollution originates on land, strategies for cleaning up land-based sources must receive top priority if economically important marine fisheries are to be protected. And the threats posed by global climate change

to marine ecosystems and fisheries are sufficiently well understood to justify taking immediate remedial action. Therefore, it is imperative that all relevant a coastal state government must develop estuarine management plans for sustainable development of the fisheries. Developing a detailed coastal zone management plan for sustainable coastal aquaculture development equally important. Specific scientific studies need to be undertaken on a need basis to better understand fisheries resources and ecosystem to make appropriate management decisions based on scientific evidence.

Waste prevention, management and mitigation: The World coastal populations dumped about 8m tonnes of plastic rubbish into the oceans in 2010, an annual figure that could double over the next decade without major improvements in waste management efforts, scientists warn. The situation in Indian coastal states is no different (Fig 3). The mountain of plastic litter, including bags, food packaging and toys, was equivalent to five full shopping bags of debris for every foot of coastline bordering nearly 200 countries, the team studied according to the Guardian article 2015. Though researchers have known about plastic waste in the oceans for 40 years, the latest report, published in the journal Science, is the first to attempt a detailed estimate of how much plastic made on the planet finds its way into the oceans. China topped the table with 1.32 to 3.53 MT of plastic reaching the oceans in 2010. Indonesia



Figure 3. Waste dumping in the coastal area

followed, where 83% of waste was mismanaged, added 0.48 to 1.29 MT of marine plastic to the seas that year. The US ranked 20th, where only 2% of waste was badly handled, and 0.04 to 0.11m tonnes of plastic found its way to the ocean. Sixteen of the top 20 polluters are middle income countries where fast economic growth is not accompanied by major improvements in waste handling. The cumulative amount of plastic in the seas will soar tenfold by 2025 if nothing is done to slash waste generation or manage it more effectively. The current annual rate of 8m tonnes put into the oceans could also double by 2025 without action (The Guardian 2015). If changes are made, they could have a huge impact, the scientists claim. Reducing mismanaged plastic waste by 50% in the top 20 ranked countries would cut the pile of plastic likely to end up in the oceans by 41% in 2025. More stringent caps on plastic in waste streams, and better disposal in the top ten-ranked countries could reduce the amount of new marine plastic to 2.4 to 6.4m tonnes annually by 2025.

Fisheries infrastructure facilities development and management: The construction of fisheries infrastructure development in coastal areas must be based on detailed scientific studies and proper validation considering scientific evidence. Social demand should not alone drive the development which can negatively impact natural resources. This being particularly more relevant to infrastructure such as fish landing centres, fishing harbour and other related assets, construction in the shore area must be based on scientific evidence supporting such structures. Coastal Zone Management study should identify suitable locations for such assets and the development should be based on such investigation. Similarly, installation of artificial reef also needs to be based on proper scientific study which include identification of appropriate location, the size and

structural requirements.

Integrated multisector food security engagement. It should be noted that the investments of some developing countries (with the support of World Bank and Asian Development banks') in core and other areas of operations have made significant contributions to address food security constraints (ADB 2009). The three core areas identified are:

- **Productivity:** depleting wild aquatic resources and environmental cost to rapid development of aquaculture an alternative source of food production.
- **Connectivity:** lack of access to rural finance, infrastructure, technology, markets, and nonfarm income opportunities.
- **Resilience:** threat of climate change and volatility of food prices.

The interventions in these areas of influence potentially help countries strengthen inclusive food and agriculture value chains that enable integration of production, processing, markets, and distribution networks; and promote improved farm and nonfarm employment opportunities, increased incomes, and better living standards of the poor, women, and other vulnerable groups.

Strategic and tactical Investments in irrigation development and/or modernization, improved management of Aquatic resources, and enhanced access to financial services and products. Similarly, investments in transport infrastructure, trade facilitation, and promotion of small and/or medium-sized rural enterprises helped to address connectivity constraints significantly, while investments in disaster risk management (e.g. flood dikes), food safety nets, postharvest and value adding technology, nutrition, and vocational training addressed resilience constraints (Kumar 2014).

Food safety standards: It has been recognized that there is a need for the improvement in food safety and quality standards of fish and value-added fish products. The safety measures of fish for human consumption begins once the fish has landed on the fishing boat. With aquaculture, it is vital to meet safety standards with the conditions under which the product is farmed (such as water quality). Product safety procedures therefore need to involve fishers, transporters, processors, handlers, wholesalers and retailers. A code of conduct or regulated control scheme is essential with the prime purpose to

control, manage, and eliminate, or minimize risk factors associated with fish production, processing, storage, transport and sales. Key objectives establishing food safety standards is to ensure that all fish and fishery products are marketed either for export or domestic consumption satisfy quality requirements cited in HACCP (Hazard Analysis and Critical Control Point) and other protocols. Fish processing centres and value-added products producing units need to be promoted based on market demand which will significantly improve the value realisation of the product, generate employment and deliver quality fish products to consumers.

Development of appropriate level of Cold Chain will not only improve the food safety standards but also enable the producers to realise better value for their products. Fish distribution/transportation and marketing need to be established in all major production centres and in some cases the existing system needs to be improved for delivering quality fish to consumers (applicable for both inland and marine sectors). The consumers will also get quality products. The government initiatives/schemes should support producers and trading organizations in establishing or strengthening infrastructure facilities (storage and transport) and providing technical training to farmers and extension officers. All reasonable steps must be taken to prevent the likelihood of fish being or becoming contaminated by both microbials and chemicals during processing, storage and distribution. Training personnel to enhance performance, increase technical knowledge and develop skills in matters related to food quality has to be one of the major policy reforms and action agenda for both National and State Governments.

Conclusion

There is a need for further actively promoting the HLPE report and the leading nations (both developing and developed countries) must take significant initiatives implement recommendations of this documentation. Similarly, there must be a tangible action for the implementation of FAO code of conduct for responsible fisheries management. Proper governance is particularly important to determine access to fisheries resources, integrity of fisheries resources and distribution of fish benefits. Integrated aquatic resource management, with multiple objectives to meet economic, social and biological goals adapting the ecosystem approach is vital for the sustainable development, equity and efficiency. Addressing the climate change also has to be one of the key agendas to be included in any national action plan.

The time is right for India to launch a Fisheries Strategic Master Plan and associated action program of support where increased fisheries production, both captured and cultured, and improved value-addition in order to drive both domestic and export-oriented growth, while maintaining an ecosystem-based focus for resilience and sustainability. India's "Blue Revolution" potentially will come from underutilised inland resources (reservoirs, irrigation tanks, lakes, swamps, rivers and streams) and aquaculture sector. While freshwater and brackish water aquaculture has more than doubled over the last 10 years, the current overall yield is only about one-fifth of the best performing farms in China and other countries of East Asia. A four to six-fold increase in yield in the near-term is possible with the adoption of well-honed "best practices", which takes human and animal health, environmental, and socially sustainability considerations into account.

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