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BUILDING CAPACITY IN THE LEAST DEVELOPED COUNTRIES TO FULLY HARNESS THE POTENTIAL OF FISHERIES AND AQUACULTURE

Training Manual

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ABBREVIATIONS

ACP	African, Caribbean and Pacific Group of States
AfDB	The African Development Bank
AHPND	Acute Hepatopancreatic Necrosis Disease
AMR	Antimicrobial Resistance
ASCM	Agreement on Subsidies and Countervailing Measures
BCBS	Bureau of Customs and Border Security
BGI	The FAO Blue Growth Initiative
BTI	BioTrade Initiative
B2B	Business to Business
B2C	Business to Consumer
CAADP	Comprehensive Africa Agriculture Development Program
CAF	Development Bank of Latin America
CAMFA	The Conference of African Ministers of Fisheries and Aquaculture
CCP	Critical Control Point
CCRF	Code of Conduct for Responsible Fisheries
CFCs	Chloro Fluoro Carbons
CITES	Convention on International Trade of Endangered Species
CoC	Chain of Custody
COFI	FAO Committee on Fisheries
CSOs	Civil society organizations
CSR	Corporate Social Responsibility
CSW	Chilled Sea Water
DAP	Defect Action Point
DOALOS	United Nations Division for Ocean Affairs and the Law of the Sea
DWPE	Detention (of a shipment) Without Physical Examination
EEZ	The Economic Exclusive Zone
EHP	Enterocytozoon hepatopenaei
EMP	Environmental Monitoring Plan
EPA	The US Environmental Protection Agency
EU	The European Union
EUS	Epizootic Ulcerative Syndrome
FAO	Food and Agriculture Organization of the United Nations
FIP	Fishery Improvement Programme or Project
FiTI	Fisheries Transparency Initiative
FSMA	The US Food Safety Modernization Act
FVSP	The US Foreign Verification Supplier Program
GAP	Good Aquaculture Practice
GHP	Good Hygienic Practice
GMP	Good Manufacturing Practice
GDP	Gross Domestic Product
GFSI	Global Food Safety Initiative
GSSI	Global Sustainable Seafood Initiative
GHG	Green House Gas
GSTP	General System of Trade Preferences
GSSI	Global Seafood Sustainability Initiative
HACCP	Hazard Analysis Critical Control Point
ICES	International Council for the Exploration of the Sea

IFFO	International Fishmeal and Fish Oil Organization
ICFA	International Coalition of Fisheries Association
IOI	International Oceans Institute
IPOA	International Plan of Action
ISEAL	International Social and Environmental Accreditation Labeling Alliance
IsPoA	Istanbul Plan of Action
IUU	Illegal, unreported and unregulated fishing
LDC	Least Developed Countries
LIFDC	Low Income Food Deficit Countries
LMEs	Large Marine Ecosystems
MAP	Modified Atmosphere Packaging
MC 11	The WTO 11th Ministerial Conference, 2017
MCS	Monitoring, control and surveillance
MHLW	The Ministry of Health, Labor and Welfare of Japan
MRL	Maximum Residue Limit
MSC	Marine stewardship Council
MFN	The Most Favored Nation
MGO	Marine Gas Oil
MSY	Maximum Sustainable Yield
NTMs	Non-tariff Measures
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Co-operation and Development
OETS	Ocean Economy and Trade Strategy
OOPC	Office of the Pacific Commission
PFRS	The Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa
PSMA	FAO Port State Measures Agreement
PPD	Public Private Dialogue
PPP	Public-private partnerships
RASFF	Rapid Alert System for Food and Feed of the European Union
RFBs	Regional Fisheries Bodies
RFMOs	Regional Fisheries Management Organizations
RMP	Residues Monitoring Plan
RSN	The FAO Regional Fisheries Bodies Secretariat Network
RSW	Refrigerated Sea Water
SAMOA	SIDS Accelerated Modalities of Action
SDGs	Sustainable Development Goals
SDT	Special and Differential Treatment
SIDS	Small Island Developing States
SOFIA	The State of World Fisheries and Aquaculture
SPR	Sao Paolo Round of negotiations on GSTP
SPS	Sanitary and Phytosanitary Measures
SSAF	Small Scale Artisanal Fisheries
SSOPs	Sanitation Standard Operating Procedures
TAC	Total Allowable Catch
TBT	Technical Barriers to Trade
TiLV	Tilapia Lake Virus
TURFs	Territorial Use Rights in Fisheries

UNCLOS	The United Nations Convention on the Law of the Sea
UNCTAD	The United Nations Conference on Trade and Development
UNDP	The United Nations Development Programme
UNFSS	United Nations Forum for Sustainable Standards
UNGA	The United Nations General Assembly
VME	Vulnerable Marine Ecosystems
VMS	Vessel Monitoring Systems
VGSSF	FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication
WB	The World Bank
WCO	The World Customs Organization
WHO	The World Health Organization
WTO	The World Trade Organization

GENERAL INTRODUCTION

From ancient times, fisheries and aquaculture have been a major source of food and a provider of employment, recreation, trade, culture, environmental and economic benefits to many people throughout the world. These activities attain greater significance along the coastal areas of many developing countries, especially the Least Developed Countries (LDCs) where there are limited opportunities for employment and where access to fisheries and aquaculture resources remains sometimes the only option open for earning a livelihood, improving income and the quality of lives.

Until fifty years ago, the wealth of living aquatic resources was often considered an unlimited gift of nature. However, with increased scientific knowledge, this myth has faded as we realized that these aquatic resources, although renewable, are not infinite and need to be properly managed. Indeed, by the late 1980s, it became clear that aquatic eco-systems could no longer sustain such rapid and often uncontrolled exploitation, and that new approaches to fisheries and aquaculture management, embracing conservation and environmental considerations were needed urgently.

In 1995, the Food and Agriculture Organization of the United Nations (FAO) adopted the Code of Conduct for Responsible Fisheries (CCRF).

The Code was followed by the adoption of supporting guidelines, International Plans of Action (IPOAs), strategies and agreements. This Code and its supporting instruments set out principles and international standards of behavior for responsible practices along the fisheries and aquaculture value chain with a view to ensure effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.

Concurrently, The United Nations Conference for Trade and Development (UNCTAD) has identified fisheries and aquaculture as a sector that holds a great potential for diversification and development despite the many challenges it faces. UNCTAD has streamlined sustainability of living aquatic resources in its programmes on trade and development and partnered with FAO and other organizations to support and enable coastal developing countries, in particular LDCs and SIDS, to achieve greater benefits from sustainable fisheries and aquaculture.

A new global opportunity has arisen with the adoption of the 2030 Agenda for Sustainable Development on 25 September 2015 by the 193 Member States of the United Nations. The Sustainable Development Goals (SDGs) of the Agenda represent a set of 17 aspirational objectives with 169 targets for guiding development actions of governments, international agencies, civil society and other institutions over the period 2016 - 2030. The 2030 Sustainable Development Agenda calls on countries to express their priorities and commitments, to formulate strategies and plans and adopt policies, programmes and partnerships to achieve their national goals and targets. Although fisheries and aquaculture contribute to several goals, the 2030 Agenda for Sustainable Development adopted for the first time a Global Goal on Oceans and Seas. SDG 14 is exclusively dedicated to "conserve and sustainably use the oceans, seas and marine resources for sustainable development". It includes ten targets relating to marine pollution, protecting marine and coastal ecosystems, minimizing ocean acidification, sustainable management of fisheries and ending harmful fisheries subsidies, conserving coastal and marine areas, increasing economic benefits to Small Island Developing States (SIDS) LDCs.

Despite complex challenges facing the sector, some developing countries have made significant gains from the fishery resources they are endowed with. To help coastal developing countries in addressing

[3] http://www.fao.org/fishery/code/en
[4] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

these challenges, UNCTAD has been implementing a Development Account Project designed to build the export capacities of LDCs and other vulnerable economies to enhance the role of the fisheries and aquaculture sector. The outputs of the project include the establishment of Regional Centres of Excellence in Asia and Africa for training experts, policy practitioners and policymakers, for conducting research and policy analysis, preparation of training manuals to upgrade and diversify fishery exports and support implementation of training modules.

This manual was prepared to serve as a principal reference for UNCTAD's training and technical assistance programmes. Its objectives are:

• To make available a coherent, consolidated and updated document to train experts, policy practitioners and policy makers on how to best maximize socioeconomic and environmental benefits of the fisheries and aquaculture sector;

• To serve as a key document to assist LDCS and other vulnerable economies to develop their fisheries and aquaculture sector by learning from the experiences of successful developing countries;

• To facilitate sharing of successful experiences and best practices by enhancing South-South Cooperation and reinforcing the Regional Centres of Excellence, and

• To provide holistic training and capacity building support in harnessing the potential of the fisheries and aquaculture sector.

Equally important, this manual can also help to identify policies and strategies for enhancing the role of the fisheries and aquaculture sector in achieving SDGs in structurally weak and vulnerable economies in Asia and Africa including by enhancing their capacities to develop and diversify their fish exports. This is particularly important in view of the stringent requirements of importing countries which continue to undermine exports of fish and fish products, which, in turn, limit the export baskets of several developing countries to a few primary commodities.

The manual is organized into five chapters that address respectively a) the multidimensional potential of fisheries and aquaculture to contribute to food security, socio economic development and environmental protection; b) the fundamentals and practical aspects of fisheries management to restore the productive capacity of oceans and sustainable fisheries; c) the potential and requirements for aquaculture to sustain food and nutrition security, economic growth and environmental protection; d) best practices for value addition along the fish and seafood value chain; e) standards and certification in international fish trade.

The manual is destined for fisheries and aquaculture policy practitioners and policy makers. Care has been exercised to demystify the concepts and present key information aligned with internationally recognized instruments and codes of best practices. A bibliography has been compiled to access further information of interest to academicians, researchers and technical experts.

Chapter 1: Environmental, Social and Economic Roles of Fisheries and Aquaculture

This chapter reviews the key benefits of fisheries and aquaculture and the challenges the sector is facing to reap full benefits of its potential for the present and for the future generations.

The key messages are:

- Oceans and wetlands in general, and the sector of fisheries and aquaculture in particular, present great benefits of relevance to the environment, the social and economic wellbeing of coastal communities in developing countries, in particular the LDCs;
- However, the sector is confronted with many constraints that limit the capacity of LDCs to take full advantage of the opportunities offered. Overfishing and unsustainable fishing and aquaculture practices and their root causes need to be understood and addressed;
- International trade represents an enabling factor that can expand the sector's opportunities from niche to mainstream global markets, particularly for developing countries where domestic markets remain limited.
- Entering international lucrative markets requires improved fisheries management and implementation of best practices along the fisheries and aquaculture value chains. Capacity building is necessary to disseminate, and upscale promising experiences of successful developing countries to other LDCs.

1. ENVIRONMENTAL BENEFITS

Oceans cover more than two thirds of the surface of our planet and constitute more than 95 percent of the biosphere. Life originated in the oceans and they continue to support all life today by generating oxygen, absorbing carbon dioxide (CO_2), recycling nutrients and regulating global climate and temperature. Oceans and wetlands produce half the oxygen we breathe, absorbs around 30 per cent of the anthropogenic emissions of CO_2 and around 93 per cent of the added heat arising from human-driven changes to the atmosphere (Hoegh-Guldberg, 2015). The ocean is home to a largely uncatalogued diversity of life, from single-celled organisms to our planet's largest creature, the blue whale. These species are intertwined in a complex food web within which humans play an increasing role.

In addition, oceans and seas offer a myriad of eco-systems services vital for sustaining life on earth although markets for these services do not exist yet. They include protection by coastal areas from floods and erosion for low lying communities, and act as a sink for waste and nutrient disposal, provide off shore energy sources, biotechnology for cosmetics and pharmaceuticals and the protection of biodiversity. Ocean habitats, including mangroves, salt marshes, sea grasses and seaweed. In addition to producing half of the oxygen on earth's atmosphere, marine phytoplankton produce the organic matter that determines the carrying capacity of the ecosystem which sustains the food web up to fish and marine mammals, and ultimately human consumption. Biodiversity and habitat protection and restoration are of fundamental importance to maintaining resilience of ocean ecosystems services

Four categories of ecosystem services can be distinguished of which enhancement and conservation imply different processes: i) Support, ii) regulation, iii) products and iv) recreation and cultural services (Levrel, Pioch and Spieler, 2012).

Table1.1: Examples of services rendered by marine and coastal ecosystems

Support	Regulation	Products	Recreation and Cultural services
• Bioturbation and energy transfer • Primary and secondary production • Cycles of water, carbon and oxygen • Soil formation • Creation of marine habitats	• Spawning grounds and refuge for fish species • Control of phytoplankton dynamics • Control of pollution and detoxification • Control of waves and energy from currents • Control of erosion and siltation	• Algae and derivatives for food • Fish, crustaceans, molluscs • Construction materials (sand, shells) • Molecules for pharmaceutical, industrial and cosmetic products • Genetic resources	• Recreational fishing • Scuba diving • Sightseeing tourism (scenery, marine mammals) • Source of inspiration and well-being • Source of cultural identity

Source: (Levrel and Spieler,2012)

Equally important is the impact of fishing and aquaculture on the environment, in particular its carbon footprint and pollution of the aquatic environment. Studies showed that production of 1 kg of tilapia or salmon generates around 2 – 2.5 kg CO2/ kg of tilapia or 2.7 to 5.2 kg CO2 / kg of salmon as compared to 16 – 40, 3 to 6 or 1.5 – 7 kg CO2/ kg of beef, pork or chicken respectively (Little and Newton 2010). Likewise, fish and seafood produce less nitrogenous and phosphorous discharges (102 to 306 kg / tonne of protein produced) as compared to beef (180 – 1200 kg / tonne of protein produced) or pork (120 – 800 kg / tonne of protein produced). Mollusc bivalves have even a negative discharge (27– 29 kg / tonne of protein produced) of phosphorous and nitrogenous compounds because of their filter feeding system (HPLE, 2014).

Some 10 years ago, there was a major debate around the carbon foot print of imported vs. locally harvested/ cultured fish and seafood. Many countries claimed that transportation of imported fish exacerbated carbon foot print of the fish. Several studies (Farmery et al., 2015) have demonstrated the contrary and confirmed that most CO2 produced by fisheries and aquaculture is due to energy consumption during harvesting and feed production for aquaculture.

2. SOCIAL BENEFITS

2.1. Food and nutrition security

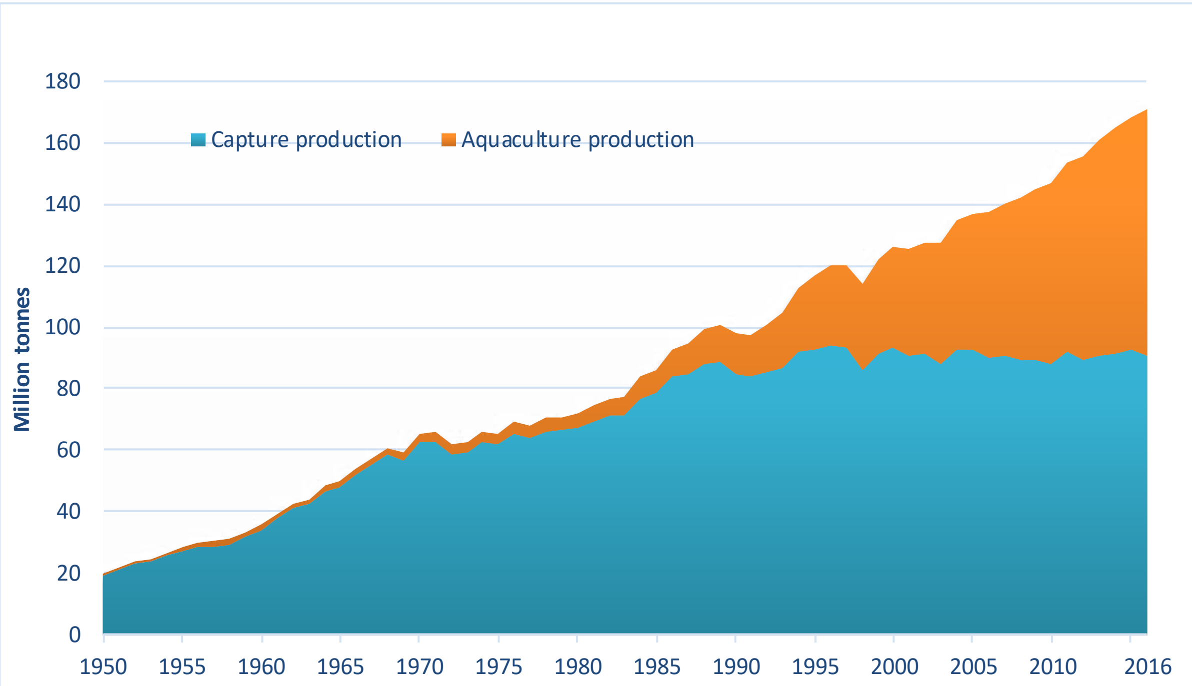
Fisheries and aquaculture make a significant contribution to food security and livelihoods of millions of people in the world. Global fish production was estimated at 171 million tons in 2016, supplying around 20.3 kg/capita per year and 17 percent of global animal proteins and many essential micronutrients (Table 1 and Figure 1.1). Fish and seafood consumption accounted for 20 per cent of animal protein intake for 3.2 billion people about 26 percent in LDCs, 19 percent in other developing countries and about 16 percent in Low Income Food Deficit countries (LIFDCs) (HPLE, 2014; FAO, 2018a).

Table 1.2. World fisheries and aquaculture production and utilization

	2012	2013	2014	2015	2016	2026[a]
PRODUCTION (in million tons)						
Capture						
Inland	11.2	11.2	11.3	11.4	11.6	
Marine	78.4	779.4	79.9	81.2	79.3	
Total capture	89.5	90.6	91.2	92.7	90.9	91.7
Aquaculture						
Inland	42.0	44.8	46.9	48.6	51.4	
Marine	24.4	25.4	26.8	27.5	28.7	
Total aquaculture	66.5	70.3	73.8	76.6	79.5	102.1
Total world fisheries and aquaculture	157.8	162.9	167.2	169.2	170.3	193.9
UTILIZATION (in million tons)						
Human consumption	136.9	141.5	146.3	148.8	150.9	177.4
Non-food uses	20.9	21.4	20.9	20.3	19.4	16.3
Population (billions)	7.1	7.2	7.3	7.3	7.4	8.1
Per capita food fish supply (Kg)	19.3	19.7	20.1	20.3	20.4	21.6

FAO, 2018a. Excludes aquatic mammals, reptiles, seaweeds and other aquatic plants. Source: FAO-OECD (2017).

Figure 1.1. World fish and aquaculture production

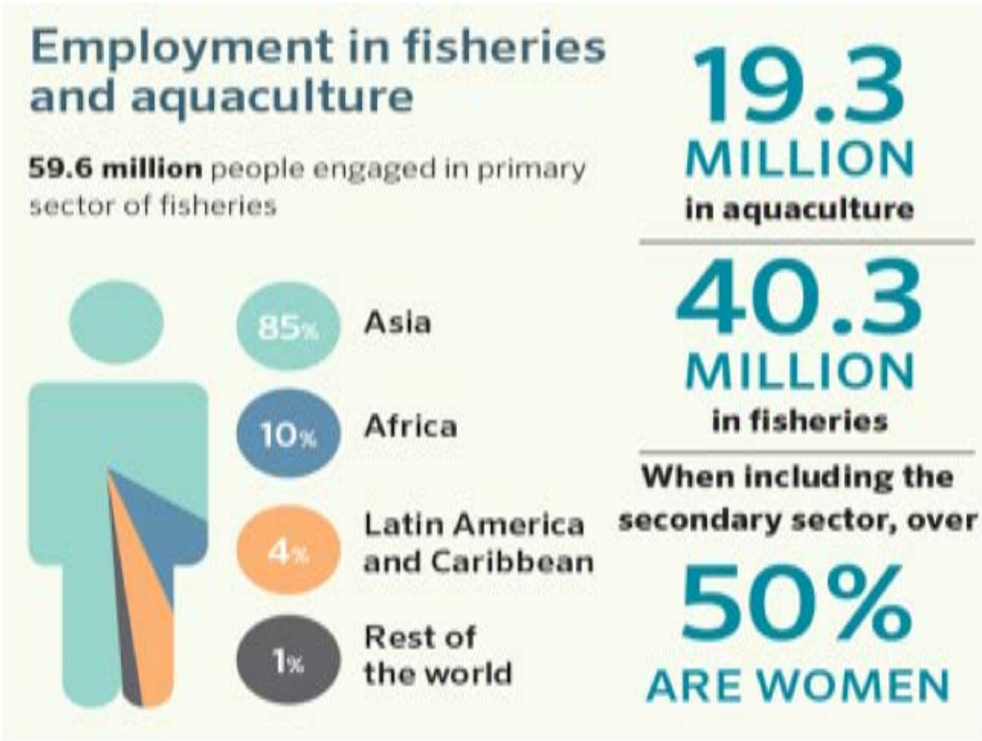


Source: (FAO, 2018a)

2.2. Employment

Around 60 million people were employed in fisheries and aquaculture in 2016 and some 200 million direct and indirect employment opportunities occur along the value chain from harvesting to distribution, making the livelihoods of some 660 to 880 million people dependent on the sector (FAO, 2018a). When including the post-harvest sector which employs mainly women, over 50 percent of employment opportunities are for women (Figure 1.2). Upstream and downstream activities in fishing harbors, landing sites, processing facilities, maritime and logistical services, insurance and other financial services provide significant employment and economic benefits to countries and local coastal communities. Fees from fishing licenses are an important source of government revenue and foreign exchange earnings for several developing countries which have agreements with distant water fishing fleet companies (UNCTAD, 2016).

Figure 1.2. Employment in fisheries and aquaculture in 2016 (FAO, 2018a)



Source: (FAO, 2018a)

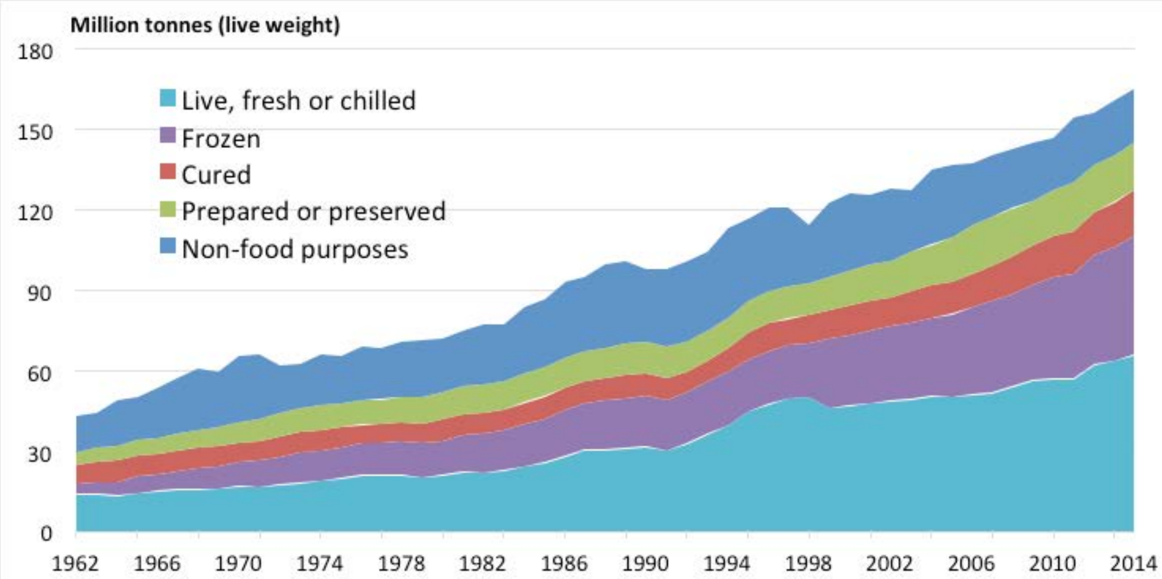
3. ECONOMIC BENEFITS

3.1. Fish utilization and processing for value addition

The fisheries and aquaculture sector has experienced a significant globalization over the last three decades. Over 1000 fish species are consumed worldwide in one way or another and more than 200 countries have reported trade in fish and seafood. Nowadays, a fish can be harvested in one country, processed in a second and consumed in a third. Sustained demand, trade liberalization policies, globalization of food systems, improvement of transportation and logistics, technological innovations to meet the rapidly changing consumption habits and consumer preferences have significantly modified the way fish is prepared, processed, marketed and delivered to consumers.

The intermingling of these drivers of change has been multidirectional and complex, and the pace of transformation relatively rapid. As a result, the share of world fish production destined for human consumption has increased and diversified significantly, up from 67 percent in the 1960s to 88 percent currently. Fresh, live and chilled fish represents some 45 percent of the fish consumed and is the most preferred and highly priced form, except for high value smoked fish. The rest is processed and distributed as frozen (31 per cent), preserved (12 per cent), cured by smoking, salting or drying (12 percent) (Figure 1.3) (FAO, 2018a).

Figure 1.3. Utilization of the global fisheries and aquaculture production



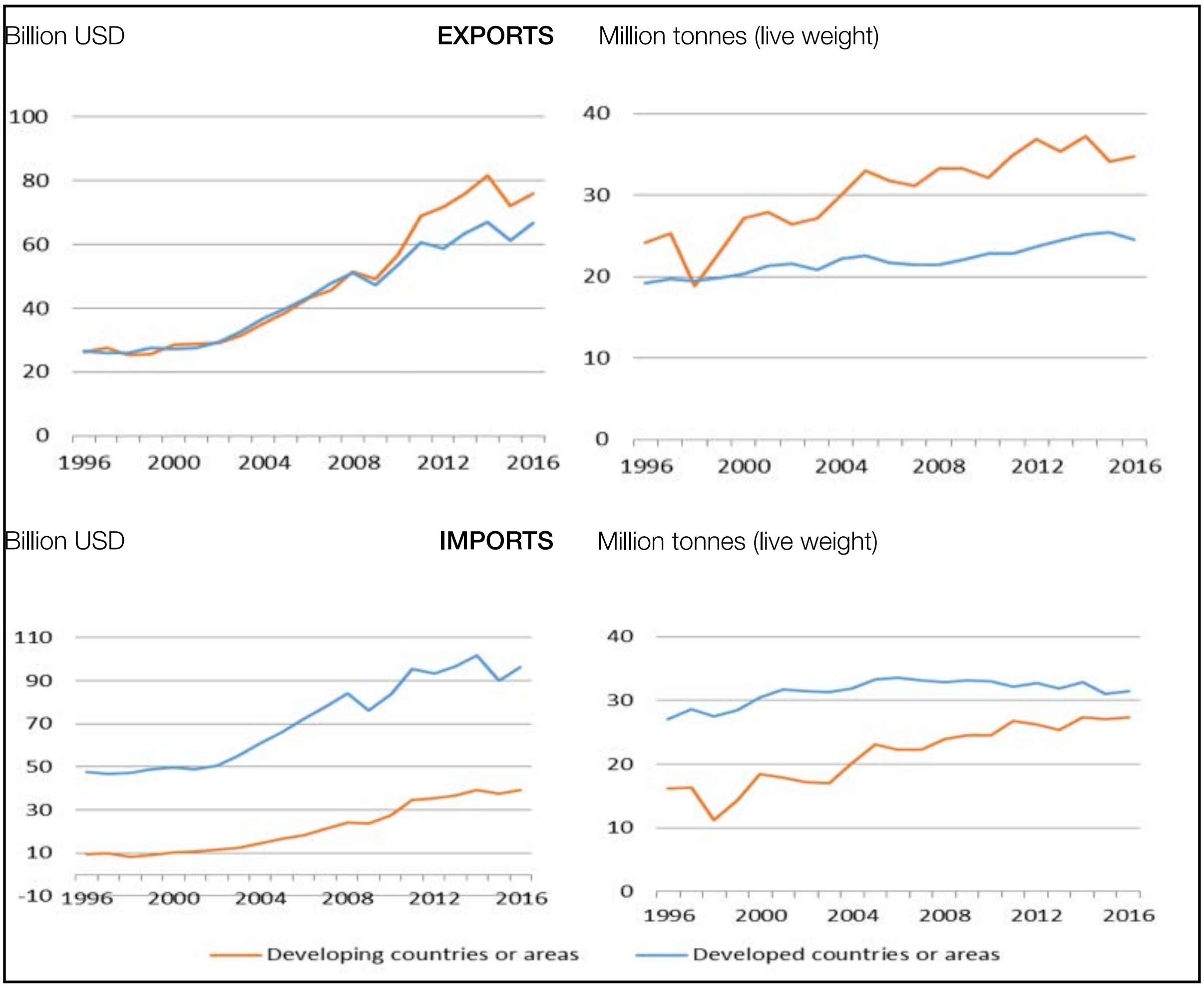
Source: FAO, 2018a.

3.2. International Fish Trade

As a result of the high demand and the globalization of utilization and distribution, trade in fish and fishery products has expanded significantly in recent decades (Figure 1.4). This is manifested most clearly in wider geographical participation in trade. In 2016, more than 200 countries reported exports and imports of fish and fishery products. Some 35 to 38 percent of the world production enters international trade and around 78 percent of seafood products were exposed to international trade competition (FAO, 2018a). This trade reached a value of USD 143 billion in 2016, and USD 152 billion in 2017 (FAO, 2017a). Over 50 percent of this trade originates in developing countries whose net trade income (export – import), valued at USD 37 billion in 2016, is greater than the net trade income of most other agricultural commodities combined (Figure 1.5). In Pacific SIDS, fishing can provide between 30 and 80 percent of exports – an advantage of the large Exclusive Economic Zones (EEZs) and the economic values they are able to capture from high value fish species such as tuna. Likewise, the share of fish trade flows for some West African countries can represent between 5 to 12 percent of GDP (UNCTAD, 2016). For example, in Mauritania, octopus fisheries is very important for export and represent over 65 percent of the value of frozen fish export. Some 78 percent of the octopus is harvested by some 60 000 small scale fishermen (MPEM, 2015).

The structure and pattern of trade differs significantly by commodity and by region. China is the main fish producer and the largest exporter of fish and fishery products. It is also a major importer due to outsourcing of processing from other countries into China as well as growing domestic consumption of species not produced locally. However, in 2015, after years of sustained increases, China's fish trade experienced a slowdown with a reduction in its processing sector. On the other hand, Norway, the second major exporter, posted record export values in 2015. In 2014, Viet Nam became the third major exporter, overtaking Thailand, which has experienced a substantial decline in exports since 2013, mainly linked to reduced aquaculture shrimp production due to disease problems (Table 1.3).

Figure 1.4. International fish trade (in US $ billion or million tonnes)

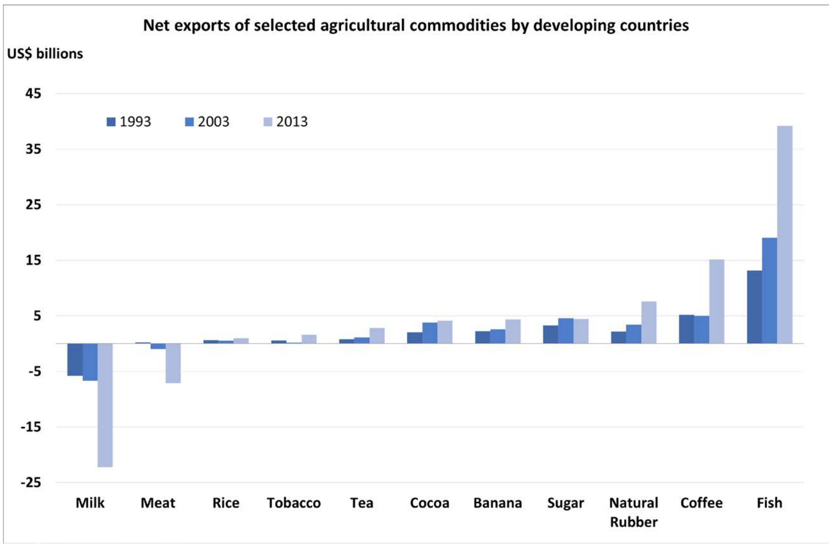


Source: FAO, 2018a.

Since its creation, the European Union was by far the largest single market for fish imports, followed by the USA and Japan. These three markets accounted in 2016 for approximately 64 percent of the total value of world imports of fish and fish products, or approximately 56 percent if trade within the European Union is excluded (Table 1.3). Developing economies, whose exports represented 37 percent of world trade in 1976, experienced a rise to 54 percent of total export value and 59 percent in volume by 2016 (FAO, 2018a). In 2016, fishery exports from developing countries were valued at USD 78 billion, and their fishery net export revenues (exports minus imports) reached USD 37 billion, greater than most major agricultural commodities (such as meat, dairy, rice and sugar) combined (Figure 1.5).

Like many globally traded food commodities, world fish prices are determined by demand and supply although these two elements of the equation are affected by key factors unique to the fish commodity. On the demand side these elements include world population, income, and the price of substitutes such as poultry or meat. On the supply side prices are influenced by levels of production which, in turn, are affected by input prices, such as energy or feed in the case of aquaculture, and the physical limits of the fisheries resources. The last of these is especially relevant for capture fisheries, which are constrained by the levels of production that wild fish stock populations can sustain. The growth of certain aquaculture species also depends upon their ability to reduce their dependence on the use of wild caught fish to produce fishmeal.

Figure 1.5. Net food trade income (export value – import value) of developing countries



Source: (FAO, 2018a)

Table 1.3. Top ten exporters and importers of fish and fish products (FAO, 2018a)

Country	2006		2016		AAGR[a]
	Value (million USD)	Share (percent)	Value (million USD)	Share (percent)	(percent)
EXPORTERS					
China	8 968	10.4	20 127	14.1	8.4
Norway	5 503	6.4	10 770	7.6	6.9
Viet Nam	3 372	3.9	7 320	5.1	8.1
Thailand	5 267	6.1	5 893	4.1	1.1
United States of America	4 143	4.8	5 812	4.1	3.4
India	1 763	2.0	5 546	3.9	12.1
Chile	3 557	4.1	5 143	3.6	3.8
Canada	3 660	4.2	5 004	3.5	3.2
Denmark	3 987	4.6	4 696	3.3	1.7
Sweden	1 551	1.8	4 418	3.1	11.0
TOP TEN SUBTOTAL	41 771	48.4	74 730	52.4	6.0
REST OF WORLD TOTAL	44 523	51.6	67 824	47.6	4.3
WORLD TOTAL	86 293	100.0	142 553	100.0	5.1
IMPORTERS					
United States of America	14 058	15.5	20 547	15.1	3.9
Japan	13 971	15.4	13 878	10.2	-0.1
China	4 126	4.5	8 809	6.5	7.9
Spain	6 359	7.0	7 108	5.2	1.1
France	5 069	5.6	6 177	4.6	2.0
Germany	4 717	5.2	6 153	4.5	2.7
Italy	3 739	4.1	5 601	4.1	4.1
Sweden	2 028	2.2	5 187	3.8	9.8
Republic of Korea	2 753	3.0	4 604	3.4	5.3
United Kingdom	3 714	4.1	4 210	3.1	1.3
TOP TEN SUBTOTAL	60 533	66.6	82 275	60.7	3.1
REST OF WORLD TOTAL	30 341	33.4	53 370	39.3	5.8
WORLD TOTAL	90 875	100.0	135 645	100.0	4.1

a AAGR: average annual growth rate for 2006–2016.

Source: (FAO, 2018a)

According to FAO/OECD (2018), fish prices continue to remain at relatively high levels. In nominal terms they are expected to follow an increasing trend during the period 2018-2027, with prices for aquaculture, capture and traded fish all growing at annual averages of less than 2 percent. In real terms, annual average prices for both aquaculture and capture species are expected to fall; aquaculture by 0.7 percent and capture by slightly over 1 percent. Real prices for traded fish tend to increase over the short term before starting to fall after 2022, resulting in the annual average growth rate falling by 0.6 percent. A major factor influencing prices in the current projection is the expectation that production growth in China will slow substantially and result in upward pressure on global prices. To put this in context, in the absence of China's reforms, the real world price of traded fish would have followed the same downward trend as anticipated for the world poultry price. In this outlook, however, the downward trend only starts in 2022. Within China, nominal fish retail prices are expected to increase by just less than two percent over the period 2018 - 2027, a rate that slightly exceeds the world average (1.65 percent).

3.3. The potential of exports from LDCs

Harvesting and trade of fish and seafood is very significant in many LDCs, ranking among the top five merchandise exports in 14 of the world's 47 LDCs. For LDCs as a group, fish and seafood make up the seventh largest export overall, and the largest food item exported. However, and despite its importance, the sector is often underdeveloped, and the bulk of fish exports frequently consists of few products sold to a limited number of importing markets. The three most exported fish products account for roughly half of all fish exports from LDCs (UNCTAD, 2018).

Tables 1.4 and 1.5 show the top three fish and seafood exports from five LDCs and the top three importers. The tables also show the same information for all LDCs on aggregate. They show lack of diversification with the share of the top three products ranging from 71 percent of exports (Uganda) to 98 percent (Comoros). Although the concentration is not as pronounced with respect to the countries receiving the LDCs' exports, Bangladesh is the only exporting country among the six cited where the top three destinations account for less than half of fish exported. This is not counting the EU as one market. If the EU is considered as one destination, then that territory accounts for 62 per cent of fish exports from Bangladesh, 55 per cent from Mozambique, and 63 per cent from Uganda. This overall lack of diversification in fish exports shows a considerable potential for the LDCs to expand exports by targeting new products and/or markets.

However, the existence of this potential does not mean that LDCs are currently in a position to take advantage of it. The challenges to doing so are numerous and include meeting the safety and quality requirements of importing countries, reducing trade costs, and improving the sustainability of fisheries and aquaculture. That said, there is hope that many LDCs should be able to tap the potential of upgrading and diversifying fish exports. Several countries are located in conducive environments, with abundant fishery resources, and some already have well-developed facilities — such as ports, processing plants and cold stores— that support fish exports. Some also have well-established trade links with the world's major importing countries (UNCTAD, 2018).

The potential for expanding fish and seafood exports from LDCs is also spurred by the high demand as projected by FAO and OECD in 2017 (Table 1.2). Growth rates will be driven primarily by developing countries, as has been the case since 2000. Trends on trade in fish from capture and aquaculture, respectively, are not easily discernible, but production rates suggest that the quantity of fish from capture will remain at roughly the same level, while the quantity of fish from aquaculture will continue to grow steadily (Figure 1.1).

There is untapped potential for fisheries in several

LDCs that, if put to good use, should result in more job opportunities, growing exports, and greater socio-economic development. The potential is significant in view of the expanding demand for fish seen in both developed and developing countries. The comparative advantages of many LDCs in fisheries and aquaculture and the sector's potential to grow, offers possibilities for governments to explore ways of upgrading and diversifying fish exports. Earlier UNCTAD studies of countries such as Bangladesh and Tanzania have shown that investments aimed at raising and enforcing norms and standards, particularly in relation to fish exports, can significantly boost export earnings and can contribute to overall growth and development (UNCTAD, 2018).

Table 1.4. Top three fish export commodities of LDCs, 2012–2013 (UNCTAD, 2018)

Bangladesh	Cambodia	Comoros	Mozambique	Myanmar	Uganda	All LDCs
Shrimps and prawns1 (frozen) (80%)	Crabs (not frozen) (29%)	Frozen fish n.e.s.2 (73%)	Shrimps and prawns (frozen) (65%)	Marine fish (69%)	Nile perch (fresh or chilled) (46%)	Shrimps and prawns1 (frozen) (27%)
Crabs (not frozen) (7%)	Crustaceans n.e.s. (not frozen) (28%)	Frozen cod-like fish n.e.s. (22%)	Dried fish, other than edible fish offal and cod (9%)	Shrimps and Prawns (15%)	Nile Perch (frozen) (14%)	Octopus (not live, fresh or chilled) (12%)
Frozen fish n.e.s (4%)	Shrimps and prawns1 (not frozen) (18%)	Shrimps and prawns1 (frozen) (3%)	Rock lobster and other sea crawfish (frozen) (8%)	Crabs, sea spiders (5%)	Fish heads, tails, and maws (11%)	Skipjack or strip-bellied bonito (9%)

Source : UNCTAD,2018.

Table 1.5. Top three destinations of sample LDCs' fish exports, 2011–2013 (UNCTAD, 2018)

Bangladesh	Cambodia	Comoros	Mozambique	Myanmar1	Uganda	All LDCs
Belgium (17%)	Korea, Rep. (41%)	Mauritius (97%)	Spain (33%)	China (36%)	Belgium (26%)	Japan (11%)
United Kingdom (16%)	China (24%)	Madagascar (3%)	Portugal (23%)	Thailand (27%)	Netherlands (14%)	Thailand (9%)
Germany (12%)	Vietnam (10%)		Zimbabwe (12%)	Malaysia (7%)	Hong Kong, China (13%)	France (8%)

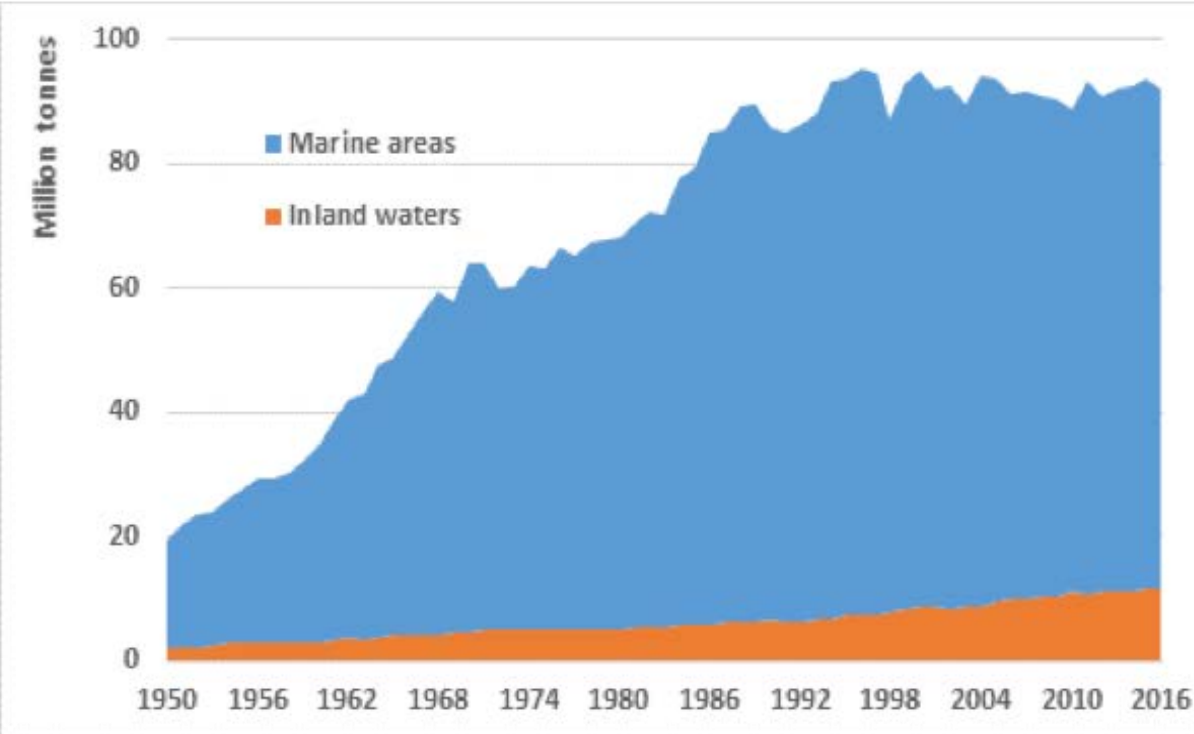
Source : UNCTAD,2018.

4. CHALLENGES FOR HARNESSING THE POTENTIAL OF FISHERIES AND AQUACULTURE

4.1. Capture fisheries: decline, future trends and recovery

Global capture fishery production in 2016 was 90.9 million tonnes, of which 79.3 million tonnes from marine waters and 11.6 million tonnes from inland waters (Table 1.2 and Figure 1.6). For marine fisheries, China remained the major producer followed by Indonesia, the USA and the Russian Federation. The Northwest Pacific remained the most productive area, followed by the Western Central Pacific, the Northeast Atlantic and the Eastern Indian Ocean. With the exception of the Northeast Atlantic, these areas have shown increases in catches compared with the average for the decade 2003–2012. Unfortunately, the situation in the Mediterranean and Black Sea is alarming, as catches have dropped by one-third since 2007, mainly attributable to reduced landings of small pelagics (FAO, 2018a).

Figure 1.6. Reported global capture fisheries production 1950 – 2016 (million tonnes)

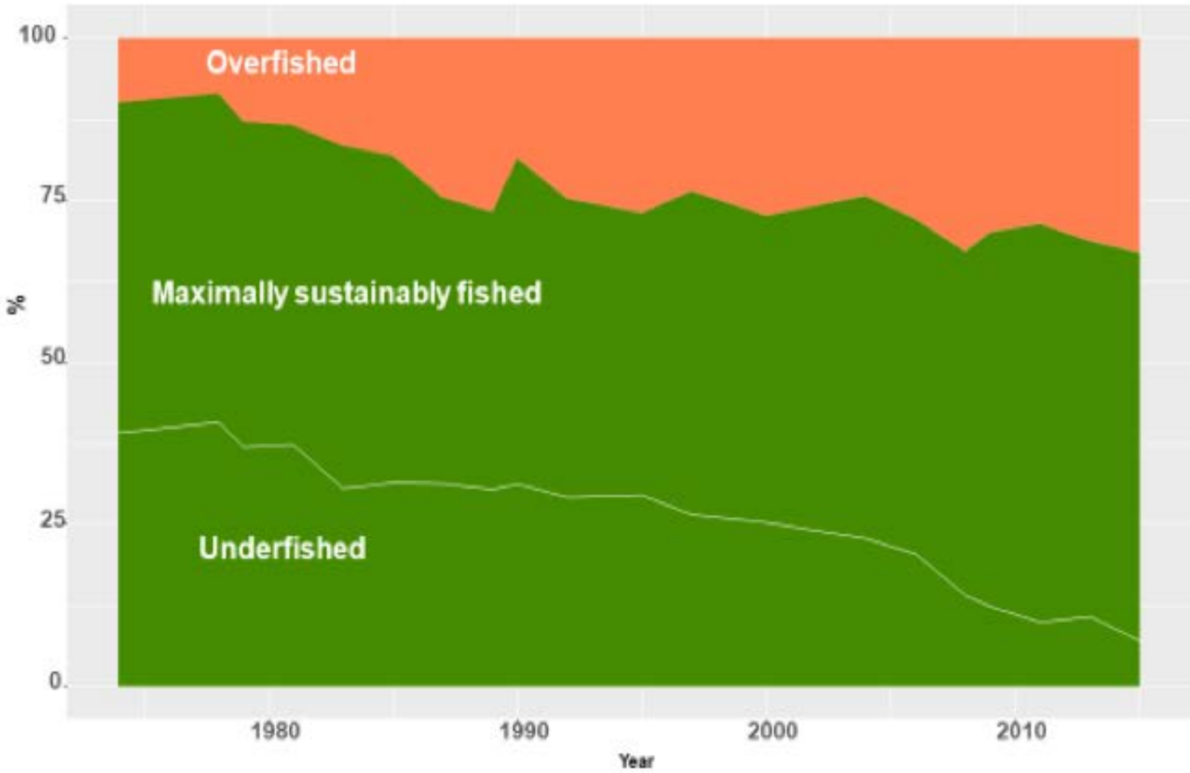


Source: (FAO,2018a

Projections over the next decade indicate that, unless major transformational changes are effected, world capture fisheries will fluctuate between lows of 91.3 million tonnes in El Niño years and highs of 93.7 million tonnes in the best fishing years (FAO/OECD, 2018). This is a higher maximum level of capture fisheries production than seen in the previous decade and should result from a combination of improved catches in some fishing areas (due to improved management regimes in some cases but increases in fishing effort in others), higher market prices, climate change impacts, and new regulations stimulating reductions in discards and by-catch from fishing.

There is a wide consensus that over the years, the state of the world's marine fish stocks has not improved overall, despite notable progress in some areas. Of the total number of fish stocks assessed, the share of fish stocks within biologically sustainable levels (fully fished and underfished) decreased from 90 percent in 1974 to 66.9 percent in 2015. In contrast, the percentage of stocks fished at biologically unsustainable levels increased from 10 percent in 1974 to 33.1 percent in 2015, with the largest increases in the late 1970s and 1980s. In 2015, maximally sustainably fished stocks (formerly termed fully fished stocks) accounted for 59.9 percent and underfished stocks for 7.0 percent of the total assessed stocks. The underfished stocks decreased continuously from 1974 to 2015, whereas the maximally sustainably fished stocks decreased from 1974 to 1989, and then increased to 59.9 percent in 2015, partly as a result of improved management and enforcement (Figure 1.7). The ten most-productive species accounted for about 27 percent of the world's marine capture fisheries production in 2013. However, most of their stocks are fully fished with no potential for increases in volume. The remainder are overfished with increases in their volume only possible after successful stock restoration (FAO, 2018a).

Figure 1.7. Global trends in the state of the world's marine fish stocks (1974 – 2015) (FAO, 2018a)



Source: (FAO,2018a)

4.2. Illegal, unregulated and unreported fishing

Overfishing is the result of suboptimal fishing capacity and effort, some of it sustained by subsidies, and Illegal, Unregulated and Unreported (IUU) fishing. IUU fishing has rapidly accrued and intensified overfishing. It represents severe threats to global fisheries, in particular for fisheries of developing countries lacking the capacity and resources for effective Monitoring, Control, and Surveillance (MCS) of their EEZ. IUU fishing also takes advantage of corrupt administrations and exploits weak management regimes in developing countries. In 2014, the UN General Assembly declared IUU fishing as one of the biggest threats to sustaining fish stocks globally. It occurs not only in the high seas but also within EEZs that are poorly managed and may sometimes be associated with organized crime. Fisheries resources available to bona fide fishers are poached in a ruthless manner by IUU fishing, often leading to the collapse of local fisheries, with small-scale fisheries in developing countries proving particularly vulnerable. Products derived from IUU fishing can find their way into international markets thus throttling local food supply. IUU fishing threatens livelihoods, exacerbates poverty, and augments food insecurity. Unfortunately, the clandestine nature of IUU fishing prevents a fair estimation of its impact. Rough calculations, however, indicate that IUU fishing across the world's oceans weighs in at around 11–26 million tonnes of fish each year or a value of USD 26 to 35 billion.

The promotion, regulation and monitoring of responsible fishing practices, through robust fisheries management and governance frameworks, are essential for the sustainability of fisheries resources in both coastal areas and high seas. The principles of responsible fisheries management prescribed in international instruments and the requirement for their implementation by RFMOs and countries around the globe are essential.

Combatting IUU locally, regionally and internationally should be deployed during fishing operations, landing the catch and marketing the fish and seafood products. This puts three levels of responsibilities: The Flag State, Port State and Market State responsibility. Several international instruments have been developed to tackle the issue of IUU fishing along these three levels.

These include the voluntary guidelines for flag state performance, the port state measures agreement, the global record of fishing vessels and the voluntary guidelines for catch documentation schemes. These instruments are discussed further in chapter 2 (section 3.2).

4.3. Fisheries subsidies

Fisheries subsidies represent any financial support allocated to the fishing industry by a government. Based on the debates at the ongoing WTO negotiation on fisheries subsidies, the impact of these subsidies can vary considerably, from positive effects on fisheries sustainability (e.g. support to fisheries management and research) to harmful subsidies (contributing to overcapacity, overfishing and to IUU fishing). It has also been reported that fisheries subsidies fuel unfair competition, particularly between large fleets and individual artisanal fishermen and foster inequality as 84 percent of all fisheries subsidies tend to benefit large scale fleets (Schuhbauer et al, 2017). The challenge is to eliminate harmful subsidies and convert its funds for investment in fisheries sustainability to reduce pressure on fish stocks.

No complete inventory of fisheries subsidies or a common understanding of their impacts exist yet. As a result, reliable and accurate data on fisheries subsidies remain sparse, partly due to a lack of transparency. In this regard, adherence to transparency initiatives and participation in fisheries governance for the benefit of a more sustainable management of marine fisheries, like the Fisheries Transparency Initiative (FiTI, 2017) , can facilitate data analysis in support of the overall negotiation process on fisheries subsidies. This information vacuum has largely been filled by broad assumptions and estimates and widely debated, although more on anecdotal evidence. A recent report estimates global fisheries subsidies to be in the region of USD 35 billion, with over USD 20 billion being in the form of capacity-enhancing subsidies (Schuhbauer et al, 2017). Based on data reported consistently to OECD by 28 countries, UNCTAD estimated their total public support to fisheries at an average annual USD 9.3 billion during the period 2010-2015. OECD estimates of government support include budgetary and non-budgetary measures.

For many years there was a hope to conclude successfully the WTO negotiations on fisheries subsidies. Unfortunately, it is not the case and the outcome of the 2017 WTO Ministerial Conference was far below expectations despite the general consensus that a WTO agreement on the prohibition of harmful fisheries subsidies would make an important contribution to the sustainability of global fisheries. As trade demands and trade regulations affect marine resources and thus international trade initiatives can be part of the solution to sustainable oceans and fisheries development. This is one of the main reasons why the negotiations on fisheries subsidies have been on-going at the WTO for the last 15 years. Over the years, some of the initial positions taken by member countries have changed and views have converged on certain issues. But some radical differences of opinions remain. Over the years, the negotiations have experienced various developments which have ensured that fisheries subsidies remain on the international agenda. However, there is fear now that due to the progress made outside the WTO, there could be a reduced urgency to further the negotiations at the WTO.

Yet, in terms of development implications, many economically smaller coastal developing countries, such as the SIDS countries, ACP States and LDCs have an interest in focusing attention on fisheries subsidies and carrying the proposed rules through to agreement in the multilateral and legally binding WTO context. They should seek to limit subsidies by developed and large developing countries to fleets that fish on overfished stocks, in order to improve the chances of their domestic producers, and at the same time potentially benefit long-term sustainability and food security in all countries.

Consequently, achieving an outcome on fisheries subsidies disciplines should be a priority for these countries to be actively pursued both within the group, and bilaterally with the main players with the objective of success by the next WTO Ministerial Conference in 2019. As a first step focus could be on the areas where there is general consensus, these being the need to address IUU fishing as well as subsidies for overcapacity. Special and differential treatment remains a problem given that among the developing countries, some are large providers of subsidies making it difficult to agree on blanket exemptions in this regard. In their approach to the negotiations on fisheries subsidies, these countries should clearly express their development concerns given that the sector is critical for food security, employment and poverty eradication efforts.

Reaching an agreement may require de-linking fisheries from other negotiation issues, since some members are unwilling to continue deliberations under the Doha Development Agenda (DDA) setting that provided for single undertaking. In this respect initiatives such as Peru's proposal premised on SDGs commitments could be a means of de-linking fisheries negotiations from other DDA issues.

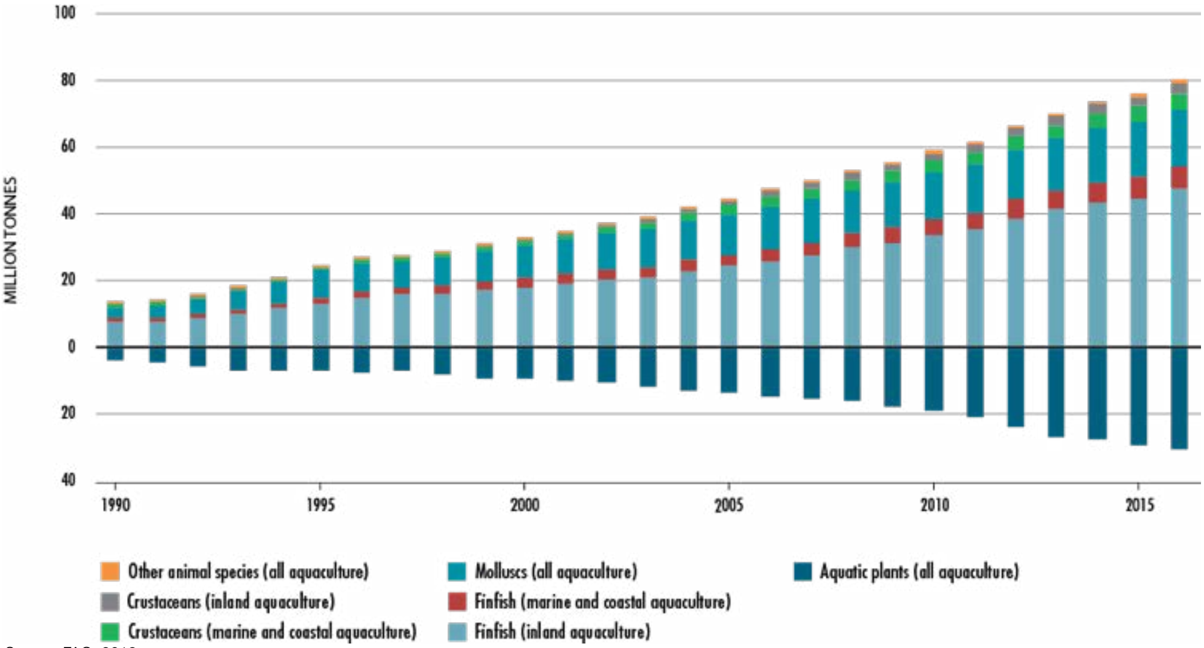
4.4. Aquaculture development and environmental concerns

Many millennia after terrestrial food production shifted from hunting to agriculture, fish and seafood production has transitioned from being mainly fishing to mainly fish farming. In 2014, the contribution of aquaculture to the supply of fish for human consumption overtook that of wild-caught fish. With capture fisheries production relatively static since the late 1980s, aquaculture has been responsible for filling the gap between supply and demand of fish for human consumption. China in particular and Asia in general have played a major role in this growth as they represent respectively more than 60 percent (China) and some 90 percent (Asia) of world aquaculture production (FAO, 2018a).

Currently, some 591 aquatic species and species groups are farmed worldwide producing 106 million tonnes in live weight, with a total estimated first-sale value of USD163 billion. This total production comprised farmed aquatic animals, aquatic plants and non-food products (pearls and shells). At continent level, aquaculture production in 2016 was 89.4 percent in Asia, 4.2 percent in the Americas, 3.7 percent in Europe, 2.5 percent in Africa and 0.3 percent in Oceania. However, aquaculture growth during 2001-2015 averaged 10.4 percent in Africa, followed by Asia (6 percent) and Americas (5.7 percent), whereas aquaculture growth in Oceania and Europe were only 2.9 percent and 2.5 percent respectively during the same period (FAO, 2018a).

In 2015, finfish farming represented the most important aquaculture species in many countries with a contribution between 63-68 percent during the last two decades. Molluscs farming, which used to count for about 30 percent of the total food fish farming production in 2000, has gradually declined to reach 21 percent in 2015. In contrast, crustacean farming increased from less than 5 percent before 2000 to close to 10 percent in the past decade. Aquatic plants farming represented 27.7 percent of the total production in 2015. With almost all farmed aquatic animals destined for human consumption, aquaculture supplied 10.42 kg of food fish for human consumption in 2015 as compared to 10.14 kg in 2014.

Figure 1.8. World production of farmed aquatic animals and plants (1990 – 2016)



Source: FAO, 2018a.

The significant growth of aquaculture during the last 40 years has raised major concerns over its environmental impact and some of its unsustainable models. Aquaculture sites have often been carved out of important natural coastal habitats with rapid expansion exceeding the capacity of planning controls and oversight. Development in aquaculture of fed species, when poorly managed, has affected key biodiversity and ecosystem functions through mangrove deforestation, excessive nutrient release, chemical pollution and the escape of farmed species and disease agents into the natural environment. Major causes of impact have been associated with feeding and nutritional wastes, the emergence and spread of diseases and the interbreeding of wild and selected strains (FAO, 2018a).

4.5. Market access/market entry requirements and non-tariff measures

The important development in international fish trade has been facilitated by favorable measures for market access (tariffs) that are not particularly high and have been decreasing slowly since 2011. A 2016 study shows that applied tariffs were globally about 4.8 per cent on average for raw fish and fish fillets in 2014, dropping from 6.7 per cent in 2009 (UNCTAD, 2016). The globally averaged most favored nation (MFN) tariff (tariffs applicable to all WTO members, unless there is a WTO preferential or regional trade agreement) for fish products stood at 11.6 per cent in 2014, a decline of more than 2 percentage points since 2009. However, tariff escalation is commonly found on tariff lines that cover processed fish products among all country groupings. For example, EU tariffs for processed fish and fish products are subject to tariff peaks of 25 per cent for processed tuna, 20 per cent for processed shrimp and 12 per cent for canned sardines. In countries like the Republic of Korea and Thailand, applied MFN tariffs are 20 per cent for tuna preparations. Tariff peaks continue to be applied to certain fish products to protect local processing and value addition, although developing countries actually resort less to tariff peaks than developed countries do. For example, average peaks per country, high-income countries have an average of 22 peaks, while the average per country among low-, middle-income and LDCs is less than 7 peaks (UNCTAD, 2016). It is worthy to note that tariffs apply to both wild capture and aquaculture and do not differentiate the production method.

As indicated earlier (FAO/OECD, 2018), fish trade between developing countries is expected to increase. To facilitate this trade, the Global System of Trade Preferences (GSTP) among developing countries should be reinvigorated. This would be accelerated once the Sao Paulo round of negotiations (SPR) concluded in 2010 enters into effect. It would reduce applied tariffs by at least 20 percent for over 70 percent of the national tariffs list. Eleven countries (including four-Member States of Mercosur as a single Party) exchanged tariff concessions and adopted SPR protocol. These are: Argentina, Brazil, Paraguay and Uruguay (forming Mercosur), the Republic of Korea, India, Indonesia, Malaysia, Egypt, Morocco and Cuba, of which five have ratified (Argentina, India, Malaysia, Cuba, and Uruguay). Fish products are often included in the schedule of commitments of the SPR protocol.

The future rounds of the GSTP should focus the negotiations on goods that contribute to environmental protection and sustainability in order to achieve SDGs targets while creating additional opportunities for South-South cooperation and further integration of value chains among developing countries.

4.5.1 Non-tariff measures

The major challenges for fish and seafood exports remain non-tariff measures (NTMs) or market entry measures applied to fish and fish products by importing countries and companies. These measures can be legitimate sanitary and phytosanitary (SPS) measures to protect the health of consumers, animals and plants or technical standards to protect consumers from fraudulent practices. This can include for example measures on traceability and catch documentation to ensure that the traded fish has been legally harvested and/or has come from well managed fisheries and aquaculture operations.

Basically, these measures find their legitimate origin in two Agreements of the WTO respectively on the application of SPS measures, and the Technical barriers to Trade (TBT). The SPS agreement, which is specific to agriculture and food including fisheries and aquaculture, confirms the right of WTO member countries to apply measures necessary to protect human, animal and plant life and health as long as they are consistent with obligations prohibiting arbitrary or unjustifiable discrimination on trade between countries where the same conditions prevail and are not disguised restrictions on international trade.

The objective of the TBT Agreement on the other hand is to prevent the use of national or regional Technical Regulations (TRs) and standards as unjustified technical barriers to trade. The agreement covers standards relating to all types of products including industrial products and quality requirements for foods (except requirements related to SPS measures). It provides that all technical regulations and standards must have a legitimate purpose and that the impact or cost of implementing the standard must be proportional to the purpose of the standard (Washington and Ababouch, 2011).

Unfortunately, the requirements and practices of border inspections are far from being harmonized, fit for the purpose or always aligned with the principles of the SPS and TBT agreements. Developing countries have regularly pointed to the challenge presented by NTMs that vary from one jurisdiction to another. This multitude of approaches imposes significant costs on exporting countries, unnecessary duplication and represent a severe handicap for export from many developing countries with limited resources and capacity for safety and quality management systems and infrastructures, let alone several different systems to meet diverse import market requirements.

The sector of fisheries and aquaculture is highly regulated in most countries, although at a lesser extent in LDCs. Similarly, fish and seafood are generally more exposed to NTMs than non-fish products because of the high incidence of SPS measures on food products that are usually not applied to manufactures. Based on UNCTAD's NTM database, there are on average about 2.5 times more distinct technical measures applicable per Harmonized System (HS) codes for fish products than for HS in manufactures (Fugazza, 2017). For example, 732 SPS measures (whether initiated or in force) applicable to fish and fish products were notified to WTO by 67 members by September 2015. There were also about nine specific trade concerns (e.g. regarding safety, quality and/ or import restriction) raised by members to the SPS Committee. In terms of TBT measures applicable to fish and fish products, 524 were notified by 53 members; two specific trade concerns were also raised (UNCTAD, 2015). This growth in the number of NTMs related to trade in fish and fish products calls for improved harmonization and efficiency and clearly demonstrates the challenges that some capacity-constrained exporters may face for entering markets without commensurate technical and financial support.

Further complicating the multiplicity of public NTMs, fish exporters have been increasingly subjected to a wide range of private voluntary standards. These relate to a range of objectives, including food safety and quality, animal health, environmental protection, fisheries sustainability and social responsibility. The private standards have emerged in areas where there is a perception that public institutions are failing to achieve desired outcomes. These include food safety and quality following major food scares, sustainability and responsible fisheries management, or social and environmental sustainability in the growing aquaculture industry. As a consequence, importing food firms, especially retailers, use their increasing bargaining power vis-à-vis other businesses (B2B) in the value chain, to impose certification to private standards. The increasing vertical integration and complexity of value chains in fish and seafood has also stimulated the growth of private standards, as B2B tools used in the context of procurement contracts. Complex value chains – where raw materials are sourced globally, processed in a second country and retailed in yet another – require sophisticated systems for ensuring traceability and guaranteeing consumer protection from farm/boat to fork. These traceability and chain of custody systems are built into the frameworks included in most private standards schemes.

If implemented in an appropriate manner, sustainability standards can be a valuable tool, facilitating access to international markets and driving environmental improvements upstream in the value chain and hence contributing to resource sustainability. Internationally recognized sustainability standards have become a reality for fisheries and a key feature of the modern seafood trade environment. Likewise, in response to the growing requirement of "greening" the aquaculture business, certification is gaining more traction in international fish and seafood trade (UNEP, 2009; Washington and Ababouch, 2011).

However, the fragmentation of private standards can represent an additional hurdle that must be overcome if developing countries are to effectively consolidate their market shares and engage with high-value supply chains. A systematic mapping of the existing NTMs, both public and private, and their benchmarking against internationally recognized standards (e.g. Codex standards for food safety and quality, OIE standards for animal health, FAO guidelines for eco-labelling and certification in fisheries and aquaculture, etc.) is urgently needed. Such a mapping will help raise awareness of the universe of NTMs, particularly those that exert the strongest effect on developing country exports and have the potential to become obstacles to trade, assess their potential discriminatory nature and trade distorting impact. This would help promote sound harmonization and equivalence among trading partners and Aid for Trade schemes or other technical assistance initiatives to facilitate sustainable fish trade (Washington and Ababouch, 2011). Harmonization and benchmarking tools such as Global Food Safety Initiative (GFSI)7 and Global Seafood Sustainability Initiative (GSSI)8 can minimize many of these concerns. Equally important is the need to determine how private standards fit into the overall governance framework for sustainable fisheries and aquaculture. Many governments, including of developing countries, have recognized the potential of private standards to increase market access for exported products and services (UNFSS, 2016), and how sustainably certified fish products can increase export revenues for countries while helping advance environmental policy objectives (UNEP 2013). Private standards when aligned with technical regulations are not likely to conflict with public regulations. Duplication is more likely to be an issue, including between certification schemes, if not in relation to the content of requirements, then certainly in the compliance assessment and verification (including multilevel documentation).

Arguably more problematic than the actual costs of certification is the distribution of those costs. At present, the compliance costs associated with certification to a private certification scheme are borne disproportionately by those upstream in the supply chain rather than those downstream where the demands for certification originates. Yet the most robust evidence of price premiums suggests that the financial benefits accrue to importers and retailers who demand certification. Should these retailers help foot the bill for certification? Is some redistribution of costs possible, and using what levers? These are areas for promising Public Private Partnerships (PPP) across borders (Washington and Ababouch, 2011).

A study by UN Environment (2016) on green trade opportunities in sustainable aquaculture in Vietnam, which surveyed 55 farms and processors of shrimp and pangasius, found variable environmental and economic benefits. Overall, the economic and environmental impact of certification was positive in shrimp farming, but uncertain or even negative for pangasius. The study highlighted various obstacles for further expansion of a sustainable aquaculture in Vietnam, including the ability to comply with international standards, and insufficient capacity both in the private and public sectors. Overall, the study emphasized that capacity building will be key towards facilitating a transition to sustainable aquaculture.

[7] https://www.mygfsi.com/

[8] http://www.ourgssi.org/

5. THE FUTURE OF SUSTAINABLE FISHERIES AND AQUACULTURE

This chapter one of this manual presents the multidimensional potential of fisheries and aquaculture and the many challenges the sector faces. Meeting these challenges calls for a paradigm change to fisheries and aquaculture management to restore the health and sustainability of living aquatic resources so that it can fully achieve its social and economic potential. This requires capacity building, revamping institutional and regulatory frameworks to address the root causes of unsustainability, namely overcapacity and overfishing, IUU fishing, harmful subsidies, the application of environmentally harmful aquaculture practices and the use of NTMs as TBT to constrain trade from developing countries.

This can be achieved by sharing successful experiences, up-scaling proven solutions, based on strengthened partnership, innovative approaches and investment necessary to restore the productive capacity of the oceans. The potential for sustainable aquaculture development, in particular in coastal developing countries, can help decrease the pressure on wild stocks, produce fish at affordable prices for food and nutrition security and high value seafood for international markets. However, the current aquaculture production model will need to improve its sustainability performance drastically by minimizing negative impact on the environment, diversifying feed sources to lessen wild catch inputs, avoiding or reducing the use of antibiotics, and recycling effluents. Markets have responded to these concerns by requesting certification against sustainability standards and traceability criteria in international fish trade. As a result, Corporate Social responsibility (CSR) policies of most fish importing companies typically include a sustainability component, with a target for wild-caught fish to be legally fished and certified to an ecolabel. Likewise, fish farming during the last 15 years has seen a significant growth for certification against organic or broader sustainability standards (UNEP, 2013). Some of these schemes already involve comprehensive and reliable traceability systems, which could also be used to ensure fish legality in the supply chain. However, existing schemes have limitations, in particular for developing countries where many fisheries are not covered by certification, traceability of fish products, especially from low-capital fisheries, is very difficult; and mislabeling of fish products is common.

While trade policies of many importing countries contain provisions for consumer and environmental protection, sustainability standards and certification schemes have emerged because of the perception that public policies are not achieving the desired outcomes in terms of fisheries and aquaculture sustainability and management (Washington and Ababouch, 2011). Harmonization initiatives, like the Global Sustainable Seafood Initiative (GSSI), have the potential to improve transparency in the seafood market, to remove the need for multiple certifications thus lowering certification costs for both producers and processors.

Post-harvest processing, distribution and marketing of fish and seafood should catalyze further economies of scale to promote competitive value chains and sustainable trade. The major players in fisheries and aquaculture should promote common sustainable solutions driven by international trade and innovations. This will require a higher level of cooperation and partnership to share knowledge and experiences to improve policies, innovations (e.g. in best fisheries practices and gears, feed and seed production, vaccine production and animal health protection, value addition, logistics and services to promote marketing and distribution). This can generate important employment opportunities, in particular for the youth and restore fish stocks productivity to its maximum economic yield and thus support countries to shift towards inclusive green economy pathways that result in improved human well-being while significantly reducing environmental risks and ecological scarcities. Achieving the trade related targets of SDG 14 is a unique opportunity to channel these reforms at the local and national levels and the cooperation and partnership on the regional and international scenes. The next chapters of this manual will address these aspects.

5.1. Main challenges for developing countries

As stated earlier, developing countries play a major role in the production of fish and seafood, both for national food security and for supplying international markets. LDCs possess untapped potential for fisheries and aquaculture, which if put to good use, should result in more job opportunities, growing exports, and greater socio-economic development.

The comparative advantages of many LDCs in fisheries and aquaculture, and the sector's potential to grow, offers possibilities for governments to explore the possibility of upgrading and diversifying fish exports (UNCTAD, 2018). Unfortunately, LDCs are plagued with many obstacles that need to be overcome before exploring the full exploitation of their potential. These constraints concern:

• The fisheries and aquaculture institutions that are weak, underfunded, with inadequate capacity and poor policy coordination, in particular in relation to shared stocks and water bodies;

• Inadequate infrastructure for landing, cold storage, value addition, transportation and distribution and air connectivity challenges; and

• Poor and fragmented domestic and regional marketing systems, with informal and illegal trade, long customs clearance and delays at border-crossing.

In the case of marine aquaculture, a highly capitalist activity, the business environment is not attractive for private investment as it is considered a high-risk sector that requires proper investment promotion and facilitation policies, in addition to adequate support services such as insurance, credit, technical expertise, etc. The following chapters will address these aspects and propose policy recommendations that have been proven useful in many countries, with a focus on how to address the challenges of LDCs.

Chapter 2: Fisheries management in the context of the 2030 Sustainable Development Agenda

This chapter reviews the main challenges to capture fisheries and modern fisheries management principles and best practices to restore fish stocks and healthy oceans. The key messages are:

- Fisheries and their exploitation and conservation are embedded in comprehensive international, regional and national regulatory frameworks;
- Effective fisheries management requires science-based regulation and enforcement for balancing resources exploitation and conservation;
- Managing fisheries within the context of multiple actors and players of the public maritime domain, requires adoption of best practices based on the ecosystem approach to fisheries;
- Member States should consider to formulate and implement development-oriented bilateral, plurilateral and regional agreements on the optimum and sustainable use of fishery resources, especially in shared water resources.

1. INTRODUCTION

As stated in Chapter 1, until fifty years ago, the wealth of living aquatic resources was often considered an unlimited gift of nature. However, this myth started fading already in the 1970s, as scientists confirmed that these living aquatic resources, although renewable, are not infinite and that aquatic eco-systems could no longer sustain such rapid and often uncontrolled exploitation under regimes of open access to fisheries. They stressed that approaches to fisheries and aquaculture management, embracing conservation and environmental considerations, were needed urgently.

The widespread introduction in the mid-seventies of exclusive economic zones (EEZs) saw world fisheries becoming a market-driven, dynamically developing sector of the food industry. Coastal States have striven to take advantage of their opportunities by investing in modern fishing fleets, infrastructure and services in response to growing international demand for fish and seafood. Novel trade policies and strategies were promoted and trade agreements were facilitated. The year 1995 saw the creation of the World Trade Organization (WTO) and several trade agreements were adopted to support a robust and predictable multilateral trade system for goods and services.

Since then, programs, initiatives and projects were implemented not only to increase production, but also to improve fisheries management and conservation and to address emerging issues such as overfishing, IUU fishing, fisheries subsidies and destructive fishing practices. Despite notable progress achieved in some areas, real progress in addressing the key threats of living aquatic resources has not been substantive. Implementation has been uneven in many countries, and success in meeting the targets set for addressing the key drivers of change in ocean health remained elusive – at great cost to the global fisheries economy and particularly to coastal and island developing countries. Yet meeting the successive commitments the world has made (Figure 2.1) for healthier oceans is doable. The causes for the long-term decline of the oceans' health are fairly known. Successful experiences have been reported and documented. The challenge before the global community is not to establish a new treaty or agreements for ocean health, but rather to accelerate efforts to implement those successive commitments to reverse the trend in oceans health decline.

Adoption of the 2030 Agenda for Sustainable Development offers a new opportunity. This Agenda calls on countries to express their priorities and commitments, to formulate strategies and plans and adopt policies, programmes and partnerships to achieve their national goals and targets. For the first time a Global Goal on Oceans and Seas has been adopted. SDG 14 is exclusively dedicated to "conserve and sustainably use the oceans, seas and marine resources for sustainable development". Aspirational aims and targets have been set and sought in the past, but achievements have been insufficient and progress not substantive because of uneven implementation between countries and the fragmentation of approaches, initiatives and interventions at global, regional and local levels.

This chapter covers aspects related to modern fisheries management principles and best practices to restore fish stocks and healthy oceans, to eradicate IUU fishing and eliminate harmful fishing practices and to discipline subsidies in fisheries.

2. FISHERIES MANAGEMENT AND SDG 14

Adoption of the SDGs in general, and Goal 14 in particular, has generated new momentum among coastal states and at the regional and multilateral levels to reinvigorate efforts to address unsustainable fisheries and aquaculture policies and practices. SDG 14 and its targets are legitimately ambitious, and their implementation faces many challenges. SDG 14 covers ten targets relating to marine pollution, protecting marine and coastal ecosystems, minimizing ocean acidification, sustainable management of fisheries and ending harmful fisheries subsidies, conserving coastal and marine areas, increasing economic benefits to Small Island Development States (SIDS) and Least Developed Countries (LDCs). Of great relevance to fish and seafood trade, there are six targets of SDG 14, including three means for their implementation. They aim at restoring fish stocks, eliminating IUU and harmful fishing practices, prohibiting harmful fisheries subsidies and improving market access and economic benefits for small scale fisheries and aquaculture operators of SIDS and LDCs.

Target 14.4 aims to effectively regulate harvesting, to end by 2020 overfishing, IUU fishing and destructive fishing practices, and to implement science-based management plans, to restore fish stocks in the shortest time feasible.

Indicator 14.4.1: Proportion of fish stocks within biologically sustainable levels.

As explained in Chapter 1, this is a major undertaking given the state of the world's marine fish stocks which has deteriorated over the years. Overfishing is the result of suboptimal fishing capacity and effort, some of it sustained by subsidies, and IUU) fishing. IUU fishing represents severe threats to global fisheries, in particular for fisheries of developing countries lacking the capacity and resources for effective monitoring, control, and surveillance (MCS) of their EEZs. In 2014, the UN General Assembly (UNGA) declared IUU fishing as one of the biggest threats to sustaining fish stocks globally (see footnote 3, Page 14). It occurs not only in the high seas but also within EEZs that are poorly managed and is sometimes associated with organized crime. Although the clandestine nature of IUU fishing prevents a fair estimation of its impact, available figures indicate that IUU fishing across the world's oceans weighs in at around 11– 26 million tonnes of fish each year or a value of USD 26 to 35 billion (UNCTAD/FAO/UN Environment, 2018). Traceability and catch documentation schemes are now market tools that can support enforcement and MCS operations leading to improved transparency about fishing operations and helping to prohibit illegal fish from entering mainstream fish value chains and international markets.

Target 14.6 aims to prohibit, by 2020, certain forms of fisheries subsidies, which contribute to overcapacity and overfishing, and refrain from introducing new such subsidies. Fisheries subsidies represent any financial support allocated to the fishing industry by a government. The impact of these subsidies can vary considerably, from positive effects on fisheries sustainability (e.g. support to fisheries management and research) to harmful subsidies (contributing to overcapacity, overfishing or IUU fishing).

Indicator 14.6.1: Progress by countries in the degree of implementation of international instruments aiming to combat IUU fishing.

Target 14.7 aims to increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources.

Indicator 14.7.1: Sustainable fisheries as a percentage of GDP in SIDS, LDCs and all countries.

This requires adequate capacity to integrate best practices for harvesting and value addition and to take advantage of opportunities offered around the concepts of Oceans/blue economy in the fish and seafood value chains. This is more so as international fish and seafood trade is characterized by favorable measures for market access (tariffs) that are not particularly high and have been decreasing slowly since 2010 (UNCTAD, 2016). However, Non-Tariff Measures (NTMs) applied to fish and fish products by importing countries and companies, remain a major obstacle for fish exports of developing countries, in particular SIDS and LDCs. These measures can be binding and reflect policy objectives for consumer protection, social welfare, resource sustainability, marine biodiversity and the environment. They also include measures on traceability and catch documentation to demonstrate that the traded fish has been legally harvested and has come from well managed fisheries and responsible aquaculture operations.

To achieve the targets of SDG 14, including the trade related ones, three key means of implementation have been identified:

Target 14 a: Increase scientific knowledge, develop research capacities and transfer marine technology to improve ocean health;

Indicator 14.a.1: Proportion of total research budget allocated to research in the field of marine technology;

Target 14 b: Provide access of small-scale artisanal fishers to marine resources and markets;

Indicator 14.b.1: Progress by countries in the degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries;

Target14 c: Enhance the conservation and sustainable use of oceans and their resources by implementing internationally agreed instruments (e.g. UNCLOS, CCRF, CBD, PSMA, etc.).

Indicator 14.c.1: Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in UNCLOS and other instruments, for the conservation and sustainable use of the oceans and their resources.

These are cross cutting areas of intervention which necessitate appropriate capacity, technical assistance, coordination and efficient governance frameworks at all levels from local to global.

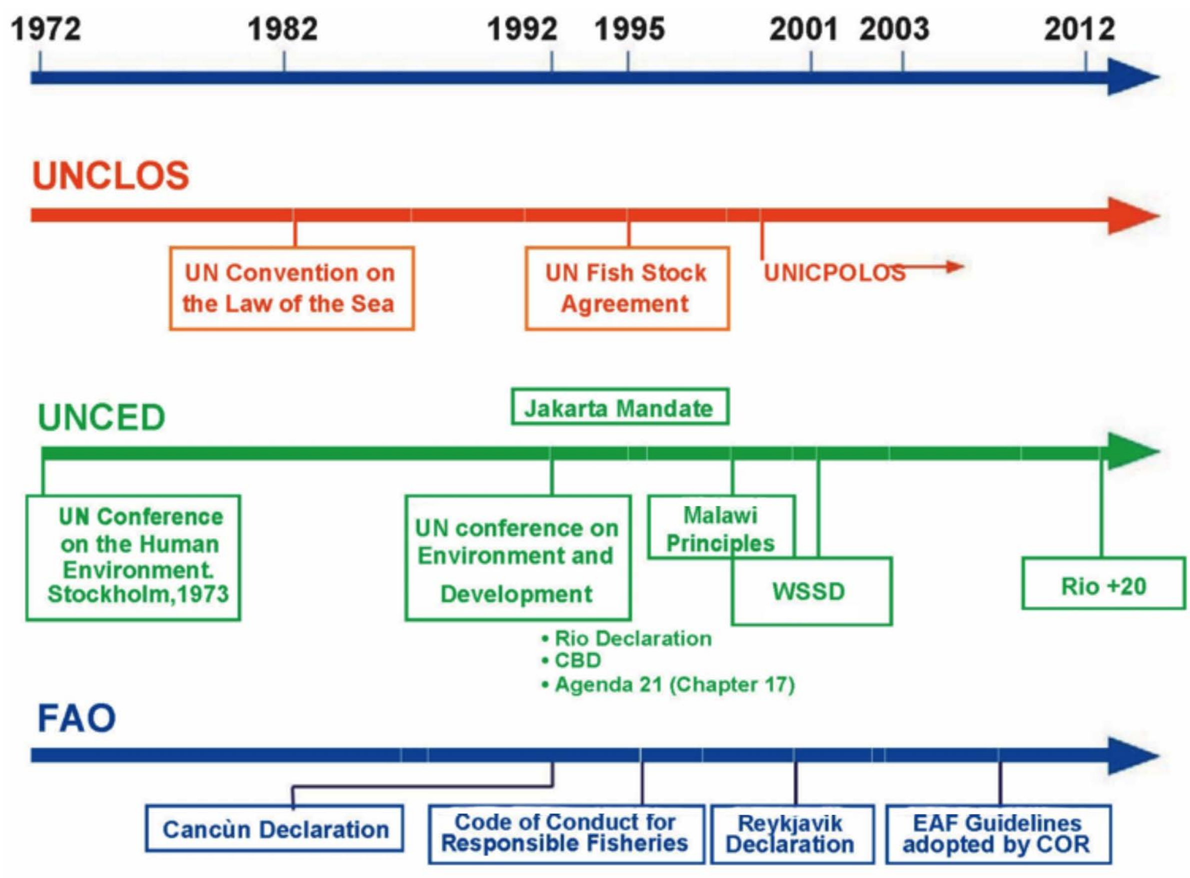
3. GLOBAL FISHERIES GOVERNANCE

Over the years, various international instruments have been adopted to regulate global governance of fisheries and aquaculture. Figure 2.1 illustrates the history of key events that shaped the international fisheries governance along at least three areas. These are the legal, environmental and management areas of fisheries. The legal string started with UNCLOS (1982), the environmental string with the UN Conference on Environment and Development (UNCED, 1992) and the fisheries management string with the FAO CCRF (1995).

These instruments can be divided into two groups, respectively binding (mandatory) or non-binding (voluntary) instruments (Table 2.1). Both instruments are the result of wide consultations and expert inputs and are often used as a benchmark for national policies and best practice guidelines. The voluntary instruments are equally important and widely adopted. The widespread introduction in the mid-seventies of EEZs prompted the adoption in 1982 of the United Nations Convention on the Law of the Sea (UNCLOS) which provided a good framework for the better management of marine resources. UNCLOS was further strengthened by the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement, 1993) and by The United Nations Agreement for the Implementation of the Provisions of UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Fish Stock Agreement, 1995). This new legal regime of the oceans gave coastal States rights and responsibilities for the management and use of fishery resources within their EEZs, which embrace some 90 percent of the world's marine fisheries. Figure 2.2 describes the boundaries of the marine space in relation to fisheries and Figure 2.3 illustrates how various stocks occupy this space.

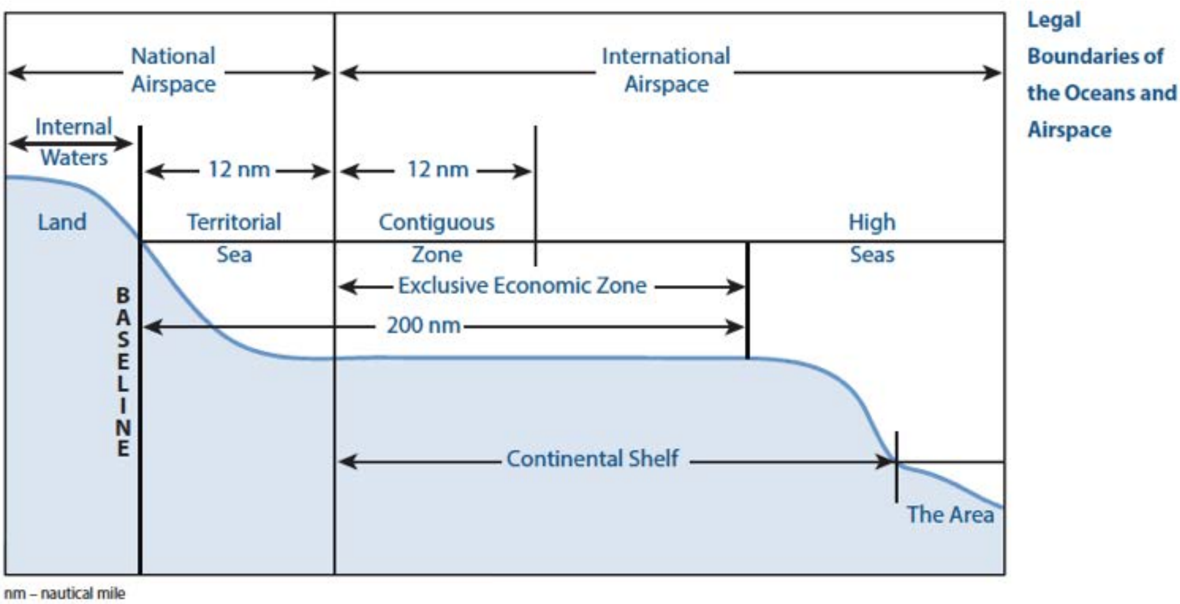
Another major fisheries achievement by the International community was the adoption in 1995 of the CCRF. The CCRF sets out international principles and standards of behavior to ensure effective conservation, management and development of both marine and freshwater living aquatic resources. It accounts for the impact of fishing on ecosystems, the impact of ecosystems on fisheries, and the need to conserve biodiversity. The CCRF is global and comprehensive in scope. It is directed toward members and non - members of FAO; fishing entities; sub-regional, regional, and global organizations (governmental and nongovernmental); everyone concerned with conserving fishery living aquatic resources, managing fisheries, and developing fisheries; and other users of the aquatic environment in relation to fisheries. The CCRF provides a reference framework for national, regional and international efforts, including the formulation of policies and other legal and institutional frameworks and instruments, to ensure sustainable exploitation of aquatic living resources in harmony with the environment. To support implementation of CCRF, FAO has developed a wide range of instruments (guidelines, international plans of actions, strategies, agreements) as presented in Table 2.1.

Figure 2.1. Development of legal, environmental and fisheries related international instruments



Source: Illustration by L.Ababouch

Figure 2.2. Legal boundaries of the oceans



Source: https://sites.tufts.edu/lawofthesea/files/2017/07/MaritimeZoneSchematic-1.png

Figure 2.3. Schematic representation of fish stock movement

Source: Author's elaboration

Table 2.1. Main international instruments governing international capture fisheries

Binding instruments	Non-binding instruments
1. UN Convention on the Law of the Sea, 1982 (UNCLOS) 2. UN Agreement for the Implementation of the Provisions of UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995 (UN Fish Stocks Agreement) 3. FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, 1993 (Compliance Agreement) 4. FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) Fishing, 2009 (Port State Measures Agreement) 5. Convention on Biological Diversity, 1992 (CBD) 6. Convention on International Trade in Endangered Species, 1973 (CITES)	1. FAO Code of Conduct for Responsible Fisheries (Code of Conduct, 1995) 2. FAO International Plans of Action (IPoA seabirds, 1999; IPoA management of fishing capacity, 1999; IpoA sharks, 1999; IPoA IUU, 2001) 3. Strategies for Improving Information on Status and Trends, respectively for Capture Fisheries (STF, 2003) and for aquaculture (2008) 4. International guidelines for management of by-catch and discards (2003), deep-sea fisheries (2009), eco-labelling (2009), Sea turtles (2009), Responsible trade (2008), flag state performance (2013), certification in aquaculture (2014) 5. UN General Assembly resolutions on sustainable fisheries, including deep sea fisheries and impacts of climate change 6. Johannesburg Plan of Implementation (adopted at the WSSD, 2002) 7. Declarations (e.g. Cancun Declaration on responsible fisheries, 1992, Reykjavik Declaration on responsible fisheries in the marine ecosystem, 2001, UN Declaration on sustainable development at Rio + 20, 2012)

Source: Author's elaboration

3.1. Fisheries management

3.1.1 What is fisheries management and how does it work?

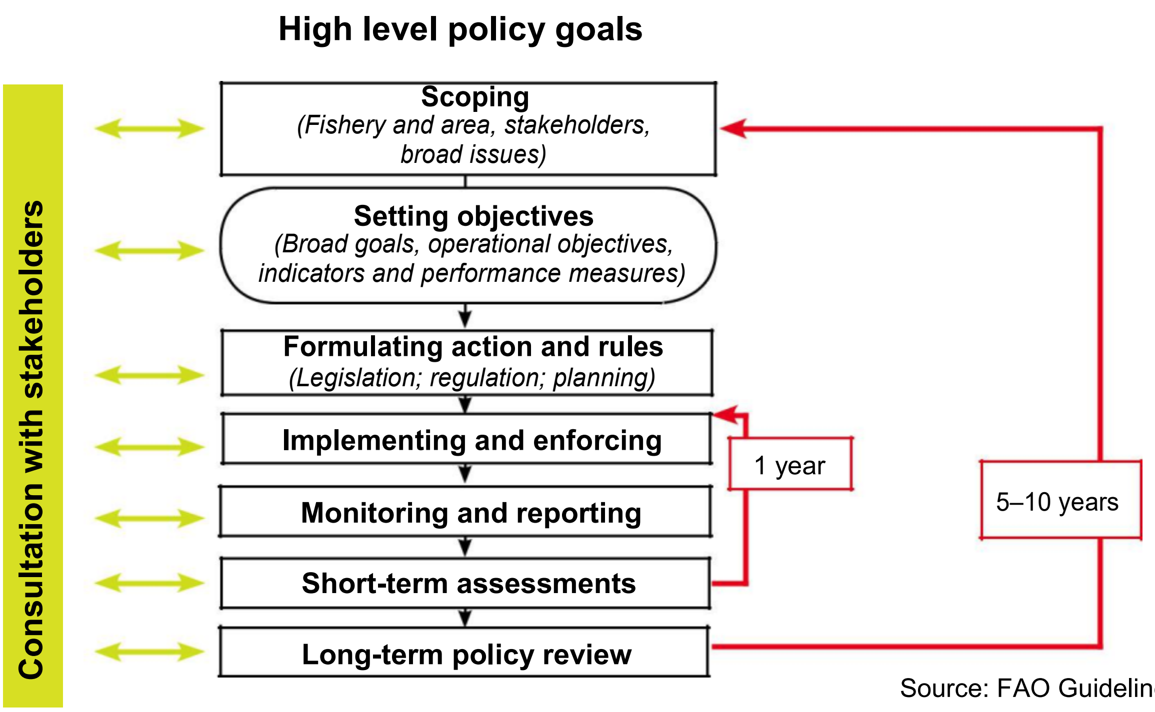
Fisheries management has a long history. Documented attempts to manage the harvesting of fisheries resources appeared as early as the tenth century. However, the practice of establishing rules for aquatic living resource extraction is probably much older, being an integral part of the traditional knowledge of societies that depended on fisheries for subsistence purposes. Fisheries management has evolved through time, partly to meet challenges such as the constant advance in fishing technologies and evidence of resource exhaustion and ecosystem impacts. It has also adapted to changes in institutions, paradigms and scientific knowledge, particularly those that occurred in the second half of the twentieth century.

There is no generally accepted definition of fisheries management. In this manual, we use the definition provided in the FAO Technical Guidelines on fisheries management: "The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives".

Fisheries management therefore involves a wide-ranging set of tasks that collectively aim to achieve sustained optimal benefits from the resources. These tasks are illustrated in the Figure 2.4 below which highlights that the process of fisheries management is guided by the overarching goals of the policies under which a fishery operates (FAO, 2016a). These goals are often adopted into by national policy instruments, typically expressed as laws, strategies and sectoral plans. They are based on international policy instruments aiming at sustainable development of fisheries by balancing ecological, social and economic aspects.

One of the first tasks of the fishery manager(s) is to translate these high-level policy goals into operational objectives that can be achieved by applying management measures. As a result, fishery management plans are promoted as the interface between the policy objectives and the activities of the fishers. This process is detailed further later in this chapter.

Figure 2.4. Process and activities for developing and implementing a fishery management plan



Source: FAO Guidelines

[9] http://www.fao.org/3/a-w4230e.html

3.1.2. Why is fisheries management necessary?

There are four main reasons why fisheries management is required to ensure sustainability of fisheries activities.

Fisheries resources are finite but renewable: Fish stocks are finite and the potential yield of a fishery is constrained by their biological productivity. The size and structure of the stock and of the ecological environment with which it interacts determine its biological productivity, but natural and human-induced changes in its environment also play a role. Modern technology provides fishers with the means to fully exploit fishery resources. Unfortunately, the high demand for fish and seafood exacerbates the motivation to exploit fish biomass at much higher rates than can be sustained. The uncontrolled harvesting of a fish stock can lead to a situation of overfishing and, in extreme circumstances, stock depletion. Therefore, fisheries management is necessary to ensure optimal exploitation of fish stocks in a sustainable manner.

Fisheries resources are common pool resources: Fisheries resources, like water, pastures, forests or air, are common pool natural resources, or common property resources. One of the main characteristics of common pool resources is that they should benefit the majority and it is difficult to exclude certain users to the benefit of others. This is the case of fisheries on which many people depend as means of subsistence and livelihoods. In the common property theory this notion is referred to as the exclusion problem.

Fisheries resources also present another characteristic typical of common pool resources: Harvesting by one individual or group means that less is available for other users. This is known as the subtractability problem. Thus, a situation can arise where many users compete for resources that are finite and deplete them by harvesting them beyond their natural productive capacity. Furthermore, if one individual catches too much, others will necessarily have less to catch. Typically, this situation leads to competition between users and the overexploitation of resources; everybody wants to catch the maximum amount possible in the shortest period of time because if they don't others will. Management plans define rules to control access to and use of fisheries resources. Such rules dictate who may fish, what can be harvested, how much can be harvested, and where and when.

Conflicts of interest and their impact on fisheries: Owing to the fact that there is a wide range of societal objectives for fishery resources and marine ecosystems, fisheries are prone to conflicts between the social actors involved in their use. For instance, a single resource can be exploited by artisanal and subsistence fisheries as a source of food, by other small-scale fisheries as a source of income and livelihood, by industrial fisheries for rent generation and by recreation fisheries as a form of leisure and enjoyment. In keeping with its objectives, each sector develops fishing strategies, techniques and practices that are capable of affecting the status of the stock available to the other sectors. In this way, objectives can be conflicting and become a source of tension between the sectors.

The marine space used by fisheries may also become a matter of dispute with other users. Aquaculture, tourism, agriculture, urban and industrial development, navigation, oil and gas exploration are examples of sectors that can directly and indirectly affect the status of resources and compete with fisheries for the use of the maritime space. In situations where multiple users compete for marine resources and spaces and if rules regulating access to and use of these resources and spaces are not well established and enforced, social conflicts can degenerate to a point of confrontation, tension and social unrest.

The need to control fishing practices: The right to access a fishery does not give the right to a fisher to use any fishing practice and gear. Norms need to be established to control fishing practices to ensure they are sustainable. Examples of fishing practices and gears that have been banned for their destructive effects, both on target resources and the overall ecosystem, include oceanic drift gillnets or fishing with poisons and explosives. Also, in some cases trawling has been banned because of the extent of trawl bycatch and the effects of trawl gear on the seabed. Other measures have been devised to protect fish during reproductive periods (temporary fishing closures also called biological rests) and to protect juveniles and allow individuals to reproduce at least once in their life cycle (minimum landed size, mesh sizes, etc.).

3.1.3. Who is responsible for fisheries management?

There is rarely a single individual who fulfils the functions of "fisheries manager". The head of the authority charged with managing fisheries may have overall responsibility for implementing fisheries management. However, this individual is very unlikely to have sole responsibility for receiving information, formulating advice and making and implementing decisions. Those different functions will typically be delegated to other sub-departments and specialists. In addition, as reflected in the CCRF, fisheries management should involve legitimately interested parties in the management process.

Participation by resource users and stakeholders in fisheries management can take many forms, ranging from consultation by government with stakeholders, to their having full responsibility for a fishery or management area. There are many levels between these two extremes of participation, such as the formation of fisheries advisory bodies with representation from various subsectors, or cooperation in planning and enforcement at the community level, etc. These bodies may simply be referred to as advisory bodies, or they may be called multi-stakeholder bodies, round tables or co-management bodies. In co-managed fisheries, there is an effective sharing of power and responsibility between the state and resource users' groups.

3.1.4. Fisheries management measures and tools

Many management measures can be applied to achieve fisheries management objectives. These include:

Regulation of fishing gears and fishing methods: Traditionally, gear regulations were aimed at promoting the sustainable use of target species. For example, controlling the mesh size of nets is aimed at avoiding recruitment overfishing. Other recent regulations aim at reducing the negative impacts of fishing, such as the bycatch of mammals, sea turtles and sea birds and the destruction of corals, seagrass beds and other seabed habitats. This trend has been reinforced by increased public awareness about the ecosystem impacts of destructive fishing practices to which markets have responded through ecolabelling of fish products (e.g. dolphin-free tuna, turtle-free shrimp). Cost effectiveness and particularly fuel efficiency is another factor that is influencing the choice and regulation of fishing gears.

Input and output controls: "Input controls" mostly mean the restrictive capping of fishing effort, while "output controls" mostly refer to the restrictive capping of species catch. Either one or both controls are likely to be part of a fisheries management plan. Input controls include measures such as the number of fishing licenses or permits issued, the duration of fishing and/or restrictions on the size of vessels. In some ways, input controls are simpler to apply because they tend to be kept constant through time and they do not require as much biological data or information relating to enforcement as do output controls. Input controls are easier to apply to active towed gears than to static gears because it is usually more difficult to control the input of gear units (e.g. number of pots harvesting octopus) than the input of vessels. Furthermore, because input controls are not necessarily species-based, they may allow fishers to focus too much on certain preferred species.

Output controls, such as Total Allowable Catch (TAC), are more focused on species and become increasingly more difficult to implement in multispecies fisheries. The data required for setting output controls make them more appropriate to situations where there are a few large stocks rather than many smaller stocks. Therefore, they are more often used in temperate areas or in single species fisheries. Generally, this is not the case of developing countries which exploit multi species fisheries and small fish stocks.

Area and time restrictions: Area and time restrictions are management measures that restrict access of fishers to a geographic area, either throughout the year or at particular times, usually in specific seasons. They can be considered special cases of input control that allow managers to meet wider conservation and fisheries management objectives. Seasonal restriction can be effective in many fisheries and in general its implementation is likely to be more straightforward compared to permanent area closures. From a wider conservation perspective, however, closed areas have an important and clearly useful role to play and zoning arrangements will often effectively support conservation objectives.

Rights-based fisheries management: Rights-based management is an approach that focuses on the rights and responsibilities of individuals, communities, companies and governments involved in fishing. It takes into account property rights, or who owns the fish use rights or who has the right to access and harvest the resource; and management rights or who should be involved in fishery management. In this respect, rights-based management encompasses many elements of fisheries management and goes beyond technical management measures.

In terms of use rights, two main categories can be described: access rights and withdrawal rights. Access rights deal with participation in the fishery, specifically relating to entry ("access") to the fishery or a specific fishing ground. Examples include regulating entry (licensing) and Territorial Use Rights in Fisheries (TURFs). Withdrawal rights typically involve numerical limits on resource use, either through input (effort) or output (harvest) controls. Use rights of various forms already exist in many well-established fisheries and these need to be recognized when implementing rights-based fisheries management.

Ecosystem-based measures: Ecosystem-based measures include those aimed at protecting, restoring and enhancing habitats and ecosystems with direct or indirect impacts on fisheries. Marine Protected Areas (MPAs), for instance, are a type of area restriction with a potential role for biodiversity conservation and fisheries management. They can reduce conflicts between fishers and other users by providing areas where non-fishery users can pursue non-consumptive uses of the resources and, in some circumstances, protect fisheries resources against overexploitation.

Fisheries are highly dependent on habitats (coral reefs, mangroves, seagrass beds, and wetlands), all of which are susceptible to pollution and physical destruction caused by humans and some types of fishing gears. The restoration of these habitats, particularly those that influence the abundance of a resource at some stage of the species' life cycle, can help to improve stock productivity.

A number of methods exist to create and enhance abundance and availability of fish. Examples of these are Artificial Reefs (ARs) and Fish Attracting or Aggregating Devices (FADs). ARs are physical structures introduced in the marine environment to serve as shelter and habitat, a source of food, a breeding area, resource management tool and shoreline protection. The AR may act as an aggregating device by drawing dispersed organisms and/or enhance production by providing new or additional habitat space that results in increased survival and growth of new individuals. In addition, ARs may provide a barrier that limits trawling in coastal areas where trawlers may come into conflict with small-scale fishers. FADs are items placed in the water to encourage fish to aggregate (gather near to them). FADs are deployed in a variety of environments and can be constructed from a wide range of materials. The benefits of using FADs include: (i) increased catch; (ii) lower fuel consumption; (iii) accessibility by small-scale fishers; (iv) a shift in effort from overfished areas; (V) improved fishing vessel safety; and (vi) definition of territory and/or inhibition of certain types of fishing. Potential problems include: (i) increased risk of stock depletion; (ii) changes in feeding habits of attracted fish; (iii) lack of monitoring and evaluation; (iv) restricted access to the resource; (v) increased conflicts; (vi) periodic maintenance and replacement of the FAD; and (vii) the cost of long-lived, high-technology devices, if these are used.

Enhancing fish populations by restocking with young individuals has been most successful in small, enclosed water bodies such as ponds and lagoons. The generally high cost of producing the young for stocking means that this approach has been most cost-effective in inland fisheries or for recreational marine fisheries that provide economic returns beyond the landed value of the fish. The few instances of successful stocking programs in the marine environment are in very localized inshore habitats. Other risks should be considered when applying restocking measures, such as of genetic dilution of the wild stocks and the introduction of disease.

Incentive mechanisms: These include measures of various sorts to induce fishery participants (and others) to change behavior in keeping with fisheries management. Both positive and negative incentives can modify behavior. Positive incentives are those that reward responsible stakeholders while negative incentives penalize them (e.g. with fines for irresponsible behavior). Positive incentives include: institutional incentives (e.g. fisheries management systems and participatory governance arrangements that induce support from stakeholders); legal incentives (e.g. effective legislation creating rewards and penalties with effective enforcement); financial/material incentives (e.g. promote win-win measures, such as the use of excluder devices in fishing gear, which can actually increase profits by reducing fishing costs, even as they meet the goal of reducing bycatch); and social incentives (e.g. community-based institutions and social environments that create peer pressure, encouraging individuals to comply with agreed-upon community rules). A key positive incentive that has gained traction in international markets in recent years is the recognition by the markets of responsible behavior and practices through FIPs and ultimately eco-labeling. This aspect is discussed further in chapter 5.

Eco-tourism is another market-based conservation mechanism that promotes the substitution of extractive uses of resources with non-extractive uses. Essentially, payments from tourism compensate for lost fishing revenues and may provide for alternative or diversified livelihood options.

The most disincentive measure is that of boycotting a product and refusing its import into a given market. This is for example the case of markets refusing shrimp caught with gears not using turtle excluding devices or tuna that does not meet dolphin free tuna requirements.

An economic incentive in support of sustainable fishing practices is the granting of export permits for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed species. CITES was developed to minimize the effect of international trade on commercial species threatened with extinction (Appendix I species) or exploited unsustainably (Appendix II species). In the case of fisheries, trade in Appendix I species is all but prohibited, while trade is permitted for Appendix II-listed species if the related fishing practices are proved to be sustainable, i.e. the species "was legally obtained and if the export will not be detrimental to the survival of the species". If the potential exporter is unable to prove the sustainability of the fishery, exportation rights are not granted. In theory, however, proper management of fisheries should prevent commercial species from being placed on the CITES list.

Monitoring, control and surveillance (MCS): Fisheries management measures and regulations are effective only if they are enforced. MCS is not simply the policing of the sea by the state, it is an effective fisheries management tool that has its basis in international law (UNCLOS, 1982; FAO Compliance Agreement, 1993; and FAO CCRF, 1995). It involves three different tasks:

- Monitoring: a continuous requirement for the measurement of fishing effort and resource yields.
- Control: regulatory conditions under which the exploitation of the resource may be conducted.
- Surveillance: the degree and types of observations required to maintain compliance with regulatory controls imposed on fishing.

3.1.5. Fisheries management plans

Planning is an essential part of fisheries management. The management plan is the tool that will guide the implementation of agreed management arrangements, helping managers to make more informed decisions for the sustainable use of fisheries resources. A fisheries management plan (FMP) can be defined as "a formal or informal arrangement between a fishery management authority and interested parties which identifies the partners in the fishery and their respective roles, details the agreed objectives for the fishery and specifies the management rules and regulations which apply to it and provides other details about the fishery which are relevant to the task of the management authority".

Depending upon the jurisdiction and the fishery, a management plan may be a formal, legal document that in some cases requires parliamentary approval. At the other end of the spectrum, it may be a simple list of activities agreed to and maintained by the local community leaders. There is little chance of success if the plan is not endorsed by those who interact with, monitor and enforce rules the fishers should respect. Preparation of FMP involves four main steps:

1. Initiation and scoping: to generate an agreed and clear definition of the fishery plus a shared understanding of the social, economic and ecological objectives to be achieved.

2. Identification of assets, issues and priorities: to identify all relevant resource assets, outcomes and the issues affecting their management, and determine priorities for direct actions to best achieve the management objectives.

3. Development of a management system: to develop a cost-effective management system to effectively deal with all high priority issues, including setting clear operational objectives and indicators and assessing the merit of alternative management options.

4. Implementation, monitoring and performance review: to document the actions required to implement the management system, monitor their completion, evaluate and report on their performance in delivering acceptable community outcomes.

At a minimum, an FMP should contain:

- A description of the fishery, especially its current status and any established user rights.
- The management objectives.
- How these objectives are to be achieved (management measures and rules).
- How the plan is to be reviewed and/or appealed.
- The consultation process for review and appeal.

3.1.6. Fundamentals of stock assessment

Stock assessments provide important scientific information necessary for the conservation and management of fish stocks. Most national fisheries laws call for the best scientific information available to manage capture fisheries. Additionally, coastal states, RFMOs and international organizations rely on scientific data to make decisions and recommendation on fisheries management measures, especially for shared fish stocks.

Scientific stock assessments examine the effects of fishing and other factors to describe the past and current status of a fish stock, answer questions about the size of a fish stock, and make predictions about how a fish stock will respond to current and future management measures. As such, fish stock assessments support sustainable fisheries management by providing fisheries managers with the information necessary to make sound and science-based decisions for the exploitation of a fish stock.

Three key questions are generally requested of fish stock assessment exercises:

- What is the status of a fish stock relative to established targets? (e.g. Is a stock experiencing overfishing? Is the stock overfished?)
- How much can fishermen catch while maintaining a healthy and sustainable fish stock?
- If a stock is depleted or excessively overfished, what steps must be taken to rebuild it to healthy abundance levels?

Answers to these important questions help managers make the best decisions that ensure a healthy balance between sustainable fish stocks, ecosystem health, and productive coastal communities. Assessments also offer the technical basis for setting annual fishery harvest levels (through quotas and catch limits) and other fishery management measures. For example, if a stock assessment model indicates that a stock has rebuilt to a healthy level, fishery managers may recommend higher catch limits, longer fishing seasons, or fewer fishing area restrictions. Managers make recommendations with the intent of maintaining healthy fish populations and sustainable fisheries that provide for economically healthy coastal communities and a constant supply of seafood.

Data for Complete Stock Assessments: Stock assessments are based on models of fish populations that require three primary categories of information: catch, abundance, and biology. To ensure the highest quality of stock assessments, the data used must be accurate and timely. Key definitions in this respect are as follows (FAO, 2016a):

Fish Stock- a biological fish stock is a group of fish of the same species that live in the same geographic area and mix enough to breed with each other when mature. A management stock may refer to a biological stock, or a multispecies complex that is managed as a single unit.

Catch data—The amount of fish removed from a stock by fishing under its different forms (recreational, artisanal, coastal or industrial fishing).

Abundance data—A measure, or relative index, of the number or weight of fish in the stock.

Data ideally come from a statistically-designed, fishery-independent survey (systematic sampling carried out by research fishing vessels separately from commercial fishing operations) that samples fish at hundreds of locations throughout the stock's range. Most surveys are conducted annually and collect data on all ecosystem components. Fishery Survey Vessels use standardized sampling methods to collect data the same way each year, providing a relative index of abundance over time. In some situations, catch rates by fishermen can be calibrated to provide additional abundance measures as well.

Biology data—Provides information on fish growth rates and natural mortality. Biological data include information on fish size, age, reproductive rates, and movement. Annual growth rings in fish ear bones are used by biologists to assess fish age. The samples may be collected during fishery-independent surveys or be obtained from observers and other fishery sampling programs. Academic and research programs with the fisheries agencies and fishing industry are other important sources of biological data.

Reference point: Management reference points are agreed values of indicators of the desirable or undesirable state of a fishery resource or the fishery itself. Reference points could be biological (e.g. expressed in spawning biomass or fishing mortality levels), technical (fishing effort or capacity levels), or economic (employment or revenues levels). Biological reference points are usually estimated from models in which they may represent critical values or thresholds.

Maximum Sustainable Yield (MSY): The surplus production of a stock varies according to diverse factors, including the biological characteristics of the species, the environmental conditions in the stock distribution area and the size of the stock relative to the ecosystem carrying capacity. The maximum sustainable yield (MSY) is defined as the highest catch that can be continuously taken from a stock under existing environmental conditions.

Stock assessment is the process of collecting, analyzing, and reporting demographic information to determine changes in the abundance of fishery stocks in response to fishing and, to the extent possible, predict future trends of stock abundance.

A national network of fisheries monitoring programs regularly collects catch data and makes this information available to stock assessment scientists and managers. Sources of catch data include:

• Dockside monitoring: Often conducted in partnership with fisheries agencies in landing sites, dockside monitoring records commercial catch information to give an accurate measure of commercial landings and provides biological samples of the length, sex and age of fish.

• Logbooks: Records from commercial fishermen of their location, gear and catch.

• Observers: Biologists observe fishing operations on a certain proportion of fishing vessels and collect data on the amount of catch and discards. This is most relevant in the context of bilateral fishing agreements.

• Recreational sampling: Surveys and dockside sampling estimate the level of catch by recreational fishing.

Good stock assessment requires high quality and reliable data. Key problems result from underestimations which lead to wrong projections and mislead management decisions.
Current technologies have improved greatly stock assessment enabling:

• Electronic catch data collection and dissemination for rapid access and analysis;

• Advanced monitoring equipment attached to traditional sampling gear to collect concurrent environmental information during surveys;

• Visual surveys in complex habitats using imaging systems on robotic and autonomous underwater vehicles (AUVs);

• Non-extractive (does not harm or remove samples) abundance sampling using hydroacoustic technology;

• Better definition of stock boundaries, habitat use, and fish movements using electronic fish tags, genetic analysis, and research on the chemical structure of fish bones.

Stock assessment models: T he three types of data (catch, abundance, and biology data) feed into mathematical models that represent the main factors causing changes in harvested fish stocks. The models produce estimates of management factors for a given fishery. These factors are used by managers to make informed decisions about how to best regulate a fishery. When possible, stock assessment models include information on ecosystem and environmental effects to improve the interpretation of historical information and the precision of forecasts.

The models available for assessing fish stocks range from simple to complex based on the available data for a given stock. Scientists choose the model best suited for a stock's life history and data availability and might try multiple models to find the best possible fit.

What factors go into fish stock assessment models? Fish stock assessment models represent the processes of birth, natural death, growth, and fishery catch that affect the fish stock over time. Scientists calibrate the model by using observed data from fishery catch, fish abundance surveys, and fish biology. Most stock assessment models nowadays work as computer simulations of fish populations. Hundreds of factors may be needed in complex situations involving multiple stock areas, several fishing fleets, and lengthy time series data. In the end, how closely a fish stock assessment model fits the actual data indicates the reliability of the historical estimates and future predictions for a fish stock. Many assessment models use graphical interfaces that help standardize assessments, to graphically display many complex factors as a complete picture and make it easier for scientists to work together on projects and compare their work.

The models available for assessing fish stocks range from simple to complex based on the available data for a given stock. Scientists choose the model best suited for a stock's life history and data availability and might try multiple models to find the best possible fit. The most complete assessment model is called an integrated analysis model composed of three model layers: population, observation, and statistical.

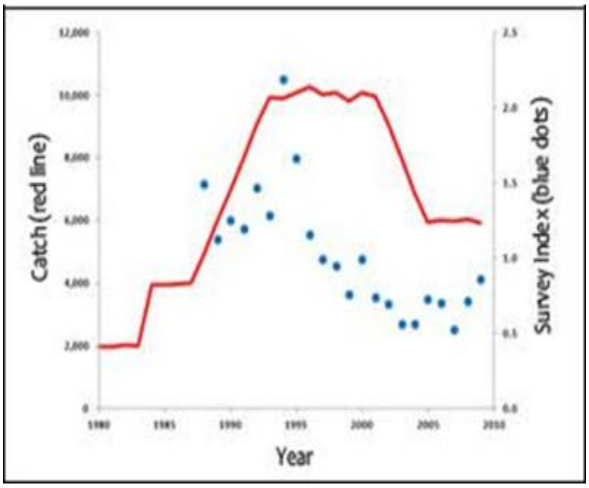
Layer 1—Population Model: First, the population model computes the essential population factors such as stock abundance, mortality, growth, reproduction, and movement for each year, typically during the past several decades.

Layer 2—Observation Model: Next, the observation model creates predictions from the population model of data that have been measured, including survey abundance index, catch, fish size and age composition, and others as available.

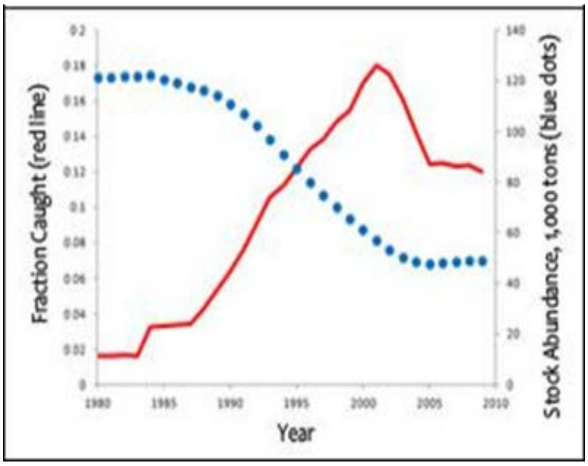
Layer 3—Statistical Model: Finally, the statistical model compares the data predictions to the data observations and adjusts the factors in the population and observation model to achieve the best possible match to all the data.

A Simplified Example of a Fish Stock Assessment Model Using Sample Data

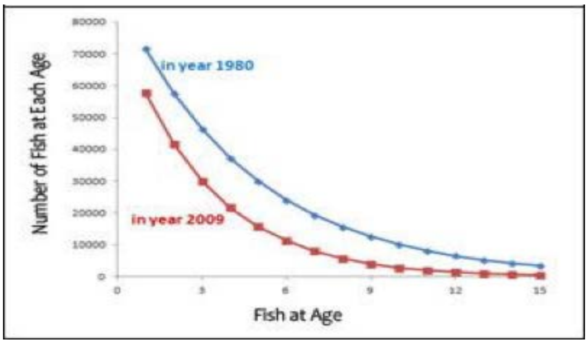
Input Data—Data on fisheries catch, stock abundance, and other important observations go into the assessment model. Here, the example shows catch data (red line) and survey index abundance (blue dots) over time.



Model Results—Mathematical simulations produce estimates of important fishery management factors. For example, assessment models estimate stock abundance (blue dots) from survey index and other data and calculate the fraction of the population removed by fishing (red line).

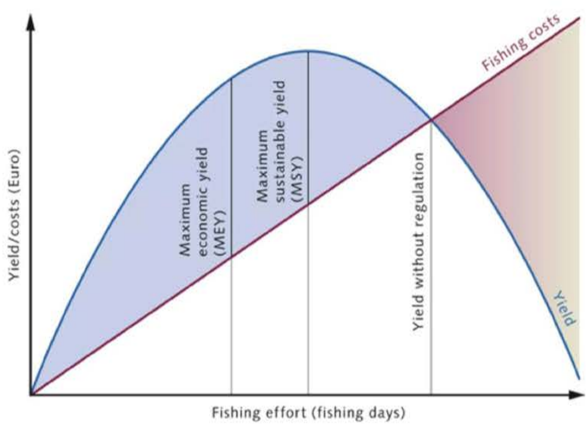


Management Advice—When supplementary data are available, such as information on fish size or age, scientists can calibrate the assessment model and produce additional results useful to resource managers. This example shows model results of how fishing has changed the age structure and reduced the number of older fish in a sample population between 1980 and 2009.



Fisheries management objectives encompass biological, social and economical dimensions. The outputs from a fishery can be measured in several ways, such as quantity of fish harvested (biological), revenue from the fishery (economic), or a composite and more intangible "benefit to society" (social and cultural). The below figure illustrates the different objectives of a fishery using a typical bio-economic yield diagram. MSY looks at the biological measure of fish harvested and attempts to take the maximum benefit of a stock in terms of food production. Maximum Economic Yield (MEY) seeks to maximize the rent from the fishery and therefore the total economic benefit to society and is biologically more conservative than MSY. The other common objectives in the diagram demonstrate the range of social benefits that should be taken into account when managing fisheries. The optimization of multiple objectives must address trade-offs and compromises and can be a challenging task. However, the process of reaching consensus on the most appropriate objectives brings people into the system far more explicitly than before, when attention was solely directed to MSY.

Challenges to fish stock assessment



Stock assessment is often challenged, especially in developing countries, by limitations in the availability of data and capacity for the assessment and monitoring of fishery resources. Data limitation tends to be more prominent in areas with high species diversity and small stocks as is the case for many small-scale fisheries. data limitations can be attributed to different interrelated factors, such as:

- The difficulty in monitoring and assessing fisheries in tropical areas of high biological diversity, dominated by multi-species and multi-fleet small-scale activities, where conventional fisheries assessment methods are not suited or have very limited application;
- The tendency of countries to allocate scientific, human and financial resources preferentially to large and economically important fisheries;
- The lack of financial support for the development and maintenance of national fisheries statistical systems; and
- Weak fisheries management systems that lack mechanisms for monitoring, enforcement and reporting management performance to stakeholders and the public at large.

Although data limitations are a reality, given the complexity of the issue, several methods have been promoted for data poor fisheries. These methods can compensate for many imbalances and produce an assessment of a significant number of representative stocks. In this context, many organizations have implemented several work schemes to enhance the capacity of developing countries for data collection, monitoring and assessment, including the development and testing of novel approaches for fisheries assessment and management in data-limited situations. The end goal of this work is to support countries in improving the knowledge and understanding of fishery status and trends, and to use that knowledge as a basis for fisheries policy-making and management. Such improvements will also be instrumental in preparing developing countries to implement any negotiated fisheries subsidies disciplines linked to the status of fish stocks.

3.1.7. Key challenges to fisheries management

There are many examples of successfully managed fisheries worldwide and the number of success stories is significant, including in developing countries. Unfortunately, the overall picture is still bleak. Many fisheries have too much capacity – too many fishers, vessels or both – and the biomass of fish stocks and ecosystems is deteriorating. The root causes have been well documented and important ones (e.g. overcapacity, IUU, subsidies) have been presented in the previous chapter. Others relate to poor governance (conflicting objectives, lack of attention, will and authority) and lack of coordination between the many users of the marine space.

Indeed, an important barrier to real progress toward sustainable fisheries management is the limited integration among the different approaches used by government agencies and in their partnership with development and environmental agencies and organizations in addressing the sector. These approaches can be broadly characterized into five main thematic areas:

• Sector-focused management priorities: Most fisheries management worldwide focus on implementing rules, regulations and measures for the proper functioning of fishing activities and achieving objectives specifically relating to the sector. The pursuit of these objectives, and the instruments developed for achieving them continue to have an important role.

• Safeguarding of human well-being priorities: These objectives emphasize the need for wider social and economic development for participants in the fisheries sector, their rights to food security and livelihoods and equitable distribution of benefits from fisheries.

• Biodiversity and ecosystem health priorities: This approach targets the maintenance of biodiversity and ecosystem health in the marine environment, both in coastal areas and the high sea, including through interactions between the marine and terrestrial environments. It is supported by key conventions such as the Convention of Biological Diversity (CBD), the protection of critical habitats and the introduction of controls on resource use are considered key to achieving these objectives

• Postharvest and value chain priorities: Given the limited scope worldwide for increasing production from fisheries that are frequently already exploited at or beyond their sustainable capacity, the opportunities for reducing wastage and adding value to fish being caught is frequently seen as a priority objective. Opportunities for incentivizing sustainable fisheries through market measures and consumer demand for fish products from well-managed fisheries often underpin the approaches used to achieve these objectives;

• Wealth creation and investment priorities: This prioritizes the introduction of appropriate economic incentives for resource users, and particularly secure tenure rights to fisheries resource, as key to achieving sustainable fisheries. The emphasis is often on ensuring the economic performance of fisheries as a sector and its contribution to wider economic growth and well-being through more efficient exploitation and management and the capture of resource rent for reinvestment in the development of fisher communities in particular and the wider society in general.

These thematic areas are by no means exclusive, and most successful fisheries management plans already incorporate wider objectives and seek to find common ground between them. Unfortunately, governments currently do not always receive consistent advice from development and environmental agencies and organizations. When different development and environmental agencies and organizations promote different approaches, it may create unproductive confusion at the local, national and regional levels. The Ecosystem Approach to Fisheries has proven useful in addressing these shortcomings.

Ecosystem Approach to Fisheries: EAF is a risk-based management process rooted in the principles of sustainable development. According to FAO (2003) : "An Ecosystem Approach to Fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries".
FAO (2003) also states that: "the purpose of EAF is to plan, develop and manage fisheries in a manner that addresses the multiplicity of societal needs and desires, without jeopardizing the options for future generations to benefit from marine ecosystems".

The above definitions clearly indicate that EAF addresses both human and ecological well-being and merges two paradigms: that of protecting and conserving ecosystem structure and functions and that of fisheries management that focuses on providing food, income and livelihoods for people. Thus, the EAF highlights and reorganizes the principles of sustainable development, making their application more imperative.

Interest in EAF has been motivated by several issues, most prominently:

• Increased awareness of the importance of interactions between fisheries resources and the ecosystem within which they exist;

• Recognition of the wide range of societal objectives for, and values of fisheries resources and marine ecosystems within the context of the three dimensions of sustainable development;

• Poor performance of current approaches as witnessed by the poor state of many of the world's fisheries; and

• Recent advances in science, which improved our understanding and knowledge of the value of ecosystems to humans, namely the goods and services they provide.

[10] http://www.fao.org/3/a-y4470e.pdf

EAF builds on existing institutions and knowledge and provides a framework for combining data collected for a variety of purposes by different institutions. EAF is about decision-making aimed at achieving well-defined objectives based on the best available knowledge. Experience shows that firm steps can be taken even in data-poor situations, through careful consideration of precautionary measures, monitoring the effects of such measures and adoption of adaptive (corrective) management strategies.

3.2. Illegal, unreported and unregulated fishing

3.2.1. Context, definitions and impact

IUU fishing refers to:

- Fishing by "Stateless" vessels.
- Fishing in convention areas of Regional Fisheries Management Organizations (RFMOs) by non-party vessels; and
- Fishing activities which are not regulated by States and cannot be easily monitored and accounted for.

Chapter 1 has highlighted the negative detrimental effects that IUU fishing has on global fisheries and its detrimental impact on the marine environment and on distorting international fish trade, in addition to its criminal and human rights abuse aspects. The qualifier Illegal refers to fishing and related activities conducted in contravention of national, regional and international law; fishing without a license in prohibited areas, with prohibited gear, on prohibited species, or extracting over the allowed quota. Unreported fishing refers to any fishing operation or catch that is not recorded or that is misreported to proper authorities, any withholding of catch type, size, and location. Unregulated fishing refers to catch from areas of the sea, including the high seas, not under jurisdiction of a state or a fisheries management organization (FMO).

IUU fishing remains one of the greatest threats to marine ecosystems due to its potent ability to undermine national and regional efforts to manage fisheries sustainably and efforts to conserve marine biodiversity. IUU fishing takes advantage of corrupt administrations and exploits weak management regimes, in particular those of developing countries lacking the capacity and resources for effective monitoring, control, and surveillance (MCS). It is found in all types and dimensions of fisheries, occurs both on the high seas and in areas under national jurisdiction, concerns all aspects and stages of the capture and utilization of fish, and may be associated with organized crime. Fisheries resources available to bona fide fishers are poached in a ruthless manner by IUU fishing, often leading to the collapse of local fisheries, with small-scale fisheries in developing countries proving particularly vulnerable. Products derived from IUU fishing can find their way into international markets thus throttling local food supply. IUU fishing therefore threatens livelihoods, exacerbates poverty, and augments food insecurity. The dynamic, adaptable, highly mobile, and clandestine nature of IUU fishing prevents a straightforward estimation of its impact. Rough calculations, however, indicate that IUU fishing across the world's oceans weighs in at around 11–26 million tonnes of fish each year, valued at US$ 10–23 billion (FAO, 2018a).

In summary, the effects of IUU fishing are:

- Overfishing: Stock assessments do not include IUU catches, resulting in quotas set too high to be sustainable, threatening food security.
- Collapse of Vulnerable Fisheries: for example, the value of endangered bluefin tuna on the black market is estimated at $4 billion annually (ref).
- Slowed recovery of depleted stocks: it takes 3 to 4 sharks finned illegally for every 1 shark caught legally.
- Exploitation of developed countries: Illegal foreign vessels remove an estimated $300 million from Somalian waters alone each year, destroying local livelihoods (ref).
- Seafood fraud: illegal fish mixed with legal catches and often mislabeled, so they can be sold as a higher valued fish to boost profits.
- Criminality: IUU fishing is often linked to human trafficking, drug smuggling, physical and sexual abuse, child labor, dangerous working conditions, and forced labor.
- Endangered seafood safety: poor sanitation, disease, and unsafe food handling endangers the health of consumers.

Areas beyond national jurisdiction (ABNJ) are those areas of ocean for which no one nation has the specific or sole responsibility for management. Achieving sustainable management of fisheries resources and biodiversity conservation in ABNJ is extremely difficult given the complexity of the ecosystems as well as the many and diverse actors involved, and yet is at the heart of the IUU fishing discussion. The benefits of managing ABNJ effectively also extend to coastal countries, as ABNJ fisheries resources often straddle into their exclusive economic zones.

3.2.2. How to combat IUU fishing

Combatting IUU locally, regionally and internationally should be deployed on three fronts: during fishing operations, during landing the catch and during marketing the fish and seafood products. This puts three levels of responsibilities on States: flag State, port State and market State Responsibility.

The promotion, regulation and monitoring of responsible fishing practices, through robust fisheries management and governance frameworks, are essential for the sustainability of fisheries resources in both coastal areas and high seas. The principles of responsible fisheries management prescribed in international instruments (see table 2.1) and the requirement for their implementation by States and RFMOs around the globe are essential.

The Voluntary Guidelines for Flag State Performance (FAO, 2014a), provide guidance to strengthen and monitor compliance by flag States with their international duties and obligations regarding the flagging and control of fishing vessels. It covers the relevant responsibilities of Flag States on the basis of elements contained in international law, including binding and nonbinding international fisheries instruments. Fisheries management, registration and records of vessels, authorizations, MCS and cooperation between flag States and coastal States are among the central components of the Guidelines. RFMOs have a key role to play to ensure implementation of these Guidelines to strengthen flag State performance.

Considering that fishing vessels are highly dependent on the use of ports, including ports of States other than their own, support for the implementation of port State measures in combatting IUU fishing increased remarkably over the years leading to the adoption of the landmark FAO Agreement on Port State Measures (PSMA) to prevent, deter and eliminate IUU fishing. The PSMA, which entered into force in June 2016, sets conditions for the entry and use of ports by foreign fishing vessels and defines minimum international standards to be applied by port States in reviewing information prior to the vessels' entry into port, conducting inspections in their designated ports, taking measures against vessels found to have engaged in IUU fishing, as well as for information exchange with concerned States, RFMOs and other international entities.

Global implementation of the PSMA would effectively establish "compliance check-points" at ports around the world for a large number of fishing vessels, especially those which operate in waters outside the jurisdiction of the flag State and seek entry into ports of other States. As of August 2018, there were 55 parties to the PSMA, including the European Union.

The Agreement provides an opportunity for States to collaborate and exchange information on fishing vessels and their activities, including through and with RFMOs, thereby creating a network which supports Port States in combatting IUU fishing, flag States in the control of their vessels, coastal States in protecting their fishery resources and market States in ensuring that fishery products derived from IUU fishing do not enter their markets.

The Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record) concept has been widely supported and the information tool is expected to play a crucial role in closing the information gap on vessels carrying out IUU fishing and related activities. In addition to the "identification" information such as registration, characteristics and ownership, the tool also integrates other pieces of information relevant to the fight against IUU fishing such as previous vessel names, owners and operators as well as authorizations to fish, transship or supply, and history of compliance. The Global Record launched the public version of the information system in July 2018, with one third of the global eligible fleet already registered .

Equally important are the Voluntary Guidelines for Catch Documentation Schemes which were adopted in July 2017 (FAO, 2017b) . Their aim is to provide assistance in the development and implementation of any catch documentation scheme, improving the ability of Market States and regional entities to enhance traceability in the fisheries supply chain. Additional efforts to better understand and monitor at-sea transshipments as well as guidelines to facilitate estimating the magnitude of IUU fishing are also underway. These initiatives strengthen international cooperation as well as increase knowledge on specific aspects of IUU fishing, directly supporting the ability of States and organizations to effectively combat IUU fishing.

[11]http://www.fao.org/3/a-i4577t.pdf
[12]http://www.fao.org/3/a-i5469t.pdf
[13]www.fao.org/fileadmin/user_upload/legal/docs/037s-e.pdf
[14]http://www.fao.org/global-record/en/
[15]http://www.fao.org/3/a-i8076e.pdf

3.2.3. Assisting developing countries in fulfilling their obligations under the governance framework

Becoming Party to various international instruments is only the first step; the real challenge arises when working towards their implementation. While all countries may face some obstacles and challenges in implementing these instruments, the obstacles that developing countries often face are much more extreme. In most cases, these international instruments recognize that developing States may have special requirements and that assistance should be provided to address these.

In 2017, FAO launched its Global Capacity Development Umbrella Programme in support of the PSMA and complementary instruments and has been providing support to over 33 countries in its first 5 years of implementation. Other organizations such as UNCTAD or UN Environment are participating actively to these international efforts by providing technical assistance and capacity building to combat IUU fishing. For example, UNCTAD has launched in collaboration with the UN Division for Ocean Affairs and the Law of the Sea a project on "Evidence-based and policy coherent Oceans economy and Trade Strategies". The project aims to support developing countries in the Caribbean region in realizing economic benefits from the sustainable use of marine resources. It will assist coastal developing countries, particularly SIDS and LDCs, in promoting the sustainable trade of products and services in ocean economy-based sectors by analyzing, elaborating and adopting evidence-based and coherent Oceans Economy and Trade Strategies.

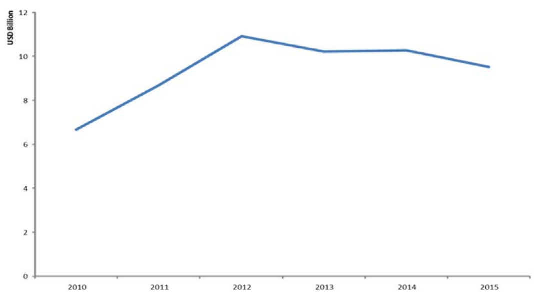
The global community has been making real efforts to raise awareness about the prevalence and deleterious effects of IUU fishing; the result is that it has become a priority at national, regional and the global levels for its elimination. While the elimination of IUU fishing will not alone resolve neither the issue of overfishing nor of food insecurity, it will certainly mark an important progress in that direction.

3.3. Fisheries subsidies

Chapter 1 presented the overall issue of fisheries subsidies and the current situation of its global estimates and challenges. Fisheries subsidies represent any financial support allocated to the fishing industry by a government. Based on the debates at the ongoing WTO negotiation on fisheries subsidies, the impact of these subsidies can vary considerably, from positive effects on fisheries sustainability (e.g. support to fisheries management and research) to harmful subsidies (contributing to overcapacity, overfishing and to IUU fishing).

No complete inventory of fisheries subsidies or a common understanding of their impacts exist yet. As a result, reliable and accurate data on fisheries subsidies remain sparse, partly due to a lack of transparency. This information vacuum has largely been filled by broad assumptions and estimates that are widely debated, although more on anecdotal evidence. A recent report estimates global fisheries subsidies to be in the region of USD 35 billion, with over USD 20 billion being in the form of fishing capacity-enhancing subsidies (Schuhbauer et al, 2017). Based on data reported consistently to OECD by 28 countries, UNCTAD (2018) estimated their total public support to fisheries at an average annual USD 9.3 billion during the period 2010-2015. OECD estimates of government support include budgetary and non-budgetary measures. This period has experienced a growth of 42 per cent in total, with a peak of USD 11 billion in 2012 followed by steady decline (Figure 2.5). Of this reported support, the majority was devoted to fisheries management, monitoring and control, infrastructure, research and fuel costs. A similar study by the EU reports around USD 9.7 billion annually in fisheries subsidies in major non- EU fishing countries (EU, 2016).

Figure 2.5. Global fisheries support estimate, (2010-2015)



Source: UNCTAD, 2018

This UNCTAD analysis uncovered important insights on general support provided to fisheries by major fishing nations, including its incidence on exports.

[16]http://www.fao.org/port-state-measures/capacity-development/ongoing-capacity-building-efforts/en/

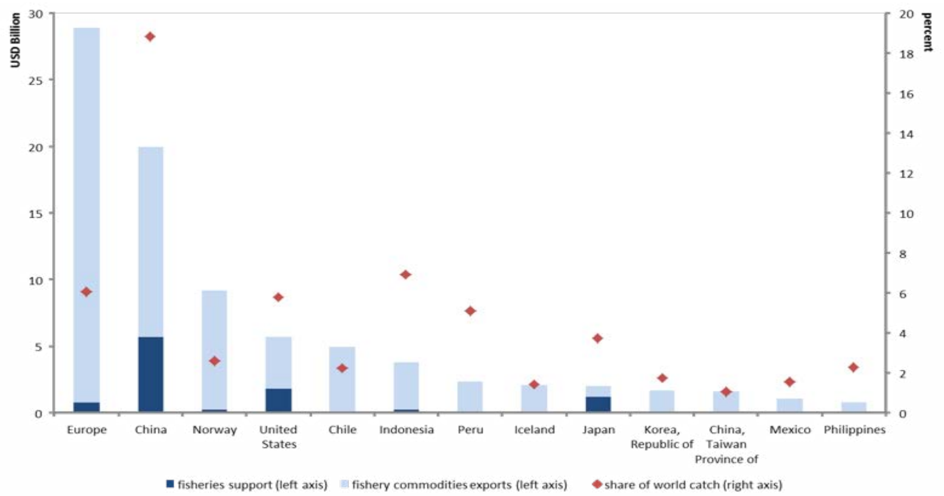
Figure 2.6 compares fisheries' support; fishery commodities exports and world catch data for these countries. Some major producers and exporters of fish and seafood, such as China and the USA, provide important support to fisheries, averaging 30 percent of the value of gross exports. In other countries, including Indonesia, this average is relatively small (6.5 percent). In Japan, a country with a large domestic market, a significant use of fishery support measures (60 percent) may be motivated by internal market demands rather than export motives.

It has also been reported that fisheries subsidies fuel unfair competition, particularly between large fleets and individual artisanal fishermen and foster inequality as 84 percent of all fisheries subsidies tend to benefit large scale fleets (Schuhbauer et al, 2017).

The challenge is to eliminate harmful subsidies and convert its funds for investment in fisheries sustainability to reduce pressure on fish stocks.

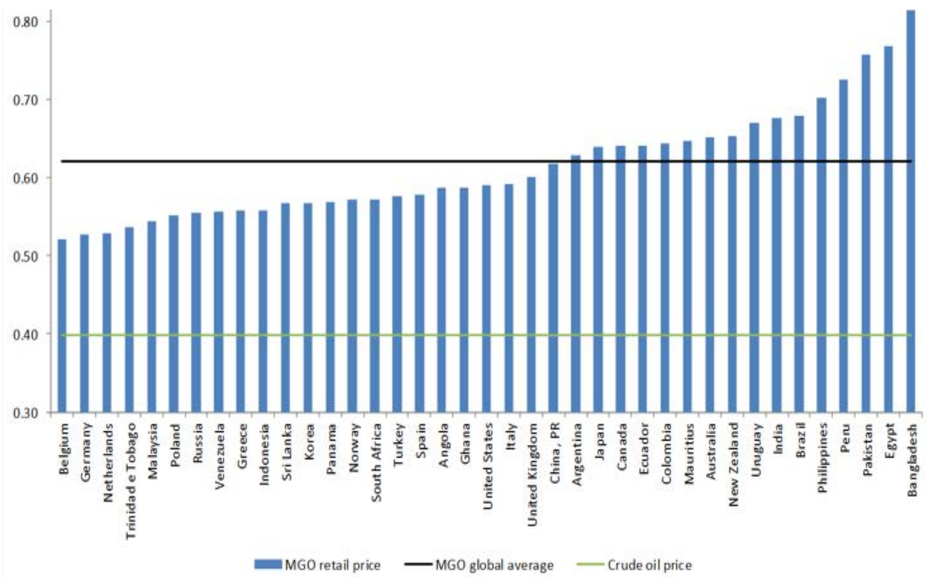
Fuel subsidies, a prominent type of fisheries support has been studied by UNCTAD through a scenario assessment on marine gasoil (MGO) retail prices in the world largest ports. The study shows high variability across countries and regions, with many countries selling largely below the global average price for this type of fuel (Figure 2.7). This may not be a surprise in countries producing oil, such as Russia, Malaysia or Venezuela with dual pricing schemes. In other countries, this suggests the existence of some forms of price support or subsidy maintaining MGO retail prices fairly low in some of the world's major fishing ports.

Figure 2.6. Incidence of support of fishery commodities export of major fishing nations (2015)



Source: UNCTAD, 2018

Figure 2.7. World prices (2018) of Marine Gazoil (MGO) in the world's largest ports



Source: UNCTAD, 2018

3.3.1 Fisheries subsidies at the WTO negotiations

For many years there was a hope to conclude successfully the WTO negotiations on fisheries subsidies. Unfortunately, it is not the case and the immediate future is not promising. Following is a review of the process of negotiations since 2001, for drawing lessons for future negotiations. A WTO agreement on the prohibition of harmful fisheries subsidies would make an important contribution to the sustainability of global fisheries.

In 2001, at the WTO Ministerial Meeting in Doha, countries agreed to clarify and improve WTO rules applicable to fisheries subsidies While the issue of fisheries subsidies had been discussed by the WTO Trade and Environment Committee for many years and, in legal terms, their trade effects were already covered by the WTO Agreement on Subsidies and Countervailing Measures (ASCM). It was not until the issue was specifically mentioned in the Doha Ministerial Conference that fisheries subsidies became a topic within the Negotiating Group on Rules. Notably, the resulting WTO Doha Ministerial Declaration explicitly mentioned the importance of the fishery sector for developing countries.

The original Doha mandate on fisheries subsidies was then further refined at the Hong Kong Ministerial in 2005, where it was agreed that fisheries subsidies rules should be strengthened, including “through the prohibition of certain forms of fisheries subsidies that contribute to overcapacity and overfishing.” Ministers also urged countries to promptly detail future work in this area, “including the nature and extent of those disciplines, including transparency and enforceability.”

In addition, the development aspect mentioned in the Doha Ministerial Conference was further highlighted, with ministers indicating that the negotiations should take into consideration the importance of the fishery sector to development priorities, poverty reduction, livelihood and food security concerns. This call for specific rules on fisheries subsidies resulted from concern about the effect of such subsidies on overfishing and overcapacity—widely considered to be two of the main challenges affecting the sustainability of global fisheries resources.

At the 2017 WTO Ministerial Conference in Buenos Aires, ministers decided on a work programme to conclude the negotiations by aiming to adopt, at the 2019 Ministerial Conference, an agreement on fisheries subsidies which delivers on SDG 14.6. This mandate defines the key policy lines for negotiators to tackle certain fish subsidies by 2020. These policy lines are:

- Prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing
- Eliminate subsidies that contribute to IUU fishing;
- Refrain from introducing new such subsidies;
- Recognize that appropriate and effective special and differential treatment for developing and least developed countries;
- All these should be an integral part of the WTO fisheries subsidies negotiation.

3.3.2. Fisheries subsidies, LDCs and WTO negotiations

Fisheries subsidies in LDCs were estimated by Bahety and Mukibi (2017) at 44 percent for beneficial subsidies and 56 percent for harmful ones. Of the beneficial subsidies, 64 percent were for fisheries management and services, 34 percent for research and 2 percent for MPAs. Of the harmful subsidies, 28 percent for marketing support and storage infrastructure, 18 percent for boat construction and modernization, 19 percent for fuel subsidies and 24 percent for fisheries development and support services. It can be argued that supporting building storage infrastructure or modernizing fishing vessels should not be considered harmful subsidies. In the first case, adequate storage infrastructure is essential for reducing post- harvest losses and therefore improving the value extracted from a fisheries without needing to fish more. Modernizing fishing vessels to improve safety of the fishermen at sea and the hygienic conditions on board the vessels, in particular small-scale vessels improves fish quality.

The fisheries subsidies negotiations have largely focused on production from marine wild capture fishing, as distinct from production from aquaculture. In the case of aquaculture, the existing WTO rules on subsidies are already able to regulate government support measures to the sector. A farmed fish product is a national product produced in the territory of a country and thus is no different from other domestic products covered by the current rules.

For capture fishing operations in areas outside national jurisdictions, however, the fish has no specific origin before it is caught and can be considered a common good. If subsidies are provided in some countries to promote this particular fishing activity, access to the resource at sea as well as trade of the product can be distorted. Taking into consideration that the general pattern of trade involves developing countries supplying fish to developed countries, the distortion of access to resources caused by subsidies can particularly affect developing countries, with negative spillover effects on income generation, poverty alleviation, food and nutrition security. In addition, unsustainable wild capture fishing can have environmental impacts that are borne by, or are of concern to countries other than the fishing nation.

At the WTO, the proposals under discussion and the associated debate gravitate around specific issues that could be addressed in future rules on fisheries subsidies, including concepts like overfishing, overfished stocks, overcapacity, small-scale and artisanal fisheries, RFMOs and IUU fishing. For example, among the proposals under discussion are prohibiting subsidies to any stock that was assessed to be overfished, prohibiting just those subsidies with negative impacts on an overfished stock or even subsidies to vessels that target an overfished stock. In all cases, the operationalization of the disciplines would require tackling the issue of determining when a stock can be considered overfished, and what to do in the case of stocks which are currently unassessed because of insufficient scientific information.

Because trade demands and trade regulations affect marine resources, international trade initiatives can be part of the solution to sustainable oceans and fisheries development. This is one of the main reasons why the negotiations on fisheries subsidies have been on-going at the WTO for the last 15 years. Over the years, some of the initial positions taken by member countries have changed and views have converged on certain issues. But some radical differences of opinions remain.

During the same period, the UNCTAD-FAO-UNEP Joint Declaration for regulating fisheries subsidies has garnered support from many countries and independent organizations. Other initiatives include, the United States' push for a plurilateral agreement with like-minded countries for fisheries subsidies rules. These developments have ensured that fisheries subsidies remain on the international agenda. However, there is fear that due to the progress made outside the WTO, there could be a reduced urgency to further the negotiations at the WTO.

Yet, in terms of development implications, many economically smaller coastal developing countries, such as the SIDS countries, ACP States and LDCs have an interest in focusing attention on fisheries subsidies and carrying the proposed rules through to agreement in the multilateral and legally binding WTO context. They should seek to limit subsidies by developed and large developing countries to fleets that fish on overfished stocks, in order to improve the chances of their domestic producers, and at the same time potentially benefit long-term sustainability and food security in all countries.

It is important to achieve an outcome on fisheries subsidies disciplines. This should be a priority for LDCs to be actively pursued both within the group, and bilaterally with the main players with the objective of success by the next WTO Ministerial Conference in 2019. As a first step focus could be on the areas where there is general consensus, these being the need to address IUU fishing as well as subsidies for overcapacity. Special and differential treatment remains a problem given that among the developing countries, there are big providers of subsidies making it difficult to agree on blanket exemptions in this regard.

Reaching an agreement may require de-linking fisheries from other negotiation issues, since some members are unwilling to continue deliberations under the DDA setting that provided for single undertaking. In this respect initiatives such as Peru's proposal premised on SDGs commitments could be a means of de-linking fisheries negotiations from other DDA issues.

It may also be useful to bring on board the emerging economies like China that has a large fleet of distant water fishing vessels. This may require a carve out of concessions that would for instance allow these emerging economies to maintain support of their small fleets, since they also have a sizeable population still faced with similar challenges to those in smaller developing countries and LDCs. LDCs in their approach to the negotiations on fisheries subsidies should clearly express their development concerns given that the sector is critical for food security, employment and poverty eradication efforts. Away from political and tactical considerations, there is general consensus amongst WTO members to assist LDCs in overcoming such challenges.

Chapter 3: The potential of aquaculture production to sustain food security, human nutrition and economic growth

This chapter compiles information on global aquaculture opportunities and challenges, policy analyses and examples of relevance to many developing countries aspiring to develop sustainable aquaculture, with a special focus on LDCs, Asian and African countries. The key messages are:

- Aquaculture systems are diverse using inland and marine waters, fed and non-fed species, raising fish, bivalves or seaweeds, with various nutritional and environmental requirements;
- Aquaculture has experienced significant growth for decades. It is expected to play an important role for fish supply from LDCs, but with different challenges for African and Asian developing countries
- The future of aquaculture development requires robust legal and institutional frameworks that address biosecurity, sustainable seed selection and feed supply, environmental protection and social responsibility as well as compliance with residue monitoring plans.

1. INTRODUCTION

In 2018, UNCTAD published a manual on "Harnessing the Potential of Aquaculture for Export Diversification and Sustainable Development of Developing Countries in Africa and Asia". The UNCTAD manual analyzed policy challenges and options for addressing these challenges using the case of Vietnam to illustrate concretely how the options were weighted to address diverging priorities, to adapt the proposed solutions to local conditions in terms of species, level of technical know-how, size of the enterprises and knowledge of market requirements. The lessons learned and presented in that manual (UNCTAD, 2018a) can be very useful and are strongly recommended to policy makers in developing countries, in particular for countries in Asia and Africa facing similar challenges and producing similar species for international markets.

This Chapter 3 will expand on that manual enriching it with information on global aquaculture opportunities and challenges, additional policy analyses and examples of relevance to many developing countries aspiring to develop aquaculture, with a special focus on LDCs, Asian and African countries. In general, many countries in Asia, particularly in South and South East Asia, have had a long history of aquaculture development and are leading the global context in terms of production volumes and export. Few other countries in Asia and most African countries are still far behind, despite a recognized potential in their untapped large maritime and inland waters spaces. So far the case of most African countries, except Egypt, Nigeria, Zambia,…) have experienced limited or no aquaculture development, in particular marine aquaculture. Total African production of farmed aquatic animals and plants amounted to 2.5 percent of the global production in 2016, including 1.7 percent produced in Egypt alone (table 3.1). For a continent that has experienced over 7 percent yearly economic growth during the last 15 years, suffers from overexploitation of marine fisheries and has a high demand for affordable fish and seafood, it is important to analyze the reasons why aquaculture has not attracted the necessary investment for its development. This is even more important because of the strong political will expressed by African leaders to make fisheries and aquaculture leading sectors for food security, employment, in particular for youth, and for wealth creation. Equally important, aquaculture development is strongly considered for reducing pressure on wild fisheries. This presents a unique opportunity, both for North-South and for South-South cooperation to transfer know how from Asia and attract investment, including Direct Foreign Investment (DFI) into aquaculture development. DFI has been shown to catalyze rapid and efficient transfer of know-how and best practices.

2. GLOBAL AQUACULTURE PRODUCTION: KEY FACTS AND FIGURES

In 2018, FAO produced the State of Food and Aquaculture (SOFIA) which provides detailed information on aquaculture production, consumption and trade worldwide. In addition to information on global production by continent, region and species, it also summarizes key issues that have hampered aquaculture development recently and main global and regional analyses of relevance to the sector. SOFIA is a highly recommended reading for any person interested in aquaculture. The following is a summary of SOFIA 2018 (FAO, 2018) relevant to this workshop, with a particular focus on Asia and Africa.

Aquaculture production was 106 million tonnes in live weight, with a total estimated first-sale value of USD163 billion in 2016 (Table 3.1). This production comprised farmed aquatic animals, aquatic plants and non-food products (pearls and shells). The total production included 80.0 million tonnes of fish and seafood for human consumption (food fish) and 30.1 million tonnes of aquatic plants as well as 37 900 tonnes of non-food products (mainly feed). Farmed fish for human consumption included 54.1 million tonnes of finfish, 17.1 million tonnes of molluscs, 7.9 million tonnes of crustaceans and some 940 000 tonnes of other aquatic animals such as turtles, sea cucumbers, sea urchins, frogs and edible jellyfish. Farmed aquatic plants included mostly seaweeds and a much smaller production volume of microalgae. The non-food products included only ornamental shells and pearls.

Aquaculture contributed 46.8 percent of total fish and seafood production in 2016, up from 25.7 percent in 2000. If China's production is not included, aquaculture's share reached 29.6 percent in 2016, up from 12.7 percent in 2000. At the regional level, aquaculture accounted for 17 to 18 percent of total fish production respectively in Africa, the Americas and Europe, followed by 12.8 percent in Oceania. The share of aquaculture in Asian fish production (excluding China) increased to 40.6 percent in 2016, up from

Table 3.1. Aquaculture Production of main groups of fish species by continent, 2016

Inland aquaculture	Africa	Americas	Asia	Europe	Oceania	World
Finfish	1 954	1 072	43 983	502	5	**47 516**
Crustacea	0	68	2 965	0	0	**3 033**
Molluscs			286			**286**
Other aquatic animals		1	531			**531**
Subtotal	**1 954**	**1 140**	**47 765**	**502**	**5**	**51 367**
Marine and coastal aquaculture						
Finfish	17	906	3 739	1 830	82	**6 575**
Crustacea	5	727	4 091	0	6	**4 829**
Molluscs	6	574	15 550	613	112	**16 853**
Other aquatic animals	0		402	0	5	**407**
Subtotal	**28**	**2 207**	**23 781**	**2 443**	**205**	**28 664**
All aquaculture						
Finfish	1 972	1 978	47 722	2 332	87	**54 091**
Crustacea	5	795	7 055	0	7	**7 862**
Molluscs	6	574	15 835	613	112	**17 139**
Other aquatic animals	0	1	933	0	5	**939**
TOTAL	**1 982**	**3 348**	**71 546**	**2 945**	**210**	**80 031**

Source: (FAO, 2018)

[17] http://www.fao.org/3/i9540en/I9540EN.pdf

19.3 percent in 2000. Aquaculture growth rate was 5.8 percent annually during the period 2001– 2016, much slower compared to its previous rates of 10.8 percent and 9.5 percent respectively during the 1980s and 1990s. Nevertheless, aquaculture continues to grow faster than other major food production sectors, namely crops, livestock and poultry.

3. AQUACULTURE SYSTEMS AND SPECIES

Aquaculture systems range from very extensive, through semi-intensive to highly intensive aquaculture (Funghe-Smith and Philip, 2001). When using this terminology, the specific characterization of each system must be defined, as there are no clear distinctions and levels of intensification represent a continuum. Farming systems are also diverse, for example including:

- Water-based systems (cages and pens, inshore/offshore);
- Land-based systems (rainfed ponds, irrigated or flow-through systems, tanks and raceways);
- Recycling systems (high control enclosed systems, more open pond-based recirculation);
- Integrated farming systems (e.g. livestock-fish, agriculture and fish dual use aquaculture and irrigation ponds);

Various aquatic organisms are grown in different ways including:

- Fish (ponds, polishing ponds, integrated pond systems);
- Seaweeds and macrophytes (floating/suspended culture, onshore pond/tank culture);
- Molluscs (bottom, pole, rack, raft, long-line systems, culture- based fisheries);
- Crustaceans (pond, tank, raceway, culture-based fisheries);
- Other minor invertebrates, such as echinoderms, coelenterates, seahorses, etc (tanks, ponds, culture-based fisheries);

The phases of aquaculture include brood stock holding, hatchery production of seed, nursing systems, grow-out systems, and quarantining.

Together, this mix of intensity, culture systems, species, farming systems and different phase of culture create a very diverse collection of aquaculture systems and technologies. Global aquaculture statistics report on production data by distinguishing inland from marine aquaculture and whether the species are fed on not, in addition to specific data on plants and micro-algae (FAO, 2018a).

3.1. Inland aquaculture

World production of farmed food fish relies increasingly on inland aquaculture, which is typically practiced in a freshwater environment in most countries. In a small number of countries (e.g. China and Egypt), aquaculture with saline-alkaline water is carried out with suitable species in areas where soil conditions and the chemical properties of available water are inhospitable for conventional food grain crops or pasture. Earthen ponds remain the most commonly used type of facility for inland aquaculture production, although raceway tanks, above-ground tanks, pens and cages are also widely used where local conditions are favorable. Rice–fish farming remains important in areas where it is traditional (Bangladesh, India, etc.), but it is also expanding rapidly elsewhere, especially in Asia (e.g. Indonesia). Rice-fish culture is good for both the fish and the rice. Safely hidden from birds, the fish or shrimp thrive in the dense rice plants, while they in turn provide a source of fertilizer with their droppings, eat insect pests and help to circulate oxygen around the rice field. Farmers tell us that keeping fish in rice fields can increase rice yields by up to 10 percent– plus they have the additional supplies of fish, in addition to a lower need for pesticides.

In 2016, inland aquaculture produced 51.4 million tonnes of food fish, or 64.2 percent of the world's farmed food fish production (Table 3.1), as compared with 57.9 percent in 2000. Finfish farming dominates inland aquaculture, accounting for 92.5 percent (47.5 million tonnes) of the total, but this proportion was down from 97.2 percent in 2000, due to strong growth in the farming of other species, particularly crustaceans in Asia, including shrimps, crayfish and crabs. Inland aquaculture production includes some marine shrimp species, such as white-leg shrimp, that can grow in freshwater or inland saline-alkaline water after acclimatization.

3.2. Marine and coastal aquaculture

Marine aquaculture, also known as mariculture, is practiced in the sea, while coastal aquaculture is practiced in completely or partially man-made structures in areas adjacent to the sea, such as coastal ponds and gated lagoons. In coastal aquaculture with saline water, the salinity is less stable than in mariculture because of rainfall or evaporation, depending on the season and climate. Marine aquaculture production was estimated at 28.7 million tonnes in 2016. In sharp contrast to the dominance of finfish in inland aquaculture, shelled molluscs (16.9 million tonnes) constitute 58.8 percent of the combined production of marine and coastal aquaculture. Finfish (6.6 million tonnes) and crustaceans (4.8 million tonnes) together amounted to 39.9 percent (Table 3.1).

3.3. Aquaculture production with and without feeding

The share of unfed species in total aquaculture production decreased from 41 percent in 2000 to 30.5 percent in 2016. In 2016, the total unfed species production reached 24.4 million tonnes, consisting of 8.8 million tonnes of filter-feeding finfish raised in inland aquaculture (mostly silver carp and bighead carp) and 15.6 million tonnes of aquatic invertebrates, mostly marine bivalve molluscs raised in seas (oysters, mussels, scallops, etc.) lagoons and coastal ponds.

In Asia, Central and Eastern Europe and Latin America, filter-feeding carps are typically raised in multispecies polyculture farming systems, which enhance fish production by using natural food and improving the water quality in the production system. In recent years, another filter feeding finfish species, Mississippi paddlefish (Polyodon spathula), has emerged in polyculture in a few countries, particularly in China, where the production volume is estimated to be several thousand tonnes.

Marine bivalves, which extract organic matter for growth, and seaweeds, which use photosynthesis to grow by absorbing dissolved nutrients, are sometimes described as extractive species. When farmed in the same area with fed species, they are very beneficial to the environment from which they eliminate waste materials, including waste from fed species, and therefore lowering the nutrient load. Integrated culture of extractive species along with fed species in the same sites is highly encouraged in aquaculture development planning and zoning. Extractive species production accounted for 49.5 percent of total world aquaculture production in 2016.

3.4. Aquatic plants

In 2016, 96.5 percent by volume of total aquatic plants was produced by aquaculture, the rest came from the harvest of wild plants. Global production of farmed aquatic plants, overwhelmingly dominated by seaweeds, reached 30 million tonnes in 2016, as compared to 13.5 million tonnes in 1995. This rapid growth was driven by seaweed production in Indonesia to supply units for carrageenan extraction. Indonesia increased its seaweed farming output from less than 4 million tonnes in 2010 to over 11 million tonnes in 2015 and 2016.

In addition, some 89 000 tonnes of microalgae were produced by some 11 countries in 2016, although most of it (88 600 tonnes) were reported from China. Farming of microalgae such as Spirulina spp., Chlorella spp. and others, was destined for production of human nutrition supplements and other uses

3.5. Major producers

Some 194 countries have reported some aquaculture production in the past few years. However, Asia has accounted for almost 89 percent of world aquaculture production for over two decades (Table 3.2). A few countries dominate the production of main groups of farmed aquatic animals. Inland finfish farming is dominated by developing countries, while several developed countries are major contributors to world marine finfish farming, especially cold-water species. Marine shrimps dominate the production of crustaceans typically farmed in coastal areas and are an important source of foreign exchange earnings for several developing countries in Asia and Latin America.

Although the quantity of marine molluscs produced by China dwarfs that of all other producers, several countries in all regions rely rather heavily on mussels, oysters and, to lesser extent, abalone for their aquaculture production.

Table 3.2. Aquaculture food fish production by region and selected major producers (thousand tonnes; figures in brackets are percentage of world total)

Region/selected countries	1995	2000	2005	2010	2015	2016
Africa	**110 (0.5)**	**400 (1.2)**	**646 (1.5)**	**1 286 (2.2)**	**1 772 (2.3)**	**1 982 (2.5)**
Egypt	72 (0.3)	340 (1.1)	540 (1.2)	920 (1.6)	1 175 (1.5)	1 371 (1.7)
Northern Africa, not including Egypt	4 (0)	5 (0)	7 (0)	10 (0)	21 (0)	23 (0)
Sub-Saharan Africa, not including Nigeria	17 (0.1)	29 (0.1)	43 (0.1)	156 (0.3)	259 (0.3)	281 (0.4)
Americas	**920 (3.8)**	**1 423 (4.4)**	**2 177 (4.9)**	**2 514 (4.3)**	**3 274 (4.3)**	**3 348 (4.2)**
Chile	157 (0.6)	392(1.2)	724 (1.6)	701(1.2)	1 046 (1.4)	1 035 (1.3)
Rest of Latin America and the Caribbean	284 (1.2)	447 (1.4)	785 (1.8)	1 154 (2.0)	1 615 (2.1)	1 667 (2.1)
North America	479 (2.0)	585 (1.8)	669 (1.5)	659 (1.1)	613 (0.8)	645 (0.8)
Asia	**21 678**	**28 423**	**39 188**	**52 452**	**67 881**	**71 546**
	(88.9)	**(87.7)**	**(88.5)**	**(89.0)**	**(89.3)**	**(89.4)**
China (mainland)	15 856	21 522	28 121	36 734	47 053	49 244
	(65.0)	(66.4)	(63.5)	(62.3)	(61.9)	(61.5)
India	1 659 (6.8)	1 943 (6.0)	2 967 (6.7)	3 786 (6.4)	5 260 (6.9)	5 700 (7.1)
Indonesia	641 (2.6)	789 (2.4)	1 197 (2.7)	2 305 (3.9)	4 343 (5.7)	4 950 (6.2)
Viet Nam	381 (1.6)	499 (1.5)	1 437	2 683 (4.6)	3 438 (4.5)	3 625 (4.5)
Bangladesh	317 (1.3)	657 (2.0)	882 (2.0)	1 309 (2.2)	2 060 (2.7)	2 204 (2.8)
Rest of Asia	2 824 (11.6)	3 014 (9.3)	4 584 (10.4)	5 636 (9.6)	5 726 (7.5)	5 824 (7.3)
Europe	**1 581 (6.5)**	**2 051 (6.3)**	**2 135 (4.8)**	**2 523 (4.3)**	**2 941 (3.9)**	**2 945 (3.7)**
Norway	278 (1.1)	491 (1.5)	662 (1.5)	1 020 (1.7)	1 381 (1.8)	1 326 (1.7)
EU-28	1 183 (4.9)	1 403 (4.3)	1 272 (2.9)	1 263 (2.1)	1 264 (1.7)	1 292 (1.6)
Rest of Europe	121 (0.5)	157 (0.5)	201 (0.5)	240 (0.4)	297 (0.4)	327 (0.4)
Oceania	**94 (0.4)**	**122 (0.4)**	**152 (0.3)**	**187 (0.3)**	**186 (0.2)**	**210 (0.3)**
WORLD	**24 383**	**32 418**	**44 298**	**58 962**	**76 054**	**80 031**

Source: (FAO, 2018)

4. CHALLENGES

Globally, aquaculture has been responsible for filling the gap between supply and demand of fish and seafood for human consumption. China in particular, and Asia in general have played a major role in this aquaculture growth as they represent respectively more than 60 percent (China) and some 89 percent (Asia) of world aquaculture production. However, this significant growth of aquaculture has raised major concerns over its environmental impact and some of its unsustainable models.

Aquaculture sites have often been carved out of important natural coastal habitats with rapid expansion exceeding the capacity of planning controls and oversight. Development in aquaculture of fed species, when poorly managed, has affected key biodiversity and ecosystem functions through mangrove deforestation, excessive nutrient release, chemical pollution and the escape of farmed species and disease agents into the natural environment. Major causes of impact have been associated with feeding and nutritional wastes, the emergence and spread of diseases and the interbreeding of wild and selected strains. Another major challenge to aquaculture, considered a viable venue for food security and nutrition and international market supply, is the control and prevention of irresponsible use of antimicrobials, which is contributing to the development of antimicrobial resistance, considered a major threat to human health during the 21st century .

FAO and OECD (2018) prepare a yearly report called Food outlook which makes assumptions and projections over a ten-year period for various food commodities. Chapter 8 of the Food Outlook is dedicated to fish and seafood. It is worth highlighting that the current projections for fisheries and aquaculture are highly affected by the China's five-year plan (2016-2020) that aims to, among other things, improve efficiency and sustainability in its fisheries and aquaculture sector, with potentially substantial reductions in production growth and increases in prices. World fish production is expected to continue growing, although the overall growth is expected to be relatively low, with total production increasing by 13.4 percent between 2016 and 2027 and an annual average growth rate only slightly above 1 percent. This is around half the increase rate seen in the previous decade (27.1 percent). This global growth will result solely from continued but slowing growth in aquaculture output, which is expected to increase by 30.1 percent over the outlook period (24 M tonnes) and overtake total capture fisheries in 2020.

However, a number of uncertainties and challenges exist that influence the evolution and dynamics of aquaculture sector. Factors of uncertainty that may affect these projections are:

- Conflicts of use, directly or indirectly related to access to land, water and the public maritime domain;
- Availability of quality feed for aquaculture;
- Supply of quality seeds and access to aquatic genetic resources;
- Integrity of the environment and the risks of diseases and their spread within and across territories;
- Development and adoption of new or improved aquaculture technologies, in particular technologies that rely less on fishmeal and fish oil, minimize water use and effluent release and that make high sea aquaculture economically accessible and competitive;
- Evolution of markets, international trade and food security and their influence on market access requirements and prices;
- Climate change;
- impediments to investment; and
- Enforcement of best aquaculture practices.

Climate change and the extreme weather events they cause need increased attention. A business as usual scenario is not possible anymore. Climate change events exacerbate the threats to sustainable fisheries and aquaculture. It is still difficult and complex to quantify and predict these effects, which will vary across countries and regions, with a special impact on coastal countries. It is quite likely that they will influence effect on the distribution of marine species,

[18] https://www.who.int/antimicrobial-resistance/global-action-plan/en/

which will be redeployed according to their thermal preferences and to avoid areas of low oxygen content. Fish population size, breeding cycles or survival rates will also be affected.

The effects of climate change on aquaculture can be significant, encompassing the progressive acidification and warming of marine waters, rising sea levels and the resulting intrusion of salt water, as well as extreme phenomena such as variation in the frequency and intensity of storms. For aquaculture, climate change will affect not only fish production, but also the infrastructure, inputs and services needed to fish and practice aquaculture. It should also affect prices, trade and consumption of fish and aquaculture products by changing competitiveness and disrupting habits. It is therefore imperative to integrate climate change adaptation and mitigation measures into policies and strategies for sustainable aquaculture development.

5. THE FUTURE OF AQUACULTURE DEVELOPMENT

Aquaculture development in the coming decades is necessary, expected and doable, including in developing countries of Asia and Africa. Aquaculture development will be challenged by stricter environmental, social and consumer protection requirements, many driven by international markets. More than ever before, aquaculture development should therefore be responsible and sustainable, respecting international, regional and national regulations and standards of aquaculture best practices which integrate economic, social and environmental aspects. The implications will be significantly different for various countries, depending on whether they have been active in aquaculture production (e.g. many Asian countries) or aspiring to invest in this sector in the near future (e.g. African countries). For major producers in Asia, this means adopting and implementing policies, laws, regulations and best practices that protect effectively the environment and promote social responsibility in aquaculture operations. In Africa, where aquaculture in almost inexistent except in few countries, this requires the establishment of an enabling environment to attract investment into aquaculture. It gives Africa an opportunity to start on the right footing, building on experiences from other parts of the world and adapting internationally promoted best practices.

Issues that need high level of attention relate to proper aquaculture planning, accessibility and availability of sites and water resources, accessibility to technology and finance reducing environmental degradation and habitat destruction, adaptation to and mitigation of climate change, weather patterns, poor governance, invasion of non-native species, diseases and escapes,. A key starting instrument for responsible aquaculture policies is the CCRF (FAO, 1995). In its article 9, the CCRF addresses:
National legal and administrative framework

• States should establish, maintain and develop an appropriate legal and administrative framework which facilitates the development of responsible aquaculture.

• They should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.

Responsible aquaculture development in waters within national jurisdiction.

• States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

• In so doing, States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments.

• States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities. Responsible aquaculture within transboundary eco-systems.

• States should protect transboundary aquatic ecosystems by supporting responsible aquaculture practices within their national jurisdiction and by cooperation in the promotion of sustainable aquaculture practices.

• They should, with due respect to their neighboring States and in accordance with international law, ensure responsible choice of species, siting and management of aquaculture activities which could affect transboundary aquatic ecosystems.

• States should consult with their neighboring States, as appropriate, before introducing non-indigenous species into transboundary aquatic ecosystems.

• States should establish appropriate mechanisms, such as databases and information networks to collect, share and disseminate data related to their aquaculture activities to facilitate cooperation on planning for aquaculture development at the national, subregional, regional and global level.

• States should cooperate in the development of appropriate mechanisms, when required, to monitor the impacts of inputs used in aquaculture.

Use of aquatic genetic resources

• States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin.

• States should, whenever possible, promote steps to minimize adverse genetic, Disease and other effects of escaped farmed fish on wild stocks.

• States should cooperate in the elaboration, adoption and implementation of international codes of practice and procedures for introductions and transfers of aquatic organisms.

• States should, in order to minimize risks of disease transfer and other adverse effects on wild and cultured stocks, encourage adoption of appropriate practices in the genetic improvement of brood stocks, the introduction of non-native species, and in the production, sale and transport of eggs, larvae or fry, bloodstock or other live materials.

• States should facilitate the preparation and implementation of appropriate national codes of practice and procedures to this effect.

• States should promote the use of appropriate procedures for the selection of bloodstock and the production of eggs, larvae and fry. States should, where appropriate, promote research and, when feasible, the development of culture techniques for endangered species to protect, rehabilitate and enhance their stocks, taking into account the critical need to conserve genetic diversity of endangered species.

Responsible aquaculture at the production level

• States should promote responsible aquaculture practices in support of rural communities, producer organizations and fish farmers.

• States should promote active participation of fish farmers and their communities in the development of responsible aquaculture management practices.

• States should promote efforts which improve selection and use of appropriate feeds, feed additives and fertilizers, including manures.

• States should promote effective farm and fish health management practices favoring hygienic measures and vaccines. Safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals should be ensured.

• States should regulate the use of chemical inputs in aquaculture which are hazardous to human health and the environment. States should require that the disposal of wastes such as offal, sludge, dead or diseased fish, excess veterinary drugs and other hazardous chemical inputs does not constitute a hazard to human health and the environment.

• States should ensure the food safety of aquaculture products and promote efforts which maintain product quality and improve their value through particular care before and during harvesting and on-site processing and in storage and transport of the products.

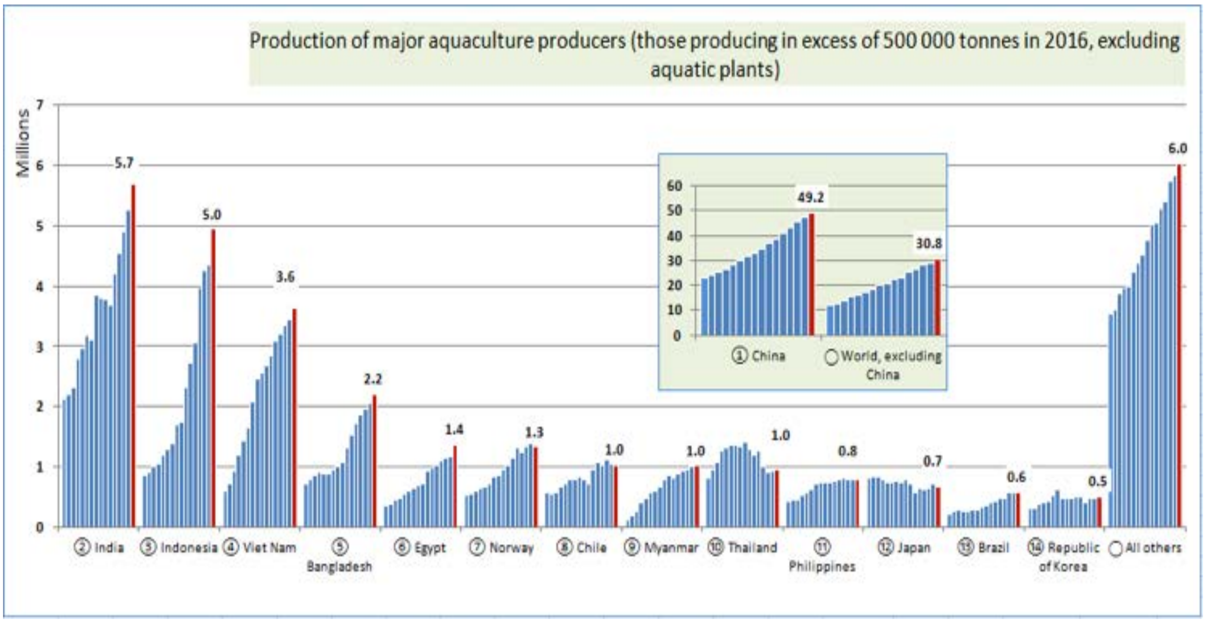
Whereas the first four sets of requirements for responsible aquaculture development are the responsibility of the government, in close consultation with farmers and other key stakeholders from the sector and from other sectors using the marine or inland waters space (e.g. tourism, transport, environment, etc.), the latter is the responsibility of aquaculture operators. The role of Government institutions consists of regulating, enforcing and facilitating the work of aquaculture operators. As for previous aspects of responsible fisheries and aquaculture addressed by the CCRF, guidelines and strategies have been developed to assist in the implementation of the provisions of article 9 of the CCRF. These are referred to in this Chapter as and where needed.

5.1. Future of Aquaculture in Asia

Differently from the rest of the world, Asia is the center of world aquaculture development. 10 of the 13 major producers and exporters of aquaculture are from Asia (figure 3.1) (FAO, 2018a). Although, there is a potential for some growth in specific geographies and for some species, aquaculture growth in Asia will mostly come from improved performance, efficiencies and innovations. The main challenges rest with the capacity of Asia to consolidate its leadership in aquaculture production and export, while embracing and enforcing internationally recognized best aquaculture practices and environmentally and socially sound policies.

Historically, Asia has always dominated global aquaculture production, and this trend is continuing. Comprehensive regional aquaculture reviews (FAO/NACA, 2011; APFIC, 2014; FAO, 2016b), have confirmed this trend. The bulk of aquaculture production comes from China, South Asia (mainly Bangladesh, India, Pakistan) or Southeast Asia (Indonesia, Philippines, Thailand and Viet Nam). Aquaculture growth in Asia has been possible because also of the significant Asian economic growth. The developing economies of Asia grew at an average 7.6 percent a year between 1990 and 2010, far exceeding the 3.4 percent global average. The rise in affluence, in conjunction with growing populations (the latter at a reduced rate), will continue to drive greater demand for more protein-rich food and better nutrition. According to OECD (2018), the size of the "global middle class" will increase from 1.8 billion in 2009 to 3.2 billion by 2020 and to 4.9 billion

Figure 3.1. Major aquaculture producers (FAO, 2018b)



Source :(FAO,2018b)

[20] http://dx.doi.org/9789264286184-en

by 2030. The bulk of the growth will come from Asia. By 2030 Asia will represent 66 percent of the global middle-class population and 59 percent of middle-class consumption, compared to 28 percent and 23 percent respectively in 2009. Middle class consumers are high fish consumers and more concerned about sustainability of food production. This has enormous implications for the intensity of production, including aquaculture production.

Aquaculture development in Asia has taken different trajectories depending on the country, its social, economic and political environments. But there are cross cutting areas that hamve shaped up aquaculture development in these different regions. These relate to:

- The governance and management frameworks of aquaculture;
- The farm systems;
- Access to investment land and water resources;
- Supply of feed;
- Supply of seeds;
- Aquatic animal health;
- Technology and innovations;
- Environmental integrity; and
- Marketing and trade.

Of particular interest is the case of Vietnam (UNCTAD, 2018a) that has successfully developed its aquaculture sector by addressing these areas with an additional and specific focus on the following:

- Ahead of the curve research and Development (R&D);
- Effective linkages between R&D facilities with the aquaculture farms and the industry;
- Increased participation of the private sector, including in supporting R&D institutions as well as teaching and technical training centers;
- Public Private Partnerships (PPPs) in aquaculture development;
- Risk mitigation through subsidized insurance systems including lower premiums for farms.

Based on the above cited reports, following is consolidation of an analysis of the status and trends, the challenges and the proposed way forwards for these major thematic areas.

5.1.1 Governance and management

Asia may have been somewhat complacent about the improvements to aquaculture governance over the past decade. However, aquaculture governance will become much even more important in the future, as the sector marches ahead. All four facets of sustainability – economic, environmental, social and technical – will face challenges in the coming decades. Some of the likely challenges that are intrinsic to the Asian aquaculture industry as it grows include the emergence of oligopolies in the production of certain species, reconciling competing claims to water and land, the need to manage aquaculture within a deteriorating ecosystem, vocal opposition from NGOs and funding of local research. These all are fully relevant to the Asia-Pacific region and should be addressed when changing/improving appropriate policies and regulatory frameworks that govern better aquaculture.

In Asia, currently most marine aquaculture operations occur in areas under the sovereignty or national jurisdiction of the coastal state. Countries may endeavor to expand aquaculture further offshore. Although this may not happen in the immediate future, the sector will compete with other activities, particularly those related to the utilization of living and mineral resources, and to tourism, navigation and communication. Thus, one of the biggest challenges facing policy-makers in Asia - will be to establish international policy, institutional, legal and regulatory frameworks/regimes for marine aquaculture operations in the high sea.

While many countries in Asia have made commendable efforts to set up policies, administrative, legal and regulatory frameworks to properly develop and manage aquaculture, some countries in the region are still lagging far behind. Moreover, in some of the countries that have made conducive policies, implementation is delayed by the lack of financial and skilled human resources. Policies and regulations may be enacted, but unless there are enough government personnel with adequate skills and financial resources to monitor and enforce them, they will remain ineffective. This issue must be addressed without delay if the aquaculture sector in Asia is to develop sustainably. The Governance and management focus on the following issues:

Farming systems: In many respects, Asia has set the trend for aquaculture production in relation to farming systems. Being the region producing the lion's share of global aquaculture, Asia deploys diverse aquatic farming systems using extensive, semi-intensive and/or intensive production practices, in all major aquatic environments including freshwater, brackishwater and marine waters. Systems range from small-scale backyard-type low technology operations to sophisticated, high technology industrial ones, reflecting an increasing trend of modernization and intensification of aquaculture throughout the region. The aquaculture systems include ponds, cages, pens, raceways and other systems, depending on the species cultured and the availability of land and water in the locality. Pond culture has been the dominant production system in the region for most species of finfish and crustaceans (mostly shrimps and prawns).

Culture of freshwater fish (carps and especially tilapias) in cages is also common in some parts of the region (particularly in Southeast Asia). High technology industrial-level offshore cage systems have recently been introduced for culturing high value marine species such as Asian seabass/barramundi (Lates calcarifer), groupers (Epinephelus spp., Cromileptes altivelis and Plectropomus leopardus) and cobia (Rachycentrum canadum) in some Southeast Asian countries. However, offshore cage farming may not become widespread in Asia, as its development is clearly hampered by the necessity of important capital investment and the hydrography of the surrounding seas, which does not allow the technology to be easily transferred.

Integrated rice-fish culture is practiced in traditional freshwater agriculture systems in Southeast Asia, particularly in China, Indonesia and the Philippines. In a few countries like Bangladesh and Viet Nam, alternate cropping of rice and shrimp is practiced in some coastal areas, maximizing year-round productivity in keeping with the natural climatic conditions. In Bangladesh, most shrimp (Penaeus monodon) farmers practice very low technology pond aquaculture with marginal unit production (less than 250 kg per ha per year). A success story in Bangladesh has demonstrated that clustering farmers into groups and empowering them with technical advice, better management practices (BMPs) and minimal financial support could increase production up to one tonne per ha per year (Kassam, Subasinghe and Philip, 2011).

Aquaculture development in Asia is a success story. Asian Aquaculture progressively improved and matured over the past four decades and has remained ahead of the rest of the world. Use and utilization of land and water in different environments has been impressive. Species composition in Asian aquaculture is diverse, reflecting the huge regional diversity. Applied research into aquaculture and the application of scientific findings in practice has improved massively, with strong private sector participation. Awareness of environmental impacts of aquaculture in the region has gained importance and traction in national aquaculture development policies. As the sector is being intensified, it is investing in innovations that allow higher per unit productivity and reduced costs of production.

However, there are several outstanding issues concerning the future. There is a need to accelerate the development and expansion of mariculture in the region. Mariculture sector growth is not as impressive as that of freshwater finfish and crustaceans. The major reasons include (a) insufficient hatchery produced seed; (b) lack of affordable formulated feed; (c) inadequate investment; and (d) low levels of technology transfer, state priority and patronage.

Although Asia produces nearly 90 percent of global aquaculture, the efficiency of aquaculture is low and this should be improved through intensification and applying novel technologies. There is a need to protect small-scale aqua farmers by providing technical and financial support and empowering them to improve their production systems and practices to be competitive with those of larger producers. There is also a need to further improve data and statistics on aquaculture to enable proper planning that is vital for its sustainability.

Asian aquaculture is poised to expand (in countries where land and freshwater are not scarce) and intensify (in countries where aquaculture is well established), with increased involvement of the private sector. Production in Asia is expected to increase in order to meet the growing global and regional demands for fish in the coming decade. The sector should grow while improving its sustainability, providing increasing quantities of aquatic food that is safer to eat, socially responsible and with reduced environmental impacts.

Land and water resources: Land and freshwater resources available for aquaculture in Asia are becoming increasingly scarce, the main reasons being the expansion of aquaculture itself and the demand for land and water for other human activities. Available freshwater resources are also becoming polluted through pesticide runoff and other land-based activities, while coastal and nearshore brackish and marine areas are becoming congested by artisanal fisheries, tourism and urbanization. Many countries in the region prioritize agriculture as the main use of their freshwater resource (second to drinking) thus making freshwater availability a continuing issue for expansion of aquaculture. Consequently, some countries such as China are moving some aquaculture offshore where appropriate.

Feed: Although the world produces an array of aquatic animal herbivores, omnivores and carnivores, the current trend is to provide supplementary feed to many species grown in commercial systems. In the coming decades, not only feeding the world, but also feeding aquaculture, has become an important issue. Since nearly 90 percent of global aquaculture production is from Asia, the issue of aquaculture feeds is an important regional subject.

Asia is the largest user of farm-made and industrially produced aquafeeds in the world. There are many controversies associated with feeds, primarily regarding the use of fishmeal and fish oil in aquaculture (Han et al., 2016). Asian aquaculture has its share of these, given its large and increasing utilization of fishmeal and trash/low-value fish (De Silva and Turchini, 2009).

In nutritionally wholesome aquafeed, the protein component is the costliest, often accounting for more than 60 percent of the cost of feed. Of all the protein sources, fishmeal is the preferred protein source for fed aquaculture because of the balanced amino acid profile, phospholipids and favorable fatty acid composition, palatability and easy digestion and absorption. A study in China indicated that imported fishmeal usage in Chinese aquaculture has been stable from 2000 to 2014, despite the sharp increase of aquafeed production in the country (Han et al., 2016).

Asia will continue to produce more fish and fish feed and will certainly utilize more feed resources than it does now. However, research into replacement of scarce and expensive ingredients, such as fishmeal and fish oil, is producing less costly alternatives. Thus, the use of fisheries resources for feeding the fish will likely not grow exponentially.

China is moving away from monoculture of species high in food chain toward producing fish through polyculture and ecological aquaculture in wetland culture systems (Han et al., 2016). These options will provide alternate pathways to bring affordable food fish at with a reduced use of fishmeal from wild fisheries in China (Wang et al., 2016). This scenario is being increasingly practiced elsewhere in the region. The challenge for aquaculture (FAO, 2016b), to produce more food fish, reduce stress on wild fisheries, while reducing the use of low-value fish as feed.

Seed: The availability of hatchery-produced, good quality fish, shrimp and prawn seed in Asia has been on the rise over the past two decades. Although quality, quantity and availability may not be even across the region, in general, as hatchery- produced seed is becoming more and more accessible, use of wild caught seed is becoming minimal. Exceptions include seed for eels, southern bluefin tuna, some grouper species and milkfish, which are still sourced from the wild. Use of wild caught shrimp seed is almost non-existent in Asia. In fact, it has now become almost general practice to use not only hatchery produced shrimp (both Penaeus monodon and Penaeus vannamei) but also hatchery produced, specific pathogen-free (SPF) post-larvae in shrimp culture, to avoid several important viral diseases during the culture period.

Life cycles of the important crab and lobster species have been experimentally closed but commercial production of their seed is still rudimentary. Hatchery production of giant clam seed in several Pacific Islands is well established and is used for the commercial production of the clam for export as well as for stock enhancement programmes. Seed production of sea cucumber is also well established in several Pacific Island states and the technology has been successfully transferred to several other Asian countries.

Research into genetics and the application of genetics in aquaculture have contributed considerably to seed quality and quantity in Asia and the Pacific. Both the Genetic Improvement of Farmed Tilapia (GIFT) and domesticated SPF shrimp (Penaeus monodon and Penaeus vannamei) now play important roles in the continued aquaculture production growth.

Aquaculture seed production in many countries in the region (mainly the lower-producing countries in South and Southeast Asia) is still practiced as a state sector activity. Seed is produced in government hatcheries and distributed and/or sold to private farmers or stocked in lakes and reservoirs. This practice is changing. Aquaculture seed production is currently being privatized in some of those countries.

Aquatic animal health management: Epizootic-level incursion and spread of disease is unfortunately not new in Asian aquaculture. Many reviews and analyses are available on diseases in Asian aquaculture, although reliable and accurate data and information on economic impacts are still scarce. Diseases affecting aquaculture can be categorized into three kinds:

• Diseases that are important to trade (OIE list of diseases) and governed by international standards, which includes diseases of important traded species (e.g. finfish, crustaceans, molluscs) for which reporting/notification is required during an outbreak;

• Diseases that consistently affect aquaculture species at the hatchery, nursery and grow-out levels (e.g. bacteria, parasites, fungi, virus); and

• Emerging diseases, which are often known diseases that are spreading to new geographical areas or infecting new susceptible species, or diseases of yet unknown etiology. Countries need to be able to manage and contain the impacts of these diseases.

One of the earliest epizootics in Asia was Epizootic Ulcerative Syndrome (EUS) in freshwater fish. EUS and subsequent shrimp viral diseases have greatly increased awareness of the importance of aquatic animal health management and biosecurity in the region and helped to develop regional human capacity and infrastructure. However, such developments have not kept pace with the expansion and intensification of aquaculture.

Another significant aquatic disease is Acute Hepatopancreatic Necrosis Disease (AHPND), which devastated shrimp aquaculture in several Asian countries (e.g. China, Malaysia, Philippines, Thailand) during the last decade. The loss of revenue due to AHPND in Southeast Asia has been estimated at over four billion US $. The causative agent is a virulent strain of Vibrio parahaemolyticus, an aquatic bacterium commonly found in coastal waters.

Countries must be vigilant regarding other emerging diseases (e.g. Enterocytozoon hepatopenaei EHP in shrimps and tilapia lake virus TiLV in Nile tilapia) with the potential to severely impact the sector if not diagnosed and contained in a timely manner. Prevention, supported by good aquaculture and biosecurity practices, is still the key. Strengthening biosecurity governance at all levels of the aquaculture value chain is essential to deal with aquatic animal disease emergencies. It is less costly to detect, identify and prevent the emergence or spread of diseases than to eradicate them.

Other important emerging issues for Asian aquaculture include abuse of antimicrobials and other veterinary drugs, concerns about residues and development of drug resistant pathogens. With the recent approval of the Global Action Plan on Antimicrobial Resistance (AMR), spearheaded by WHO, it is now appropriate for countries to initiate development action plans on aquatic AMR to be integrated into the global action plan.

Technology and innovations: The scientific and business communities, not only in Asia, but also at the global level, have been responding to the challenges and opportunities inherent in the growing aquaculture sector with research efforts generating novel technologies that mirror the diversity of the industry. For example, the introduced species P. vannamei has now overtaken regional shrimp production that has been dominated by the native shrimp, P. monodon.

While aquaculture has performed well in Asia with the available resources and services, Asian aquaculture service sectors (seed, feed and health in particular) require strong consolidation and continued improvement. In particular, the growing direct use of low-value fish/trash fish for marine aquaculture should be seriously addressed and more efficient formulated feed, targeted to specific species and affordable to farmers, should be produced. Research into further commercialization of marine seed should be prioritized as continued collection of wild marine fish seed will further deplete the wild resource.

Asian aquaculture still does not overly suffer from lack of major resources. Support services have been improving and to some extent, they kept phase with sectoral development. As the sector is continually being intensified, further advances and support services are necessary to increase sector efficiency. More research into seed, feed, health, aquaculture engineering, etc. is essential to keep phase with sectoral development. Aquatic animal health should be considered vital to the sector and all efforts should be made to reduce risks of disease in Asian aquaculture.

Environmental integrity: Environmental performance in Asia during the past decade, although improving, needs a major upgrade. Outbreaks like the serious disease outbreaks in the shrimp sector should be prevented. According to Waite et al. (2014), if aquaculture is to grow in a sustainable manner, the sector must improve its environmental performance. In a nutshell, to achieve “sustainable intensification,” aquaculture must:

- Advance socioeconomic development;
- Provide safe, nutritious food;
- Increase production of fish relative to the amount of land, water, feed, and energy used; and
- Minimize water pollution, fish diseases, and escapes.

Intensification of aquaculture has reduced the use of land and freshwater per unit of farmed fish, but also led to an increase in the use of energy and commercial aquafeed including fish-based feed ingredients, as well as an increase in water pollution per unit of farmed fish produced. For Asian aquaculture to be more efficient, effective and sustainable, continuing efforts towards intensification of the sector should balance increasing resource efficiency with reducing environmental impacts to a minimum.

Markets and trade: During the past decades, aquaculture products from Asia have found new markets while global seafood also found new markets in Asia. Successful regional and international trading is based on transparent and predictable market access and entry requirements. Consumer demand will make products more marketable; although food quality, food safety and sustainability are paramount in achieving market penetration. Asian aquaculture should further concentrate on improving food safety and hygiene of the products, especially those coming from the small-scale sector.

Some promising opportunities for aquaculture development are in the aquarium trade (coral reef fish, hard corals, soft corals), the live seafood markets (e.g. groupers, spiny lobsters, abalone, crabs) and aquaculture for the pharmaceutical industry (e.g. algae, sponges, soft corals). These products are of high value and can be grown in small areas with a relatively simple technology. This offers great opportunity for Asia and the Pacific region.

It is apparent that more fish and shrimp are now consumed in Asia than ever. While this trend continues, the demand for improved high quality, nutritious, safer to eat and easy to cook/prepare (precooked) aquatic products will continue increasing in the region. Asian aquaculture producers should be aware of this inevitable phenomenon. Whether for Asia or other markets, internationally based SPS measures and disease prevention programmes should be fully implemented.

Sustainability: While local markets are increasing and small-scale producers are gaining better access to markets, overall costs of production in the aquaculture sector is increasing. Fuel, feed, seed and other services are becoming expensive and small-scale farmers are finding difficulties in competing in the markets with large and vertically integrated aquaculture operations. Although efficient intensification is now considered the future for sustainable aquaculture, many small-scale producers are finding it difficult to move in this direction.

Certain high value commodities such as shrimp are providing large streams of export revenue; thus, there is a trend towards increasing production of shrimp in Asia. Farming shrimp requires more feed, especially fishmeal, and is therefore more input intensive. Considering the increasing cost of fishmeal, there is also a trend in sourcing fishmeal locally using small local species that would otherwise have been consumed directly a trade-off exists between export value and local nutrition (IFPRI, 2015).

There have been increased efforts towards organizing small-scale fish farmers by developing cluster farming systems and applying better management practices (BMPs) in several countries in Asia such as Bangladesh, India, Thailand Indonesia, with very tangible success. Public-Private-Partnership arrangements in several Asian and Pacific countries to address the supply of high-quality feed and seeds and to meet certification requirements of international markets have been documented and disseminated by regional and international institutions, in particular by the Network of Asian Centers for Aquaculture (NACA), the South East Asian Fisheries Development Center (SEAFDEC) and the WorldFish Center .

As mentioned earlier, aquaculture will continue to grow, expand and intensify in Asia. If the sector is to be sustainable, not only should environmental impacts be minimized and resource efficiency maximized, but also the benefits from aquaculture should be made equitable. It is paramount that both small-scale and large-scale aquafarmers coexist, sharing profits and enjoying benefits. In a market economy world, this can only be achieved through better governance by enacting people centered and poverty reduction targeted policies and regulatory frameworks. This is of course the responsibility of the state.

External pressure factors: The 2004 Tsunami uncovered the lack of preparedness of Asia to deal with natural disasters, although the collective efforts towards responding to the disasters and supporting the ensuing rehabilitation processes are commendable (Bennett et al., 2006). However, what is important is to learn from past lessons and increase disaster preparedness for more efficient response to the possible events in the coming decades. This requires significant government involvement and it should increasingly be considered as state responsibility. Assistance from relevant international and regional agencies should be continued. In countries like Viet Nam or Bangladesh, have been taken to select for salinity-resistant aquaculture strains and to explore options such as deepening aquaculture ponds, using depth-adjustable cages, and integrating fish farming with agriculture.

Some areas to be addressed towards improving climate change adaptations of aquaculture in the region regard aquaculture zoning, better health management, improving and enforcing the ecosystem approach to aquaculture, and development and implementation of best aquaculture practices. These aspects as well as other nationally important areas towards improving climate change adaptations in several countries in the region are now being addressed through several Global projects, including Global Environmental Facility (GEF) projects.

Promoting sustainable aquatic resource management through the development and implementation of ecosystem-friendly and participatory policies, strategies and practices should be given priority in order to reduce, prevent and or mitigate impacts from natural disasters. The Asia Pacific region should recognize the importance of aquaculture (and fisheries) in resilience-building, in food security and nutrition. The countries should develop good practices in climate change adaptation, disaster risk reduction and management, which requires investment. The concept, which was used during the 2004 tsunami rehabilitation – Rebuilding Back Better and Development – is still valid and should be promoted in the efforts for rapid recovery (FAO, 2016b).

5.2. The future of aquaculture in Africa

Most analysts recognize that Africa has a great untapped potential for aquaculture development. They also recognize that most efforts and initiatives to develop the sector have yielded very little or no substantive growth so far. This is even more surprising considering that many of the world's important tropical and sub-tropical aquaculture species are native to Africa. This includes the Tilapias (especially Oreochromis niloticus), African catfish (Clarias gariepinus), seabass (Dicentrachus labrax), shrimp and prawns, and abalone (Haliotis sp). The reasons for the low aquaculture development in Africa have been analyzed by many, including by AUC-NEPAD (2014) at the request of the African Union, which recognized that aquaculture now provides the most sustainable option for increasing the continent's fish production. The identified constraints can be broadly summarized as follows:

- The sub-optimal utilization and management of the available natural resources for aquaculture;
- Challenges in the supply and access to key inputs notably, feed, seed, human resources, appropriate technology and finance;
- Challenges producers face to access markets; and
- Inadequate physical and sectoral infrastructure such as weak policies within both the public and private sector.

This recognition stems from Africa's natural resource potential for aquaculture, the rapidly increasing demand for fish amid declining natural fishery yields and sustained population growth, in particular Africa's youth that form the prospective work force and improves prospects for sustainability. The Conference of African Ministers of Fisheries and Aquaculture (CAMFA), held in Malabo in 2014, recognized the potential of Africa's aquaculture to generate wealth, social benefits and contribute to Comprehensive Africa Agriculture Development Program (CAADP), Africa's Agenda 2063 and the global Sustainable Development Goals (SDGs). As a result, CAMFA endorsed the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) as Africa's blue print to support the transformation of Africa's fisheries and aquaculture towards the CAADP. For aquaculture, the PFRS aims to create an enabling environment that shall lead to the transformation of Africa's aquaculture into a sustainable market-oriented private-sector led commercial agricultural activity that can meet the CAADP objectives.

To bring into reality a market-oriented sustainable aquaculture as envisioned in this blue-print continental policy, a continental consultative process, to internalize the PFRS with the view to actualizing its policy and strategic objectives for aquaculture, was subsequently undertaken within the scope of the African Fisheries Reform Mechanism (AFRM). The outcome of this process was the 'The African Union Ten years Aquaculture Action Plan for Africa 2016 – 2025' (AU-IBAR, 2016), a companion document to support the implementation of the PFRS within Regional Economic Communities and Member States by both the public and private sectors.

The strategic objective for sustainable aquaculture development in the PFRS is to 'jumpstart market-

[24] https://au.int/web/sites/default/files/documents/30266-doc-au-ibar_-_fisheries_policy_framework_and_reform_strategy.pdf

led sustainable commercial aquaculture' through the following key strategies and actions:

• Creating an enabling environment;

• Mainstreaming aquaculture strategies and plans into national development plans and CAADP;

• Creating an African Centre of Excellence for Aquaculture;

• Increasing research and dissemination of better practices;

• Market-led aquaculture investments operating in many countries;

• Accelerated aquaculture growth rates;

• Enabling environment for investment and governance significantly improved;

• Public-Private Sector Partnerships (PPPs) in aquaculture development significantly strengthened;

• Strategic regional cooperation in many areas of aquaculture; and

• Existence of harmonized and coherent policies, institutional and legal frameworks for aquaculture in shared ecosystems.

These strategies and actions have been subsequently consolidated into five major activity areas, notably:

Establish an enabling environment for sustainable aquaculture development: This theme addresses Policy Arena 5 of the PFRS. It seeks to put in place the framework to support the rational and sustainable utilization and management of aquatic and other resources for aquaculture production and the trade of aquaculture produce and products.

Improved Service Delivery to the Sector: This theme encompasses Policy Arenas 3, 4 and 8 of the PFRS in relation to the inputs and services necessary to establish a sustainable private-sector led commercial aquaculture. The actions seek to address the current challenges associated with adequate supply and access to inputs and services of the correct quality necessary to ensure optimal levels of production, productivity and profitability in compliance with regional and international standards.

Capacity Building: The actions under this theme address Policy Arenas 6 and 8 of the PFRS to ensure that there is an adequate human resource base with the appropriate skills, information and resources to effectively implement the Continental Action Plan along all levels of the value-chain with an emphasis on empowering the youth, women and other disadvantaged groups and to ensure the equitable distribution of benefits from aquaculture.

Trans-Boundary Ecosystem Management for Aquaculture: The actions under this theme address Policy Arenas 1, 5 and 8 of the PFRS. It seeks to ensure ecosystem health and biosecurity particularly considering that Africa's aquatic ecosystems and consequently resources are shared between Member States. Ensuring the availability of aquatic resources in the right quantity and quality for aquaculture production requires collective management. It also takes into account mitigation against impacts of climate change on aquatic resources for aquaculture production and other uses. The quality of aquatic products the fish and seafood produced also depends a lot on the sustainable management of aquatic resources as a whole.

Innovation (Research and Development): Sustainable aquaculture development dictates that the utilization and management of resources for aquaculture should fit within the context of local environmental, socio-economic and technological constraints otherwise viability and sustainability at all levels become compromised. This activity area therefore seeks to ensure that the technological, infrastructural and human capacity is strengthened appropriately to support sustainable aquaculture development in line with the expected outcomes of the PFRS.

For each of the five areas, priority activities have been identified and framed within a monitoring and evaluation framework with defined targets, indicators, timetable and responsibilities. The Blueprint Plan of Action has been adopted by continental and international development agencies, operating in both technical and financial areas. Countries Members of the AU should align their national aquaculture development strategies with this Action plan that has been based on internationally recognized best practices, including market-based instruments.

6. THE ECOSYSTEM APPROACH TO AQUACULTURE

Similarly to fisheries, experts consider that an ecosystem approach to aquaculture is key to addressing the three dimensions of sustainability, economic, social and environmental. One of the major challenges for the sustainable development of aquaculture is the sharing of water, land and other resources with other users, such as fisheries, agriculture, urbanism, maritime transport and tourism. Often, many of these users differ dramatically in terms of their objectives, goals, and resource needs, often putting them in direct conflict with each other.

Unfortunately, to date, aquaculture development in several parts of the world has been done on an ad hoc basis, with little consideration of interactions and long-term sustainability. Many examples have demonstrated that inadequate planning can lead to adverse environmental impacts, lack of economic feasibility, and/or social conflicts between users.

The ecosystem approach to aquaculture (EAA) was established by FAO in 2008 and its technical contours were further developed in 2010 . Generally considered the most appropriate framework for integrated management of aquaculture, EAA is defined as a "strategy for the integration of the activity within the wider ecosystem, such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems". Three principles govern the implementation of the EAA:

• Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity) with no degradation of these beyond their resilience.

• Aquaculture should improve human well-being with equity for all relevant stakeholders (e.g. access rights and fair share of incomes); and

• Aquaculture should be developed in the context of other sectors, policies and goals, as appropriate.

Since the emergence of EAA over a decade ago, there has been increased awareness of the holistic and participatory aspects outlined in the approach, although its practical implementation has been slow.

To encourage and facilitate EAA implementation, FAO and the World Bank (Jose Aguilar-Manjarrez et al, 2017) published a handbook depicting comprehensive guidelines for Aquaculture zoning, site selection and area management under the ecosystem approach to aquaculture: Likewise, a recent publication (Bone et al., 2018) reviews these important aspects and provides key case studies on how the EAA is being implemented in Indonesia.

Spatial planning is a fundamental component of EAA for ensuring successful and sustainable aquaculture development. It has been shown to minimize conflicts between competing users and maximize overall value of the aquatic environment. Spatial planning for aquaculture, including zoning, site selection and the design of aquaculture management areas, is an important component of EAA which considers the balance between the social, economic, environmental and governance objectives of local communities and sustainable development. One essential step is appropriate spatial planning at the local, regional and national levels, accounting for transboundary issues such as pollution, diseases, where these are relevant. Although many of the social and environmental concerns surrounding impacts derived from aquaculture may be addressed at the individual farm level, most impacts from different farms are cumulative.

Adopting an EAA framework allows the identification of BMPs that are fundamental to addressing the systemic, broad-scale challenges of aquaculture outlined above. BMPs consider three key components:

• Spatial Planning and Zoning: the process through which public and private sectors aim to influence the spatial distribution of people, access and activities at differing geographic scales.

• Waterbody Carrying Capacity Limits: determining the level of resource use, by all resource users, that can be sustained over the long term without harming ecosystems or provision of ecosystem services.

•Aquaculture Management Areas(AMAs): waterbodies, or parts thereof, where certain management practices are coordinated across all aquaculture operators in the area, to minimize cumulative impacts and risks.

[25] http://www.fao.org/docrep/013/i1750e/i1750e01.pdf

Table 3.3. Main characteristics of the process for scoping, zoning, site selection and area management for aquaculture

Characteristics	Scoping	Zoning	Site selection	Area management
Main purpose	Plan strategically for development and management	Regulate development; minimize conflict; reduce risks; maximize complementary uses of land and water	Reduce risk; optimize production	Protect environment; reduce disease risk; reduce conflict
Spatial scale	Global to national	Subnational	Farm or farm clusters	Farm clusters
Executing	Organizations	National and local	Commercial	Farmer associations;
entity	operating globally; national aquaculture departments	governments with aquaculture responsibilities	entities	regulating agencies
Data needs	Basic, relating to technical and economic feasibility, growth and other uses	Basic environmental, social and economic sets	All available data	Data for carrying capacity and disease risk models
Required	Low	Moderate	High	High
resolution				
Results	Broad, indicative	Directed, moderately	Specific, fully detailed	Moderately to fully
obtained		detailed		detailed

Source: (Author's elaboration based on FAO 2008)

Tables 3.4 to 3.5 summarize the main characteristics, tasks, data needs, policy, institutional and legal frameworks for sustainable aquaculture development based on the EAA.

Table 3.4 Summary of the main tasks and data needs to conduct a spatial planning and zoning exercise for marine aquaculture development.

Activity	Main tasks	Data needs
Scoping	1. Collect baseline information on current aquaculture production, markets and regulatory frameworks; 2. Define national priorities for aquaculture; 3. Set broad objectives; 4. Identify relevant stakeholders to consult	1. Economic or market (international and national) feasibility information; 2. Current regulations or institutions relevant to aquaculture development; 3. Aquaculture production, area and location; 4. Suitability requirements for target culture species
Site selection	1. Assess aquaculture suitability; 2. Estimate site carrying capacity; 3. Plan for biosecurity and disease control; 4. Develop authorization procedures for proposed sites	1. Water quantity and quality; 2. Hydrodynamics and bathymetry; 3. Site suitability and carrying capacity estimates; 4. Accessibility (infrastructure, markets, roads, electricity, inputs); 5. Proximity to sensitive habitats, pollution sources, and other fishing and aquaculture zones
Zoning	1.Identify suitable aquaculture areas 2. Identify regional issues or threats 3. Estimate zonal carrying capacity 4. Develop biosecurity and zoning strategies 5. Designate zones for aquaculture	1. Water quantity and quality 2. Hydrodynamics and bathymetry 3. Suitability requirements for target culture species 4. Accessibility (infrastructure, markets, roads, labor) 5. Proximity to sensitive habitats, pollution sources, and other fishing and aquaculture zones
Aquaculture management areas	1. Consult with stakeholders to delineate management area boundaries 2. Develop and enforce a management body and plan 3. Establish carrying capacity and environmental and disease monitoring procedures for management areas	1. Proximity to nearby farms 2. Information on: Waterbody, Water source, Species farmed 3. Environmental impact information (water turnover, feed conversion rate, benthic diversity, bottom anoxia) 4. Carrying capacity

Source: (Author's elaboration based on FAO 2008)

Bone et al. (2018) describe how the EAA and its tools were applied to develop the 2030 aquaculture strategy for Indonesia, based on the following key recommendations. This document should be consulted for further details on the approach and its results, beyond the below backbone set of recommendations for Indonesia.

Recommendation 1: Strengthen nationally identified areas for aquaculture by integrating them into provincial land-use plans and/or marine-coastal-small-islands zoning plans. This may require extension support to regional governments to provide the structure, skills, and capacity needed to complete the spatial planning process.

Recommendation 2: the suitability of nationally identified areas for both aquaculture intensification and extensification approaches should be assessed within the provincial land-use plans and/or marine-coastal-small-islands zoning plans for further aquaculture growth.

Recommendation 3: incorporate mangrove protection and restoration into the provincial land-use plans and/or marine-coastal-small-islands zoning plans process to identify suitability of aquaculture extensification and intensification.

Recommendation 4: assess the carrying capacity of waterbodies identified for aquaculture development in provincial land-use plans and/or marine-coastal-small-islands zoning plans, accounting for all users in the identified zone to ensure cumulative impacts are managed. aquaculture siting and licensing should be based on these carrying-capacity assessments (e.g., establish limits on farm number, size, and/or production volume).

Table 3.5 Policy, institutional and legal aspects of sustainable aquaculture

Policy, institutional and legal aspects	Instruments, institutions, requirements
International binding and non-binding instruments	Binding instruments include, for example, the Ramsar Convention on Wetlands of International Importance (Ramsar, 1971) and the United Nations Convention on the Law of the Sea (Montego Bay, 1982). Non-binding instruments include the Kyoto Declaration on Aquaculture, Agenda 21, Rio Declaration, and the CCRF,1995)[3], among others
Basic national legislation	Fisheries and/or aquaculture law Planning law Water law Sanitary law Tax law User rights law
Institutions	Fisheries and aquaculture authorities Health and sanitary authority Environmental authority Forestry and water resources authority Culture and tourism authority Indigenous people's authority Commerce authority Local authorities Trade/farmer associations
Site allocation	Site allocation criteria and user rights Required distance between farm sites Required distance between farm sites and other activities Interaction with other activities Indigenous/artisanal fishing community rights

Authorized system	Leasing or permitting system Operation license (duration, renovation, revocation) New site, change of use, or change of capacity
Environmental impact	Emission standards Water quality Sedimentation models Waste management
Control mechanisms	Environmental assessments Self-monitoring Citizen's participation Enforcement and penalties Conflict resolution procedures
Production system	Production volume Species mix Animal Welfare
Fish Movement	Notification and information Transport of species Accidental release of farmed species
Disease control	Quarantine Outbreak management Therapeutants
Feed	Feed quality Effect of feed residues on environment
Product safety and traceability	Certification systems
Education, research and development	Extension and training Research and development Public information and awareness
Aquaculture management areas	Organization and management of AMAs

Source: (Author's elaboration based on FAO 2008)

Recommendation 5: identify and implement AMAs wherein clusters of farms coordinate management practices to reduce the risks of disease introduction and transfer.

Recommendation 6: improve the management of the feed fish industry through innovations and Fishery Improvement Projects (FIPs) to ensure long-term sustainability of fisheries and security of access to fishmeal and fish oil resources.

Recommendation 7: establish and implement a protocol for tracking and monitoring the environmental impacts of aquaculture as part of the national One Data policy.

Recommendation 8: Facilitate access to finance at favorable rates of interest on loan. Leveraging impact investing or other forms of private sector finance for aquaculture helps to harness the potential role of the sub-sector

Recommendation 9: Develop market-based insurance schemes to mitigate risks, diseases and natural hazards on the aquaculture sector, especially in the short-intermediate periods.

7. CONCLUSION

Aquaculture production is expected to grow significantly over the next decades to meet the increasing global demand for fish and seafood and fill the gap between demand and offer resulting from the foreseen stagnation of capture fisheries. Whereas this growth presents different challenges for different regions and countries, international undertakings and market driven requirements require an integrated approach to sustainable aquaculture development to address its technical and economic challenges but also its environmental and social responsibility challenges.

Asia's aquaculture models will need to integrate the EAA components if it is to consolidate its leadership in aquaculture and international markets.

Except for few countries where aquaculture is well rooted, most African countries have the possibility to initiate sustainable aquaculture development policies and strategies. It is a great opportunity for the African continent. It will require major undertakings, for capacity building, transfer of know-how and investment. This chapter has outlined the main components that should be considered when developing policies and strategies for sustainable aquaculture development. It also provides a comprehensive list of references that should be consulted for this purpose.

Chapter 4: Best practices for value addition along the fisheries and aquaculture value chain

This chapter builds on successful experiences of developed and developing countries that adopted integrated solutions, based on value chain approaches to improve efficiency and performance of post harvest fisheries and aquaculture. The main key messages are:

- Optimizing fish utilization requires a good understanding of the basics of fish composition, causes of spoilage and contamination and best practices to preserve fish and seafood quality and safety;
- Fish and seafood quality and safety management and the policy implications for their practical implementation are key for value addition and export promotion;
- Effective policies and best practices are necessary to promote economic performance, social and environmental responsibility along the fish and seafood value chain in the context of blue economy;
- Effective strategies for research and development to optimize value addition and utilization of fish-by products in aquaculture, agriculture fertilization and human nutrition

1. INTRODUCTION

In the previous chapters, we showed how the sector of fisheries and aquaculture can play a major role in meeting the global demand for food of a population expected to reach 10 billion in 2050. While, the possibility of increasing the harvest still exists for some marine capture fisheries. Improvements for most fisheries can only come from their improved performance by rebuilding the resource basis and implementing proper management, increase in sustainable aquaculture production, reduction of post-harvest losses and waste and value addition during handling, processing and distribution, through implementation of best practices along the value chain. Improved quality, safety and sustainability of fish and seafood, both from aquaculture and capture fisheries is of paramount importance, for meeting the increasing demand for fish and seafood, locally, regionally and to supply international lucrative markets. Recent experiences of many countries, developed and developing, have shown the merits of integrated solutions, based on value chain approaches which catalyze public private partnerships (PPPs) to improve efficiency and performance of fisheries and aquaculture. In this Chapter, we will present the recommended policies for best practices that can lead to improved economic performance, higher processing yields, improved product quality, safety and value addition along the fish and seafood value chain.

2. BEST POST-HARVEST PRACTICES FOR HANDLING AND PROCESSING

Immediately after harvest, fish and seafood spoil very rapidly if appropriate preservation actions are not taken. Over the centuries, various techniques such as drying, salting, fermentation or smoking have been used to prevent fish spoilage, extend its shelf life and give it a characteristic taste, flavor and/or texture. These traditional techniques are still in use and highly appreciated by consumers worldwide, although using more sophisticated technologies and equipment. The 19th century saw the development of thermal processing (sterilization or pasteurization) and the ensuing booming of the fish canning industry, to preserve and increase shelf life of species such as tuna, salmon, sardines or mackerel. These fish species being seasonally caught in large quantities over a short period of time, Canning enabled availability of these fish products over extended periods and geographies. The twentieth century brought in important developments in food refrigeration, freezing, vacuum or modified atmosphere packaging, which also extended availability of fish and seafood over time and space, increased product diversification and enabled better preservation of nutritional attributes.

The basics of fish and seafood preservation are well documented in text books and other manuals used to educate food scientists, seafood technologists and veterinarians on their optimal use of raw materials in the fish and seafood industry. One of these manuals has been made available during the 2018 training course in Vietnam (UNCTAD, 2018) and can be consulted for these basic aspects and their practical application in fish and seafood processing. Other sources will be referenced s as needed along this chapter. A key international reference is the Codex Code of Practice for Fish and Fishery Products (CPFFP) (FAO/WHO, 2013), which has been fully revised to integrate new technological developments and concepts of fish safety and quality management.

However, beyond these technical aspects and the know-how taught in the various seafood science and technology institutions around the world, there are policy aspects of relevance to fisheries and aquaculture development, with key roles both for government institutions and for the industry. For example, fish ports and landing sites are very important for unloading, auctioning and distribution of fish and seafood. Their design, equipment and maintenance are of great significance for the quality, safety and marketability of the fish and seafood products that transit through them and their infrastructures. A simple example in many developing countries relates to access to ice in the ports and landing sites. Beyond producing ice and making it available at affordable prices, there are underlying requirements such as the quality of water used for the production of ice, sanitation of the premises or maintenance of the equipment that are of greater importance for the quality and safety of the landed harvest.

This Chapter will present succinctly the basics of fish and seafood preservation and develop the approaches and experiences that have been successful in adopting international best practices for fish and seafood quality and safety management, with a successful synergy and complementarity between industry, academia, research and government. It will summarize experiences of several countries that have adopted the value chain approach to manage these issues in an integrated manner It will also discuss how the value chain approach is being integrated within the concept of the Blue Economy by coastal countries and its benefits for achieving trade related SDG 14 targets.

2.1. Basics of fish and seafood spoilage, safety and preservation

2.1.1 Composition and nutritional attributes

As with many food products of animal origin, the main constituents of fish and seafood are water, proteins and other nitrogenous compounds, lipids, carbohydrates, minerals and vitamins. This chemical composition of fish and seafood varies greatly from one species and one individual fish to another depending on age, sex, environment and season (Huss, 1995).

Proteins and lipids are the major components of fish and seafood whereas carbohydrates found at very low levels (less than 0.5 percent). Vitamin content is comparable to that of other mammals except for vitamins A and D which are found in large amounts in fatty species, especially in the liver of species such as cod and halibut. Fish and seafood also contain significant amounts of minerals such as calcium and selenium (Huss, 1995)

Depending on their lipid content, which varies greatly from 0.2 percent to 25 percent, fish are classified as lean, semi-fatty or fatty. Bottom-dwelling ground fish such as cod, saithe and hake are common lean species. Fatty species include pelagics such as herring, mackerel and sardines. Fish lipids differ greatly from mammalian lipids in that they include up to 40 percent of long-chain fatty acids that are highly unsaturated and contain five or six double bonds. These polyunsaturated fatty acids, known as omega 3 fatty acids, present great health benefits (anti-thrombotic activity for adults and brain development of babies and young children) and technological challenge because of rapid lipid oxidation and development of rancidity.

Proteins are the second-most important constituent of fish and seafood. Fish proteins contain all the essential

[25] http://www.fao.org/docrep/013/i1750e/i1750e01.pdf

amino acids and, like milk, eggs and mammalian meat proteins, have a very high biological value. In addition, fish proteins are an excellent source of three essential amino acids (lysine, methionine and cysteine), and can significantly raise the value of cereal-based diets, which are poor in these essential amino acids. This is the case for many coastal communities in Africa and Asia whose diets contain predominantly rice and fish (HLPE, 2014).

Also, fish meat is generally a good source of the B vitamins and, in the case of fatty species, of A and D vitamins. Some freshwater species such as carp have high thiaminase activity so the thiamine content in these species is usually low. As for minerals, fish meat is a particularly valuable source of calcium and phosphorus as well as iron, copper and selenium. Saltwater fish have a high content of iodine.

With this composition, fish and seafood are is highly nutritious, tasty and easily digested. Fish and seafood are in high demand by a broad cross-section of the world population, particularly in developing countries. It is estimated that around 60 percent of people in many developing countries consume over 30 percent of their animal 'meat' proteins from fish, while almost 80 percent in most developed countries obtain less than 20 percent of their 'meat' proteins from fish. However, with the increased awareness of the health benefits of fish, the ensuing rise in fish prices and the sanitary problems of beef and poultry, these figures are rapidly changing (FAO, 2016b).

2.1.2 Post-harvest changes

Spoilage: Immediately after capture, several changes will take place in the dead fish, leading ultimately to rejection for human consumption because of spoilage and loss of quality. These post-harvest losses have been estimated at 10 to 12 million tonnes (around 10 percent of the world capture and aquaculture fish). Therefore, understanding these post-harvest changes that occur in fish and seafood is very important to reduce losses and improve quality and safety of the finished products.

Sensory changes are those changes perceived with the senses, i.e., appearance, odour, texture and taste. In fresh fish, the first sensory changes during storage are concerned with appearance and texture. The characteristic taste of the species develops normally during the first couple of days of fish stored in ice.

The most dramatic change is onset of rigor mortis. Immediately after death, the muscle is totally relaxed and the elastic texture usually persists for some hours, following which the muscle will contract. When it becomes hard and stiff the whole body becomes inflexible and the fish is said to be in rigor mortis. This condition usually lasts for a day or more in iced fish, then rigor resolves. The resolution of rigor mortis makes the muscle relax again and it becomes limp, but no longer as elastic as before rigor. The rate in onset and resolution of rigor varies from species to species and is affected by temperature, handling, size and physical condition of the fish.

Understanding the basics of Rigor mortis has important technological significance whether the fish is filleted before or in rigor. In rigor the fish body will be completely stiff; the filleting yield will be very poor, and rough handling can cause gaping. If the fillets are removed from the bone pre-rigor the muscle can contract freely and the fillets will shorten following the onset of rigor, shrinking up to 52 percent of the original length. If the fish is cooked pre-rigor the texture will be very soft and pasty. In contrast, the texture is tough but not dry when the fish is cooked in rigor. Post-rigor the flesh will become firm, succulent and elastic. Whole fish and fillets frozen pre-rigor can give good products if they are carefully thawed at a low temperature in order to give rigor mortis time to pass while the muscle is still frozen.

Sensory evaluation of raw fish in markets and landing sites is done by assessing the appearance, texture and odor of the fish. When used properly, this rapid and simple method is very useful for fish grading, pricing and marketing. Freshness rating using sensory evaluation is widely used in fish distribution. It has been codified for various species and conditions and represent key qualification of fish inspectors and quality controllers. During the storage of fish in ice (figure 4.1), its cooked flavor will generally follow a pattern in 4 phases:

Phase 1: The fish is very fresh and has a sweet, seaweedy and delicate taste. The taste can be very slightly metallic. In cod, haddock, whiting and flounder, the sweet taste is maximized 2-3 days after catching.

Phase 2: There is a loss of the characteristic odor and taste. The flesh becomes neutral but has no off-flavors. The texture is still pleasant.

Phase 3: There is sign of spoilage and a range of volatile, unpleasant-smelling substances are produced depending on the fish species and type of spoilage (aerobic, anaerobic). One of the volatile compounds may be trimethylamine (TMA) derived from the bacterial reduction of trimethyl-aminoxide (TMAO). TMA has a very characteristic «fishy» smell. At the beginning of the phase, the off-flavor may be slightly sour, fruity and slightly bitter, especially in fatty fish. During the later stages sickly sweet, cabbage-like, ammoniacal, sulphurous and rancid smells develop. The texture becomes either soft and watery or tough and dry.

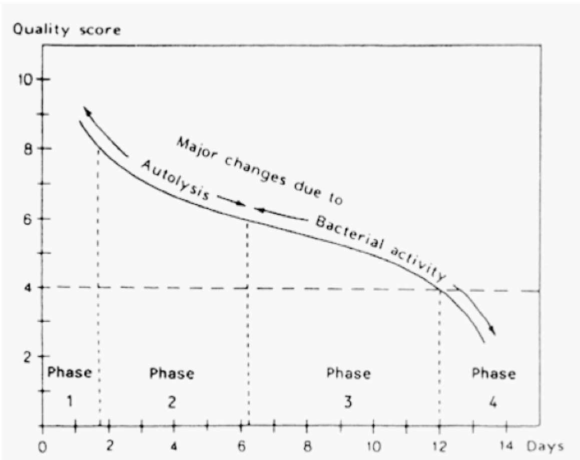
Phase 4: The fish can be characterized as spoiled and putrid.

Fish spoilage occurs following a biochemical mechanism called autolysis, which means «self-digestion». Autolysis is the result of enzymatic reactions within the fish muscle that are caused by its natural enzymes (autolysis) or bacterial enzymes. Autolysis leads to the production of by-products of Adenosine Triphosphate (ATP), whereas bacterial spoilage leads to the accumulation of substances causing undesirable odors of the fish (trimethylamine TMA, Sulphur containing compounds such as H_2S, CH_3SH, $(CH_3)_2S$, etc). For cod and yellowfin tuna, enzymatic changes related to fish freshness precede and are unrelated to changes in the microbiological quality. In some species (squid, herring), the enzymatic changes precede and therefore predominate the spoilage of chilled fish. In others, autolysis contributes to varying degrees to the overall quality loss in addition to microbially-mediated processes. Again, the biochemical processes of autolysis have been well studied and their practical implications widely documented (Ryder et al., 2014). In frozen fish, no bacterial metabolism takes place, but in some species an enzyme is present in the muscle tissue which can break down TMAO into dimethylamine (DMA) and formaldehyde (FA), inducing toughing of the muscle and water loss.

In order for bacteria to spoil the fish flesh, they need to invade the muscle. The flesh of healthy live or newly-caught fish is sterile as the immune system of the fish prevents the bacteria from growing in the flesh. When the fish dies, the immune system collapses, and bacteria proliferate freely by colonizing to a large extent the scale pockets on the skin surface. During storage, they invade the flesh by moving between the muscle fibers. Spoilage is probably to a large extent a consequence of bacterial enzymes diffusing into the flesh and nutrients diffusing to the outside.

In addition to autolysis and bacterial spoilage, fatty fish can be subject to lipid oxidation and hydrolysis which can create severe quality problems even during storage at freezing temperatures. Oxidation and hydrolysis result in production of a range of substances among which some have unpleasant (rancid) taste and smell. Some may also contribute to undesirable texture changes. The large amount of polyunsaturated fatty acids moieties found in fish lipids makes them highly susceptible to oxidation and rancidity.

Figure 4.1. Quality changes in fish stored in ice (0°C) (Huss, 1995)



Source: (Huss,1995)

Fish and seafood safety: When harvested in clean environments and handled hygienically, fish and seafood are very safe. Unfortunately, water pollution, unhygienic practices and insufficient or delayed icing or refrigeration have been at the origin of many outbreaks of fish and seafood-borne illnesses (Table 4.1).

Table 4.1. Types of fish and seafood borne illnesses

Types of illness		Causative agent
Infections	Bacterial infections	Listeria monocytogenes, Salmonella sp., Escherichia coli, Vibrio vulnificus, Shigella sp.
	Viral infections	Hepatitis A virus, Norovirus, Hepatitis E
	Parasitic infections	Nematodes (round worms), Cestodes (tape worms), Trematodes (flukes)
	Toxi-Infections	Vibrio cholerae, Escherichia coli, Salmonella sp.
Intoxications	Microbial	Staphylococcus aureus, Clostridium botulinum, Hista-mine
	Biotoxins	Ciguatera, Paralytic shellfish poisoning (PSP), Diarrhe-ic (DSP), Amnesic (ASP), Neurotoxic (NSP),
	Chemical	Heavy metals: mercury, cadmium, lead. Dioxins and PCBs. Additives: nitrites, sulphites

Source: (Ababouch,2014)

Many of these causative agents are at the origin of illnesses caused by other types of food, especially food of animal origin. They are described elsewhere in the papers mentioned in this chapter. Following is a summary of the basic necessary information.

Bacteria: Apart from 3 species of bacteria (Vibrio species, L. monocytogenes and Cl. Botulinum) that are part of the aquatic environment, the other bacteria that cause the majority of the fish-borne illnesses contaminate fish from the environment, the handlers, the equipment, water used for washing the fish or from ice. Bacteria that are indigenous to the aquatic environment and the general environment may be associated with fish at the primary production stage (aquaculture or fishing).Those derived from general environment or from animal/human reservoir may be introduced as a result of contamination of the water or during handling and processing of fish. In either case, the initial levels of the bacteria are generally low and their multiplication in fish to reach an infective dose or to produce toxin in fish precedes fish borne illnesses. Therefore, for management of the risk due to these pathogens, preventing their growth using refrigeration, freezing or other preservation techniques, would be very important.

Biotoxins: Biotoxins or phycotoxins are marine toxins that accumulate in fish or bivalve molluscs (mussels, oysters, scallops, clams). Most of these toxins are produced by species of naturally occurring marine algae (phytoplankton). There are about 5000 species of marine algae, but only 70-80 species are known to produce toxins. A proportion of the toxic phytoplankton has a red-brown pigmentation, giving rise to the naming of algal blooms as “red tides”. However, not all colored algae are toxic and incidences of poisoning have occurred in the absence of red tides. Bivalve molluscs are filter feeders and continually pump water through their gills for feeding by removing and ingesting particulate matter. During a bloom, bivalves can accumulate sufficient toxin to cause human illness after filter feeding for only 24 hours. Biotoxins have been responsible for incidents of wide-scale death of sea-life and for human intoxication. Main seafood poisoning syndromes associated with toxic marine algae are paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), diarrheic shellfish poisoning (DSP), neurotoxic shellfish poisoning (NSP) Other types of biotoxins associated with finfish include ciguatera fish poisoning (CFP) and puffer fish poisoning (PFP).

Histamine fish poisoning: Histamine fish poisoning (HFP) is an intoxication that can be caused by consumption of many different types of marine finfish that contain toxic levels of histamine. HFP is common and occurs worldwide. Many species of marine finfish have caused HFP and the intoxication is often referred to as scombroid or scombrotoxin poisoning because of the frequent association of the ill-ness with the consumption of scombroid fish such as tuna, skipjack, saury and mackerel. However, non scombroid fish such as anchovies, bluefish, herring, mahi-mahi, marlin, sardines and swordfish have also been impli¬cated in outbreaks of this illness. These fish species have significant amounts of histidine in their muscle tissues where it serves as a sub¬strate for bacterial histidine decarboxylase and formation of histamine. Prevention of HFP relies on preservation techniques to reduce growth and activity of histamine producing bacteria.

Viruses: Food-borne viruses are derived from the human gastrointestinal tract and their presence in water and food is a result of contamination with sewage, poor hygiene or by food handlers. Viral diseases are associated mainly with shellfish because shellfish feed by filtering large amount of water, which causes the viruses to concentrate when the harvesting water is contaminated. Though a number of viral groups have been detected in shellfish, clear epidemiological links with seafood exist only for Norovirus and Hepatitis A virus.

Chemical contaminants: The main chemical contaminants of concern in fisheries and aquaculture are heavy metals (mercury, cadmium and lead), organic pollutants such as dioxins and polychlorinated biphenyls PCBs, antimicrobial substances including veterinary drugs and additives such as metabisulphates. Some of these substances have maximum regulatory limits (MRL), whereas others are banned or should have no residues. MRLs are defined for authorized veterinary drugs, antibiotics, additives and certain contaminants that are already part of the environmental background.

Organic pollutants are organic chemicals produced for a variety of different applications of our daily life. Most of these substances were considered useful products before their negative impact on the environment was demonstrated. These include herbicides and pesticides for agriculture, PCBs which have been used as additives and fire retardants in a range of consumer and commercial products, including plastics, electronics, textiles, etc. Some other compounds like dioxins are by-products of certain industrial processes (e.g. metallurgical industry) and combustion processes like waste incineration, or during natural processes like forest fires or volcanic eruptions.

Heavy metals are naturally present in the aquatic environment due to volcanoes, geological anomalies and geothermal events, but anthropogenic pollution results from various industrial activities. The distribution between the natural background concentration of heavy metals and anthropogenic heavy metals in fish varies, depending on the element, the species and the area of capture. In the open seas, which are still almost unaffected by pollution, fish mostly carry just the natural burden of heavy metals. In moderate or heavily polluted areas such as those that do not have sufficient exchange with the world oceans (e.g. Baltic Sea, Mediterranean Sea), in estuaries, in rivers, lakes and especially in places with close vicinity to industrial activities, the heavy metal concentrations actually found in seafood exceed the natural concentrations.

The uptake of organic contaminants by fish occurs via diet and from the water via gills and skin. In farmed fish, whose lifespan is short compared with wild living fish, the uptake occurs mainly via feed. Inorganic contaminants are mainly stored in the intestines, liver and kidney but are also found in the muscle often bound to proteins. Of major concern in aquaculture are residues of antibiotics such as chloramphenicol, nitrofurans and malachite green. Their use in food production is banned by many countries.

Parasites: Fish-borne zoonotic parasites are prevalent in many regions of the world and are among the most important of all zoonotic parasites infecting humans. The number of people currently infected with these parasites may exceed 30 million, with the number of people at risk worldwide estimated at more than half a billion. Fish-borne parasites include species of nematodes (round worms), cestodes (tapeworms) and trematodes (flukes). They are found in both marine/brackish and fresh water wild and cultured fish. Fish-borne parasite infections in people often exist as a multiple species complex, because they have common transmissions modes that are favored by well-entrenched cultural traits, particularly fondness for raw or lightly cooked, cured or pickled fish and fish products.

Physical contaminants: Finally, physical contaminants such as glass, metal and wood pieces, nails, bones in fish fillets, hooks, etc. have also been at the origin of consumer health distress and need to be considered when designing a seafood safety assurance program. Similarly to other food groups, the burden of fish and seafood-borne illnesses is unknown because there is no reporting in most countries and even the few countries which have epidemiological surveillance programs have severe under-reporting. In these countries, fish and seafood are reported to be associated with 5 to 25 percent of all foodborne outbreaks, with scombrotoxin and ciguatoxin poisoning and Vibrio and Norovirus infections as the most prevalent illnesses (Ryder et al. 2014). In addition to the health and medical implications of fish and seafood-borne illnesses, economic and reputation losses are incurred by countries and food companies where the incriminated fish and seafood products originate. Likewise, the increased globalization of fish trade has highlighted the risk of cross-border transmission of hazardous food agents and the rapid development of aquaculture has been accompanied by the emergence of food safety and quality concerns.

2.1.3 Post-harvest handling and preservation

Fish is a very perishable food commodity that requires proper handling and preservation to increase its shelf life and retain its quality and nutritional attributes. The first obvious way to avoid spoilage and loss of quality is to keep harvested fish alive until cooking and consumption. Handling of live carp for trade and consumption has been practiced in China for more than three thousand years. This is a common practice in many countries, especially in Asia. To keep fish live, healthy fish are first conditioned in a container with clean water, while the damaged, sick and dead fish are removed. Fish are starved and, if possible, water temperature is lowered to reduce metabolic rates and make fish less active. Low metabolic rates decrease the fouling of water with ammonia, nitrite and carbon dioxide that are toxic to fish and impair their ability to extract oxygen from water.

Various fish species are usually kept alive in holding basins, floating cages, wells and fish yards. Holding basins, normally associated with fish culture operations, can be equipped with oxygen control, water filtering and circulation and temperature control. Simpler methods are also used. For instance, large palm woven baskets act as floating cages in rivers (China) or simple fish yards are constructed in a river's backwater (South America). Also, the transportation of live fish ranges from very sophisticated systems installed on trucks that regulate temperature, filter and recycle water and add oxygen, to very simple artisanal systems of transporting fish in plastic bags with an atmosphere supersaturated with oxygen.

For dead fish, handling operations after capture comprise the are: transferring of catch from gear to vessel, holding of catch before handling, sorting/grading, bleeding/gutting/washing, chilling, chilled storage, unloading. These operations can be performed in several ways, using methods that are fully manual to fully-automated operations. The number of operations and the order in which they are accomplished depend on the fish species, the gear used, vessel size, duration of the voyage and the market to be supplied. It is crucial to provide a continuous flow in handling thereby controlling properly time and temperature. It is also essential to ensure proper working conditions onboard fishing vessels by eliminating those catch handling procedures which cause physical strain and fatigue to fishers. Nowadays, this is possible because of equipment and handling procedures designed to eliminate heavy lifting, unsuitable working positions and rough handling of fish.

To control temperature, icing is the most indicated and used method for preserving fish freshness. Currently, it is widely used thanks to mechanical refrigeration, which makes ice readily available at affordable cost. In addition, ice keeps fish moist, has a large cooling capacity, is safe, is a portable cooling method that can be easily stored, transported and used by distributing it uniformly around fish. Ice can be produced in different shapes -- the most commonly used to cool fish are flake, plate, tube and block ice. Block ice is crushed before being utilized to chill fish.

It should be stressed that icing is efficient when combined with insultation, especially in tropical countries. Although, fish holds in industrial fishing boats are insulated, the use of ice on small boats, pirogues, canoes, etc. has only been possible through the introduction of insulated containers, especially under tropical, warm climates. These containers are designed and constructed locally, using natural or artificial insulating materials, with enough handling flexibility (Shaywer and Pizzali, 2003) .

Two very interesting cases are the introduction of insulated fish containers in the pirogue fleet of Senegal and onboard «navas» -- the traditional fishing vessels of Kakinada in Andhra Pradesh, India. The Senegalese example has spread steadily to comparable fisheries in West Africa (Gambia, Guinea-Bissau and Guinea) that are have adopted the use of similar insulated containers.

After landing, fish handling procedures are those described above. They often include sorting/grading, gutting/washing, chilling, chilled storage, unloading. These operations can also be done manually or using fully. Depending on the fish species, its final destination and form, fish may be subjected to one of various techniques of processing to preserve quality and increase shelf life. These techniques are designed to inhibit or reduce the metabolic changes that lead to fish spoilage by controlling specific parameters of the fish and/or its environment. They can be classified as follows:

Techniques based on temperature control: These technologies are designed to decrease fish temperature to levels where metabolic activities -- autolytic or microbial -- are reduced or completely stopped. This is possible by refrigeration or freezing where the fish temperature is reduced, respectively, to approximately 0 °C or < - 18°C. Fish refrigeration can use cool air circulating around the fish (mechanical refrigeration) or icing. Fish icing and boxing on-board fishing vessels is not always possible for example in the case of small pelagics (sardines, anchovies, mackerel) which are caught in large quantities. These are chilled using refrigerated seawater (RSW) or chilled seawater (CSW), seawater chilled by mixing it with ice. Chilled or frozen fish products require additional cooling in cold store to avoid an increase in temperature. The design (size, insulation, palletization) and management of cold stores are key for fish quality and energy saving. A major environmental issue relates to phasing out of the chlorofluorocarbons (CFCs) refrigerants, which are harmful to ozone layers and contribute to greenhouse effects.

Techniques based on the control of water activity: Water activity (aw) is a parameter that measures the availability of water in fish flesh. It is expressed as the ratio of water vapor pressure in fish/vapor pressure of pure water at the same temperature and pressure. Aw varies from 0 to 1. Water is necessary for microbial and enzymatic reactions and several preservation techniques have been developed to tie up this water (or remove it), making it less available for enzymes. These include drying, salting, hot smoking, freeze-drying, the use of water binding humectants and a combination of these. Some of these techniques, such as drying, salting and hot smoking, have been used for thousands of years. They can be implemented very simply, e.g. by manual salting, solar drying, or using fully-automated equipment with temperature and relative humidity control, etc.

Techniques based on the control of microbial fish loads, its chemical and enzymatic activity: These physical methods use heat (cooking, blanching, pasteurization, sterilization), ionizing irradiation (for pasteurization or sterilization) or microwave heating. Cooking or pasteurizing are processes that do not allow complete inactivation of micro-organisms and thus often need to be combined with refrigeration to preserve fish products and increase their shelf life. On the other hand, sterilized products are stable at ambient temperatures. These require packaging in metal cans, thus the term “canning”, or retortable pouches before the heat treatment.

Techniques based on the chemical control of microbial activity and loads: These techniques are designed to add antimicrobial agents or decrease the fish muscle pH to levels that are inhibitory to microbial growth and proliferation. Most bacteria stop multiplying at pH < 4.5. The decrease of pH is obtained by fermentation, marinades or by adding acids (acetic, citric, lactic, etc.) to fish products. In addition to the decrease in fish pH, fish fermenting lactic bacteria also produce antimicrobial compounds such as nisin, which improve preservation. This technique is often referred to as bio-preservation. Other preservatives include nitrites, sulfites, sorbates, benzoates or natural compounds such as essential oils.

Techniques based on the control of the oxido-reduction potential: Metabolism of spoilage bacteria and lipid oxidation require oxygen. Reducing oxygen availability around fish will increase its shelf life. This is possible by vacuum packaging or by controlling or modifying the atmosphere around the fish. Controlled (CA) or modified atmosphere (MA) are characterized by specific combinations of CO2, O2 and N2. Vacuum packaging, CA and MA storage are often combined with refrigeration for fish preservation.

Combination of several preservation techniques: Two or more of these techniques can be combined to improve preservation efficiency while reducing undesirable effects such as the denaturation of nutrients by severe heat treatments. Combinations already in use include pasteurization-refrigeration, CA (or MA)-refrigeration, salting-drying, salting-smoking, drying-smoking and salting-marinating.

Other forms of processing: In addition to preservation, fish can be processed into a wide array of products to increase its economic value. This has become more important because of societal changes that have led to the development of outdoor catering, convenience products and food services requiring fish products ready to eat or requiring little preparation before serving. An example of value addition is the production of surimi and surimi-based products. Surimi is a mechanically deboned, washed (bleached) and stabilized fish flesh. It is an intermediate product used in the preparation of a variety of ready to eat seafood such as Kamaboko, fish sausage, crab legs and imitation shrimp products. Surimi-based products have gained good notoriety world-wide, because of the emergence of Japanese restaurants and culinary traditions in North America, Europe and elsewhere. Ideally, surimi should be made from low-value, white-fleshed fish with excellent gelling ability and which are abundant and available the year-round. At present, Alaskan pollack accounts for a large proportion of the surimi supply. Other species, such as sardine, mackerel, barracuda, striped mullet have been successfully used for surimi production.

Transportation: Fish transportation is an important link in the fish and seafood value chain. Fish is transported live, fresh, frozen, cured or canned. It is transported by sea, air or land. Live, fresh and frozen fish require special care in comparison with cured or canned fish. The cold chain and its maintenance during transportation is key for preserving fish safety and quality.

Transportation of live fish requires oxygen for respiration and removal of the toxic gases and by-products that accumulate, such as CO2 and ammonia. Certain fish, like catfish, can obtain oxygen through the damp surface of their gills or through the body skin. Other fish, like the climbing perch, have accessory air-breathing organs. But most finfish are transported live in water supersaturated with oxygen and kept at a temperature low enough to reduce their metabolism. Some tropical fish may not support temperatures below 10°C. Fish is often Starved (also called conditioned) before transportation to reduce its metabolism and increase the packing density. Crustaceans (lobsters, crabs) are transported live in wet packages using wet sawdust or other ways to keep the atmosphere surrounding the live animals humid and cool.

Air cargo is responsible for transporting over 5 percent of the world catch and the increasing demand for fresh fish fuels a growing demand for air shipment of fish. However, successful air transport of fish and seafood requires special care in preparation and handling of the shipments, and excellent communication among the shipper, carrier and consignee along the supply chain.

Also, it should be stressed that hubs often necessitate cargo transfers under tight schedules and the reliance on combination passenger-cargo, entry and exit in all markets can influence the timing of the delivery and the quality of the delivered products. Airport should be equipped with cold stores and manned inspection offices to expedite clearances. For example, important volumes of high value demersal fish (grouper, seabass, sole, saint pierre, etc.) are shipped by air from Senegal, Mauritania to Paris (Rungis market), before being distributed to other European capitals.

The most challenging aspect of fish transportation by sea or by road is the maintenance of the cold chain, for fresh, chilled and frozen products and the optimization of the packing and stowage density. Maintaining the cold chain requires the use of insulated containers or transport vehicles and adequate quantities of coolants or mechanical refrigeration. Continuous temperature monitors and recorders are used to provide evidence that the cold chain has not been broken during transportation.

Recent development in food packaging and handling enables rapid and efficient loading, transport and unloading of fish and fishery products by road or by sea. Also, transport of fish by sea allows for the use of special containers that carry fish under vacuum, modified or controlled atmosphere, combined with refrigeration.

Clean technologies: Cleaner Production involves the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment. It encompasses the conservation of raw materials, water and energy, the elimination of toxic raw materials, and the reduction of wastes and emissions.

Aquaculture production and post- harvest fish processing typically consume s significant quantities of water and energy and discharge s significant quantities of organic material, both as effluent and as solid waste. Water is used extensively in fish processing. Its saving requires an analysis of water use patterns to identify wasteful practices and ways to address them, including by recycling water, without compromising food hygiene standards.

Management of effluents should focus on reducing the pollutant load of the effluent. Opportunities for reducing the pollutant load of fish processing effluent principally focus on avoiding the loss of raw materials and products to the effluent stream. This means capturing materials before they enter drains and using dry cleaning methods. Improvements to cleaning practices are an area where the most gains can be made.

Significant reductions in energy consumption are possible through improved housekeeping, maintenance of equipment and optimization of existing processes, the use of more energy-efficient equipment and heat recovery systems. Also, there are opportunities for using more environmentally benign sources of energy. Opportunities include replacing fuel oil or coal with cleaner fuels, such as natural gas, purchasing electricity produced from renewable sources, or co-generation of electricity and heat on site.

2.2. Fish and seafood quality and safety management

2.2.1 A brief history

Concern about food control and consumer protection dates back thousands of years. For example, the Romans had a well-organized state food control system to protect consumers from frauds and bad produce. Likewise, in Europe during the Middle Ages, individual countries passed laws concerning the quality and safety of various foods.

A major development took place in Europe following the industrial revolution in the nineteenth century. The associated demographic changes resulting from urban development created a massive demand for food that could be processed and stored. This was the start of the modern food processing industry. In the early days there were many examples of food adulteration leading to demands for a more systematic system of food control.

Starting in late nineteenth century, important developments in food safety and quality were achieved, stimulated by the discovery of microbiology and of major developments in food chemistry. Several studies linked specific agents to epidemics of diseases and documented routes by which these agents can be transmitted to humans, including through foods and water. This enabled major advances in public health to significantly reduce the burden of several devastating epidemic diseases. These achievements were consolidated further during the second part of the twentieth century to accompany the rapid developments and progress in food production, processing and distribution.

During the 1950s, many developed countries were primarily concerned with securing food supply to overcome post-war scarcity. Followed several decades of change with the expansion of modern techniques for processing, packaging, storage and distribution. Farmers relied to a greater extent on pesticides to protect crops, on additives and flavoring agents which integrated the food chain as localized production declined and large-scale food production grew. These chemicals needed to be regulated and proper enforcement of the regulations was required.

In the 1980s, globalization of food trade took off, with more food products crossing national and continental borders. Concurrently, several food scares, caused by bacteria (e.g. Salmonella) and chemicals (e.g. mycotoxins) increased the importance of food safety as an issue of major public concern. This concern was exacerbated during the 1990s because of "mad cow disease" and the "dioxin crisis", which forced regulators to revise food safety strategies integrating the various components of the value chain and introducing traceability requirements.

Since the beginning of this millennium, food production, processing and distribution became more globalized and complex and market choices even wider. Other food scares emerged globally. Media focus and consumers developed greater interest in food safety, ethical practices, environmental and social impacts of food production, processing and distribution. In parallel, further globalization of supply chains, vertical integration using direct contracts between suppliers and importers/retailers and the expansion of supermarkets in food retailing, in developed and developing countries, has led the retail sector to adopt various private standards and certification schemes. This responded s to the increasing influence and concerns of civil society related to health, social and environmental issues of fisheries and aquaculture. By so doing, the retail sector hoped to address the legal requirements of companies to demonstrate «due diligence» in the prevention of food safety risks, environmental and social protection, to attend to the growing need for «corporate social responsibility CSR» and to minimize «reputational risks».

Expansion of the food industry and food distribution systems across borders and continents required the development of quality assurance systems to support business to business (B2B) contractual agreements and verification of conformity of food supplies with the specifications. At the same time, the development of bilateral, regional and multilateral trade agreements brought about changes in national and supra national food control systems to harmonize requirements and procedures. To adapt to these changes, government and industry, in collaboration with academia and research institutions, worked on the development of codes of good agriculture, hygienic and manufacturing practices and preventative food safety and quality systems.

2.2.2 Modern food safety and quality management

As stated above, food safety and quality management systems have been based on establishing effective hygiene control and monitoring performance. In the past, confirmation of safety and quality was achieved by end-product testing. Control of hygiene was by inspection of facilities to assess adherence to established and generally accepted Codes of Good Hygiene Practices (GHP) and of Good Manufacturing Practices (GMP).

In addition to diverting important resources, sampling and testing finished products presents other shortfalls, not the least giving a sensation of "being in control" and creating a false sense of security. For example, let's consider a lot of 1000 of seafood cans with one percent defective units ((that is 10 defective cans in 1000 and therefore 10 cans out of 1000 not acceptable for human consumption). Lot inspection consists generally in drawing randomly a sample of 5 cans, of which none should be defective after analysis, otherwise the lot is rejected. In theory, the probability of accepting the lot is P = C50 (0.99)5 (0.01)0 = (0.99)5 = 0.951. In other words, the probability of accepting this specific lot of 1000 seafood cans is 95.1 percent. This implies that similar lots will be considered acceptable for human consumption 95.1 percent of the time or 95 times out of 100. This is a high probability even though there are 10 defective cans in the lot. It is even worst when the defect is linked to food safety. Ten unsafe cans will be authorized for human consumption 95.1 percent of the times. This is a high and unacceptable risk, which can be decreased by increasing the size of the sample. But the risk can never reach zero unless we analyze 991 or more cans out of 1000 to detect one or more defective ones in the lot. Unfortunately, this is not feasible and there is a limit as to the number of samples we can analyze.

To overcome this severe shortcoming and ensure high level of food safety and consumer protection, it became imperative to rely on approaches that prevent the hazard from entering the food chain at the source or reduces its likelihood to acceptable levels reflecting proper application of internationally accepted best practices.

As a result, it became imperative to adopt an integrated approach to safety and quality, considering the entire food chain. The food chain approach is recognition that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire chain by all involved with the production, processing, trade and consumption of food. In fisheries and aquaculture, there are five undertakings on which a strategy in support of the food chain approach to food safety should be based:

• Fish safety and quality should incorporate the three fundamental components of risk analysis - assessment, management and communication – and, within this risk analysis process, there should be an institutional separation of science-based risk assessment from risk management – which is the regulation and control of risk;

• Credible traceability from the primary producer (including feed, seed and medicines used in aquaculture), through post-harvest treatment, processing and distribution to the consumer;

• Harmonization of fish quality and safety standards, implying the use of internationally agreed, scientifically-based standards in international fish and seafood trade;

• Equivalence of food safety and quality systems – Recognizing a food safety management system (e.g. system of the exporting country) equivalent to another (e.g. system of the importing country) should be based on achieving the same acceptable levels of protection (ALOP) for safety and quality regardless of the means of control used; • Increased emphasis on risk avoidance or prevention at source from - from farm or sea to plate – through the development, dissemination and enforcement of GAP, GHP, GMP and HACCP.

Implementation of the food chain approach requires an enabling policy and regulatory environment with clearly defined rules and standards, the establishment of appropriate food control systems and programmes at national and local levels, provision of appropriate training and capacity building, and ownership by the industry of GAP, GHP,GMP and HACCP.
This approach defines clear and complementary roles for the different stakeholders:

• In addition to an enabling policy and a regulatory environment, government institutions should organize the control services, train personnel, upgrade the control facilities and laboratories and develop national surveillance programs for relevant hazards;

• The industry should upgrade facilities, train personnel and implement GAP, GHP, GMP and HACCP;

• The support institutions (academia, trade associations, private sector, NGOs, etc.) should provide quality training, conduct research on quality, safety and risk assessment, and provide targeted technical support to stakeholders; and

• Finally, consumers and consumer advocacy groups and other NGOs have a counterbalancing role to ensure that safety and quality are not undermined by political or economic considerations solely when drafting legislation or enforcing safety and quality policies and regulations. They also have a major role in educating and informing the consumer about the major safety and quality issues.

In the case of fisheries and aquaculture, safety and quality builds on best practices that aim at preventing the contamination of fish, crustaceans and shellfish during harvesting, landing, handling, processing and distribution and preventing microbial growth after harvesting. Figure 4.2 describes broadly the main elements of a food safety and quality system for the 3 major fish and seafood value chains (Ababouch, 2014). Depending on the fish species, prevention identifies key control measures, such as:

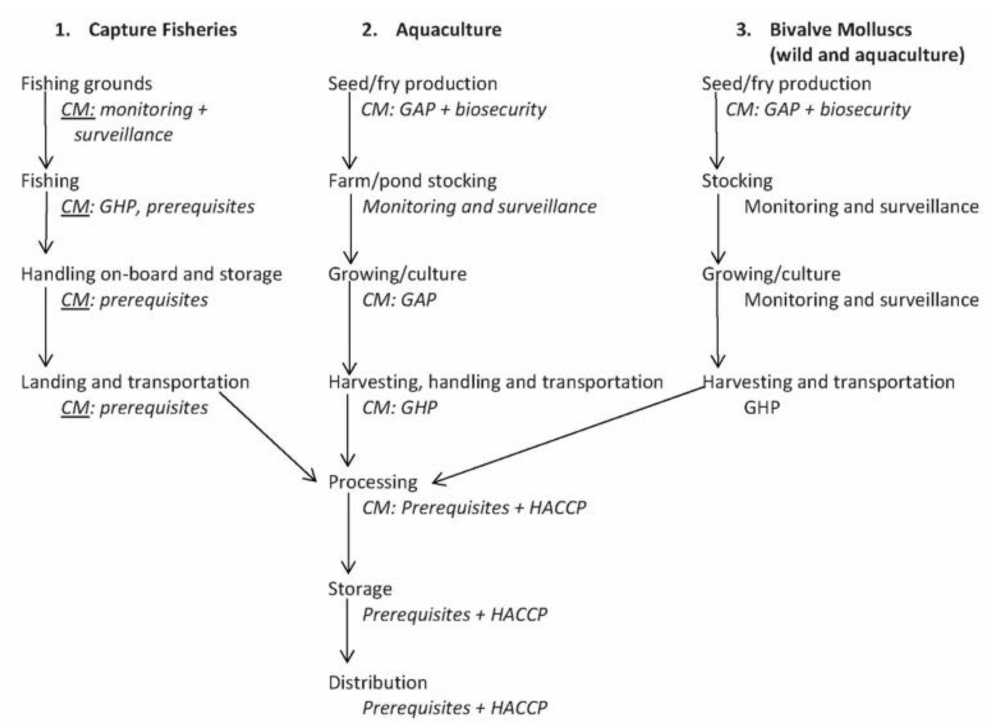
- Monitoring the harvesting grounds (e,g. for bivalve molluscs to prevent biotoxins accumulation or for some fish species to control the level of heavy metals);
- Implementing GAP, GHP and GMP during the post-harvest stages; and
- Enforcing the CM of the food safety and quality management system.

Government authorities are responsible for monitoring the harvesting grounds and certifying that good practices are adhered to on board fishing vessels, in hatcheries and fish farms and during processing and distribution.

2.2.2.1 Monitoring of the harvesting grounds

Fishing should be carried out only in clean waters. Regular monitoring of the water quality is key in assessing whether the area is suitable for harvesting fish, crustaceans or bivalves for human consumption. Open seas are unaffected by pollution and the finfish and crustaceans harvested in these areas are generally clean and fit for human consumption. Monitoring programs are required for certain fresh water, estuaries and coastal waters exposed to a risk of contamination by sewage, where shore side industries are located, or intensive agriculture using pesticides or other agro-chemicals is practiced.

Figure 4.2. Fish and seafood safety management in fisheries and aquaculture (Ababouch, 2014)



CM: Control measure; GAP: Good Aquaculture Practice; GHP: Good Hygienic Practices

Source: (Ababouch, 2014)

The monitoring programs are generally enacted through regulations that define responsibilities of food control authorities that will manage the monitoring programs, although research and industry are also involved. Environmental monitoring can identify species susceptible to contamination, magnitude of contamination and spatial distribution of contamination. For example, In the EU, monitoring fishing and aquaculture areas for environmental contaminants has been included as a part of the regulatory food safety management. A Guide for the establishment of environmental (EMP) and residue (RMP) monitoring plans for compliance with EU regulations has been developed for use by countries exporting fish to the EU. The development of sampling and analysis plan by a team consisting of the food control authority, research and industry, should be based on the knowledge of the fishery and the likely sources of contamination. When contaminants above permissible limits are found, it is necessary to:

- Trace the source of contamination;
- Define the affected area and map the boundaries;
- Suspend fishing in affected areas; and
- Review the status with further sampling and analysis.

Monitoring and surveillance programs are also required for areas where bivalve molluscs are grown. The main hazards associated with the production of bivalve molluscs is contamination by bacteria, viruses or biotoxins from the harvesting waters. The identification, classification and monitoring of these areas is a responsibility for the Competent Authority (CA) in cooperation with fishermen and primary producers. E. coli/faecal coliforms or total coliforms may be used as an indicator for the possibility of faecal contamination. The results of the microbiological analysis would enable the competent authority to classify the growing areas as either:

- Suitable for harvesting bivalves for direct human consumption,
- Relaying the harvested bivalves in acceptable water. Relaying is the removal of bivalve molluscs from a microbiologically contaminated growing area to an acceptable growing or holding area under the supervision of the competent authority and holding them there for the time necessary for the reduction of contamination to an acceptable level for human consumption;
- Depuration of the harvested bivalves in an approved depuration center. Depuration is the reduction of micro-organisms to a level acceptable for human consumption by the process of holding live bivalve molluscs for a period of time under approved, controlled conditions in natural or artificial seawater suitable for the process, which may be treated or untreated;
- Approved processing to reduce microbial contamination to acceptable level; or
- Non-suitable for growing or harvesting bivalve molluscs.

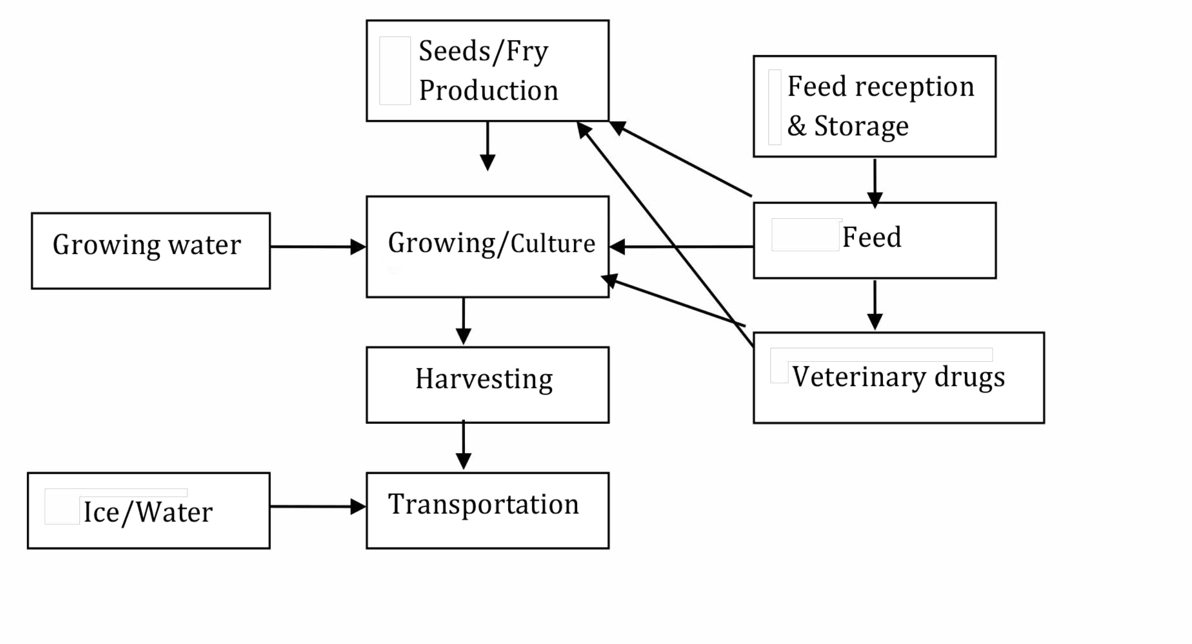
When sampling shellfish meats for classification purposes, if the limits of any biological or chemical hazard set in the end product specification are exceeded, appropriate measures must be taken under the responsibility of the CA. If biotoxins are found in the bivalve molluscs flesh in hazardous amounts the growing area must be closed for harvesting until toxicological investigation shows that the bivalve mollusc meat is free from hazardous amount of biotoxins. Harmful chemical substances should not be present in the edible part in such amounts that the calculated dietary intake exceeds the permissible daily intake.

2.2.2.2 Good Aquaculture Practices

Assurance of fish and seafood safety and quality in aquaculture requires the adoption and implementation of Good Aquaculture Practices (GAP) as pre-requisites for the implementation of the Hazard Analysis Critical Control Point (HACCP) system. The following good practices apply to the various aquaculture systems of finfish and crustaceans. The main stages of aquaculture production covered are site selection, growing water quality, source of fry and fingerlings, feeding, growing, harvesting and transport.

[28] http://sfp.acp.int/sites/all/files/tmp/07_07_ACP_EMP_RMP_Guide_EN_2.pdf

Figure 4.3. Example of a flow chart for aquaculture (only for illustrative purpose)



Source : Author

Site selection: Food safety hazards can arise from the location of the fish farm as a result of its surroundings, through the water supply, direct contact with livestock or wild animals, or airborne contamination (i.e. chemical sprays). Nearby agricultural lands that use pesticides and heavy fertilization on a regular basis could be a potential source of contamination. Fish farms should be located in areas where the risk of contamination by biological, chemical, or physical food safety hazards is minimal and where sources of pollution can be controlled. All potential sources of contamination from the environment should be considered. In particular, fish farming should not be carried out in areas where the presence of potentially harmful substances would lead to unacceptable levels of such substances in fish.

Growing water: The water in which fish is raised should be suitable for the production of food which is safe for human consumption. Fish farms should not be sited where there is a risk of contamination of the water in which fish are reared by chemical or biological hazards. Water sources should be protected from contamination by wild (birds, lizards, snakes, turtles and rats) and domestic (cattle, pig, chicken, ducks, cats, dogs,) animals, effluents and runoffs. Fish farms should be designed and built to ensure control of hazards and prevention of water contamination. Water inlets and outlets to ponds should be screened to prevent the entrance of unwanted species. Water quality should be monitored regularly to prevent fish contamination during production.

Source of Fry and Fingerlings: The source of post larvae, fries and fingerlings should be controlled to avoid the carryover of potential hazards into the growing stocks. In endemic fish borne parasitic areas, the source of fries and fingerlings should be controlled to assure that seeds are free from parasitic infection. Contaminated sources are common in endemic trematodiasis areas.

Feed Supply: Feed can transmit harmful agents directly or by attracting pests. Feed ingredients should not contain unsafe levels of pesticides, chemical contaminants, microbial toxins, or other adulterated substances. Feed should contain only such additives, growth promoting substances, fish flesh colouring agents; anti-oxidizing agents, caking agents or veterinary drugs which are permitted for fish by the CA. Industrially produced feeds and feed ingredients should be properly labelled. Their composition must fit the declaration on the label.

Medicated feeds should be clearly identified in the package and stored separately, to avoid errors. Dry fish feeds should be stored in cool and protected dry areas to prevent contamination, mould growth and spoilage. Moist feed or feed ingredients should be properly refrigerated and reach the fish farm in an adequate state of freshness. Fish silage, trash fish and offal from fish, if used, and where necessary, should be properly cooked or treated to eliminate potential hazards to human health.

Veterinary Drugs: All veterinary drugs for use in fish farming should comply with national regulations and international guidelines. Drugs used on the farm should be registered with the appropriate national authority. Control of diseases with drugs should be carried out only on the basis of an accurate diagnosis. Drugs should only be prescribed or distributed by personnel authorized under national regulations and should be used according to manufacturer's instructions, with particular attention to withdrawal periods. Records should be maintained when veterinary drugs are used. Growing: The growing phase includes various activities that can significantly affect the safety and quality of farmed fish. There is a need to control the growing water quality, the pests around the farm, the design and cleaning of equipment and holding facilities, the maintenance of pond grounds and the workers' hygienic practices.

Good maintenance of the farm grounds and GHP in the growing area and surrounding area should be applied to minimize or eliminate faecal contamination of pond water. A major concern is the contamination by pathogenic bacteria or parasites from waste materials or faecal matter from animals or workers. Fish farms should institute a pest control programme. Good water quality should be maintained by using stocking and feeding rates that do not exceed the carrying capacity of the aquaculture system. Stocking densities should be based on culture techniques, fish species, size and age, carrying capacity of the fish farm, anticipated survival and desired size at harvesting. Diseased fish should be quarantined when necessary and dead fish should be disposed of immediately in a sanitary manner.

Harvesting, holding and transportation: Appropriate harvesting techniques should be applied to minimize spoilage, physical damage and stress in the case of live fish. Harvesting should be rapid so that fish are not exposed unduly to high temperatures. In tropical areas, harvesting should be done during the night at a time when temperature is lowest (e.g. at night). Soon after harvest, fish should be washed using clean seawater or freshwater under suitable pressure to remove excessive mud and weed and be iced or immersed in ice slurry to bring and maintain its temperature to around 0 °C. Equipment and utensils such as nets, bags, pumps, baskets, tubs, bins, boxes, should be designed and constructed to ensure minimum physical damage of the fish during harvesting. All equipment and utensils used during harvesting should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate. Ice should be made from clean potable water.

Holding and transportation should be rapid so that fish are not exposed unduly to undesirable high temperatures. Fish should be packed in ice or immersed in ice slush aiming at keeping the temperature as closer as possible to 0 °C. All equipment for fish holding and transportation should be easy to clean and to disinfect and should be cleaned and disinfected regularly as appropriate. Live fish should be handled in such way as to avoid unnecessary stress. Records for transport of fish should be maintained to ensure full product tracing.

2.2.2.3 Good practices and HACCP in post-harvest operations

Pre-requisite Programmes: As stated earlier, several pathogens and spoilage bacteria can contaminate fish and seafood during handling, processing or distribution, either from handlers, equipment, surrounding environment or other sources such as cleaning water or ice. To prevent this contamination from taking place, GHP should be applied at all stages of harvesting, processing, storage and distribution. The requirements for hygienic practices constitute the pre-requisite programs which are essential for any fish and seafood operation prior to the implementation of HACCP.

The basis for developing and implementing GHP is the Codex Code of Practice for Fish and Fishery Products (CPFFP) (WHO/FAO, 2012). Its provisions are used by countries to draft national fish and seafood hygiene regulations, and by fish and seafood trade associations and companies worldwide for drafting their food safety and quality policy.

[29] http://www.fao.org/3/a-i2382e.pdf

A pre-requisite program should include hygienic requirements for:

- Fishing vessel design and construction;
- Processing facility design and construction;
- Design and construction of equipment and utensils;
- Hygiene control program;
- Personal hygiene and health;
- Transportation;
- Traceability and recall procedures; and
- Training.

For example, the FDA regulations require processors to have key sanitary conditions written into Sanitation Standard Operating Procedures (SSOPs), to monitor these conditions and practices, to correct unsanitary conditions and practices in a timely manner and maintain sanitation control records. The SSOP should address at least the following eight conditions and practices:

- Safety of water and ice;
- Condition and cleanliness of food contact surfaces;
- Prevention of cross contamination of food from unsanitary objects;
- Maintenance of facilities for personal hygiene
- Protection of food, food packaging and food contact surfaces from adulteration;
- Proper labelling, storage and use of toxic compounds;
- Control of employee health conditions; and
- Exclusion of pests.

Likewise, the European Commission's "Hygiene Package" addresses the prerequisite requirements both in 'horizontal' legislation and 'vertical' or commodity-specific legislation laying down specific hygiene rules for food of animal origin, including fish and fishery products. These rules address the following:

Chapter I. Requirements for vessels
Chapter II. Requirements during and after landing
Chapter III. Requirements for establishments, including vessels, handling fishery products
Chapter IV. Requirements for processed fishery products
Chapter V. Health standards for fishery products
Chapter VI. Wrapping and packaging of fishery products
Chapter VII. Storage of fishery products
Chapter VIII. Transport of fishery products

Hazard Analysis Critical Control Point Principles and their application: Hazard Analysis Critical Control Point (HACCP) is a system which identifies, evaluates and controls hazards which are significant for food safety (WHO/FAO, 2012; Ryder et al., 2014). It is a science-based and systematic tool that assesses hazards and establishes control systems which focus on prevention rather than relying mainly on end product testing. It not only has the advantage of enhancing the safety of the product but, because of the means of documentation and control, it provides a way for demonstrating competence to customers and compliance with legislative requirements to the food control authorities.

The logic sequence for the application of HACCP identifies 12 tasks by the Codex CPFFP:

- Assemble the HACCP Team;
- Describe Product;
- Identify Intended Use;
- Construct Flow Diagram;
- Confirm Flow Diagram;
- Conduct Hazard Analysis;
- Determine Critical Control Points or CCPs (using the Decision Tree);
- Establish Critical Limits for each CCP;
- Establish a Monitoring system for each CCP;
- Establish Corrective Action;
- Establish Verification Procedures; and
- Establish Documentation and Record keeping.

A HACCP plan is a final document that describes how a fish or seafood operation will manage the identified critical control points for each product under its particular environment and working conditions. The following are the details on how to apply the above sequence for the preparation of a specific HACCP plan.

HACCP has been in a constant state of evolution for the last 40 years. Implementation by the fish industry has been slow and at times painful – process that is still in progress in many parts of the world. Application guidelines, pre-requisite programs, decision trees and training programs have been developed and implemented. Training and technical assistance have been provided by international organizations, industry associations, extension services, food control authorities, private consulting companies, etc. Many good examples of HACCP plans, training videos, guides and manuals can be accessed via internet. Several references provided in this manual provide a detailed description of a step-wise procedure to develop HACCP plans for a specific seafood processing company. The interested reader is encouraged to study these examples to learn and practice elaborating HACCP plans. It is recommended to consult and follow the step by step methodology proposed in Ryder et al., 2014.

Currently, most national food control agencies and international institutions have adopted regulations, guidelines, codes and procedures for the development and implementation of HACCP plans by the fish industry. As a consequence of HACCP becoming the food safety regulatory system of choice, policy issues have been shaping its evolution, sometimes more than science. For policy makers, it is important to ensure that food safety policy frameworks maintain the science basis at the heart of HACCP development to embrace technological developments and the food safety challenges they bring along.

HACCP can be used to deal with both safety and quality issues, although some regulatory agencies, such as the FDA, have confined it only to safety aspects. Experts in food science argue that given that many control measures (e.g. hygiene, refrigeration, use of ice, thermal treatment, etc.) actually prevent the growth of micro-organisms of concern to both safety and quality, it is advisable to use HACCP to address both aspects. The additional burden is related to further record keeping and documentation to address both safety and quality, and consequently the additional time and manpower needed to verify and audit these records by the food control authorities. The Codex CPFFP recommends addressing both safety CCPs and quality defect action points or DAPs.

A defect is defined as the condition found in a product that fails to meet essential quality, composition and/or labelling provisions of the appropriate Codex product standards. A DAP is defined as a step at which control can be applied and a quality (non-safety) defect can be prevented, eliminated or reduced to an acceptable level, or a fraud risk eliminated.

The analysis of potential defects and identification of DAPs follows the same procedures as when conducting a hazard analysis. Defects may, as hazards, be of (micro)biological, chemical or physical (Ryder et al., 2014). The substitution of one (lower value) fish species for another (high value) is an example of a biological defect. Whether intentional or not, it is a fraud. Similarly, raw materials for production of semi-preserved herring must have a specific lipid content for the right ripening and texture to develop. Therefore, lower or higher lipid content is a biological defect. This should be monitored on the incoming raw material and batches.

HACCP in aquaculture: In aquaculture, the application of GAP is effective for preventing and controlling most, if not all food safety and quality hazards at the farm. That is why many regulatory authorities emphasize that mandatory implementation of GAP is sufficient for operating fish farms to supply safe and quality fish. However, many experts and the Codex stress that integration of GAP into HACCP-based systems at the farm level leads to improved cost effectiveness and real time prevention and control of hazards. While most control measures and critical limits are well specified in regulatory GAP, the additional requirements such as hazard analysis, identification of corrective actions, monitoring and HACCP verification allows the aquaculture farm to take ownership of its fish safety and quality program, respond in real time to food safety challenges and develop recordkeeping and traceability trails necessary for government or private audit and certification. In addition to being doable and cost effective, the application of HACCP in aquaculture complements effectively bio-security measures taken to prevent fish diseases. Currently, in several countries around the world an increasing number of aquaculture farms are applying HACCP-based concepts to control food safety and quality. The challenge for small scale farmers is being tackled in many countries such India, Thailand, Vietnam

Bangladesh or Indonesia, by organizing the farmers into clusters or self-help groups, whereby grouping farmers/farms enables the group/cluster to reach a size suitable for the application of GAP and HACCP with technical support from specialized extension institutions.

Training: Practical training in pre-requisites, GHP, GAP and HACCP is fundamental for operating good safety and quality assurance programmes in fisheries and aquaculture. All personnel should be aware of their role and responsibility in protecting fish and seafood from contamination and deterioration. Handlers should have the necessary knowledge and skill to enable them to handle fish hygienically. Those who handle strong cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques.

Each fish and seafood facility should ensure that selected individuals have received adequate and appropriate training in the design and proper application of a HACCP system and process control. Training of personnel in the use of HACCP is fundamental to the successful implementation and delivery of the programme in fish or shellfish production, handling, processing and distribution. The practical application of such systems will be enhanced when the individual responsible for HACCP has successfully completed a course. Managers should also arrange for adequate and periodic training of relevant employee in the facility so that they understand the principles involved in GHP, GAP, pre-requisite and HACCP. Periodic assessment of the effectiveness of training and instruction programmes should be made, as well as routine supervision and checks to ensure that procedures are being carried out effectively.

Traceability: The Codex CPFFP defines "traceability/ product tracing as the ability to follow the movement of a food through specified stages of production, processing and distribution. This definition has been refined by the EU to signify "the ability to trace and follow a food, feed, food producing animal or substance intended to be, or expected to be incorporated in a food or feed, through all stages of production, processing and distribution".

Traceability is key to ensure that each stakeholder in the value chain is well informed of the origin and characteristics of the fish they handle and where it is going next. The fundamental and practical aspects of the role of traceability in fish and seafood safety is discussed in more details chapter 5.

HACCP audit and verification: Application of HACCP in fisheries and aquaculture is the responsibility of the production and processing industry, whereas government control agencies are responsible for monitoring and assessing proper implementation of pre-requisite programs and HACCP. Many inspection agencies have developed approaches and procedures for carrying out HACCP compliance auditing. These approaches and modalities have used the terminology and basic requirements of the ISO 10011 and ISO 19011 standards that were adapted to the specificities of HACCP and to the countries' regulations.

Audit is a systematic and independent examination to determine whether activities and results comply with the documented procedures and whether these procedures are implemented effectively and are suitable to achieve the objectives. In HACCP terms, achieving the objectives means managing the production and distribution of safe and good quality fish products through the use of a HACCP based approach. The outcome of the audit is to have established whether the manufacturer has:

- Developed and implemented a sound HACCP system;
- The knowledge and experience needed to maintain it;
- The necessary support (or prerequisite) programmes in place to assess adherence to Good Hygienic and Good Manufacturing Practices (GHP/GMP);

The audit will encompass assessment of the management commitment to support the system and assessment of the knowledge, competency and decision-making capabilities of the HACCP team members to apply the system and maintain it. Four types of HACCP audits can be envisaged:

- An internal HACCP audit to establish the effectiveness of the HACCP system using the company's own human resources or by bringing in an external HACCP assessor;
- An external HACCP audit of suppliers of raw materials or finished products to establish whether

they have robust HACCP systems in place. This includes regulatory HACCP auditing;

• Audit of the customers HACCP system. This may be important where the customer is responsible for the distribution and sale of a high risk (e.g. a chilled ready meal) product which bears the brand of the manufacturing company;

• An investigative audit can also be conducted to analyze a specific problem area. This may be used for example when a CCP regularly goes out of control and more studies are needed to investigate the real cause in order to take corrective action, or where a previously unknown problem has arisen.

A HACCP audit needs to be properly prepared describes the steps generally required in a HACCP audit. This guidance is useful for independent (third-party) audits as well as for internal or compliance audits. It should be adapted to the particular circumstances of the operation being audited. Detailed information about HACCP audit and verification should be reserved to those specialized persons needing it for their daily work. Information regarding these procedures will not be reviewed here in details. They are available in the documents referenced in this and via internet.

2.3. Sustainable fish and seafood value chains and economic performance

As discussed earlier, sustainability, quality and safety of fish and seafood is the responsibility of operators that influence any of these 3 attributes at one or more steps in the chain "from sea/farm to fork". This sequence of the steps is described as food chain, supply chain or value chain. These terms are sometimes used interchangeably although there is for either term not one standardized definition or a clear distinction of the differences they entail. For the purpose of this manual:

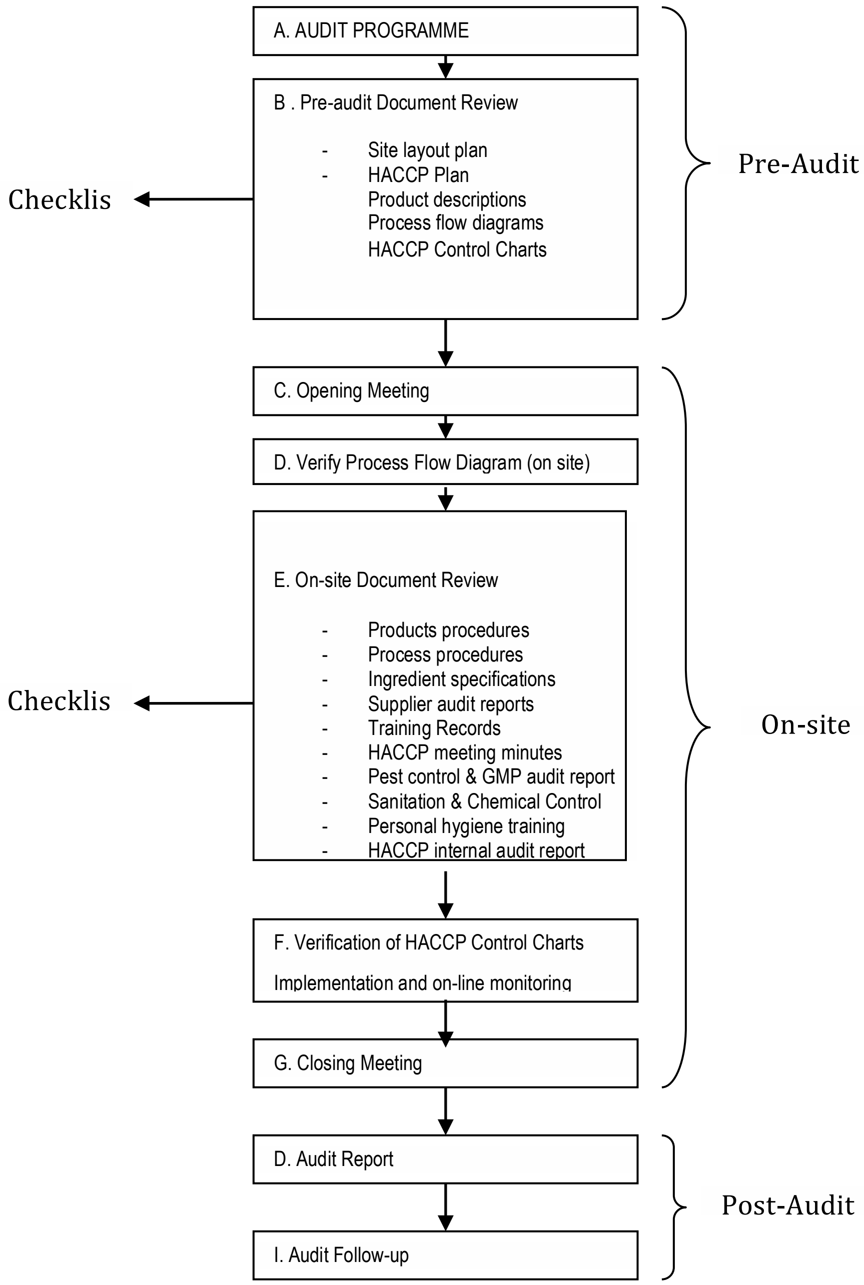
• A food chain, as defined by food safety experts, is the sequence of operations where hazards and defects can enter the chain and where they can be controlled by implementing appropriate control measure(s) to prevent the hazard or defect from occurring;

• A supply chain is a network of product-related operators (business enterprises) through which products move from the point of production to consumption, including pre-production and post-consumption activities;

• A value chain is a step further in evolution, as it moves beyond just bringing the product to market and aims at providing a more mutually beneficially environment for all stakeholders.

It is important to note that establishing good supply and food chains are essential to developing a value chain, as without a supply of safe and good quality products, adding value would not occur. In food chain, processes focus on safety and quality and how to prevent hazards and spoilage agents from entering the chain. This has been discussed in detail previously in this chapter. For supply chains, production is focused on efficient logistics using upstream and downstream businesses aimed mostly at pushing products to market. Supply chains are mostly concerned with costs and how long it takes to present the product for sale. The main objective of supply chain management is to maximize profits by reducing the number of links in the chain and keeping issues such as bottlenecks in supply, costs incurred, and time to market to a minimum. Typically, supply chains are made up of multiple companies that coordinate activities to set themselves apart from the competition. A supply chain has three key parts: supplying raw materials to manufacturing units; manufacturing raw materials into semi-finished or finished products; and distribution to ensure products reach consumers.

Figure 4.4. Steps required in a flow chart for aquaculture (only for illustrative purpose)



Source : Author

On the other hand, and similarly to supply chains, the main objectives of value chain management is to maximize net revenue, although in different manner. As the name suggests, value chains add incremental value to the product in the successive nodes of a chain either by value addition or value creation. This value is then realized from higher prices and/or the development of new (niche) products or expanded markets. For example, within fisheries and aquaculture, the term value addition is used to characterize adding value in products through some type of processing method – essentially converting raw fish to a resulting finished or semi-finished product that has more value in the market place.

Value creation is used to characterize fish and fishery products that have incremental value in the marketplace by differentiating them from similar products based on product attributes such as:

• Geographical location (Mediterranean tuna, Alaskan salmon, Thailand black tiger shrimp, etc.);

• Environmental labelling (ecolabelling, organic fish); and

• Food quality label (e.g. label rouge).

The smooth functioning of value chains requires the control of not only factors of production and technology but also efficient transport (e.g. cold chain), market information systems and management. Value addition can occur at different nodes of the chain, as the initial form of the product changes through steps in processing and distribution. Value creation can also occur by focusing on the factors of production and marketing to achieve a higher quality and better branded product.

The final value-added or value-created product can be a new product in the marketplace that has a competitive advantage over generic products as it satisfies a specific consumer demand and attracts a higher price. Therefore, value chains can be viewed as empowering the various, but often fragmented stakeholders as they recognize innovative opportunities to contribute and increase their product value. It is important to note that creating a successful value chain is not without its challenges, and stakeholders must begin with an understanding of a specific consumer demand at the right time and place.

A wide range of factors drives consumer demand for fish and fishery products, and these factors should be taken into consideration when creating a new value-added or value-created product. They include:

• Price;

• Consumer demographics;

• Nutritional content;

• Safety, substitutes;

• Tastes, presentation, convenience, fashion; and advertising and expectations of the consumers.

Once a specific demand has been identified, stakeholders must then work to create relationships between production, processing, distribution and marketing operators that can be trusted and within which information is shared freely and synergies developed. It is important for players in the value chain to think beyond just keeping costs to a minimum. Indeed, one of the main underlying ideas of a value chain is the recognition that consumer choices are not always price driven, as they may be willing to pay more for a value-added product. Supply chains, on the other hand, make assumptions that most consumers want the same product for less money, which generally leads to commodity markets and essentially no or little value added. Whereas in the case of a food chain organized around food safety, consumers take it for granted that the product they are buying is safe and free of any harmful bacteria or chemical.

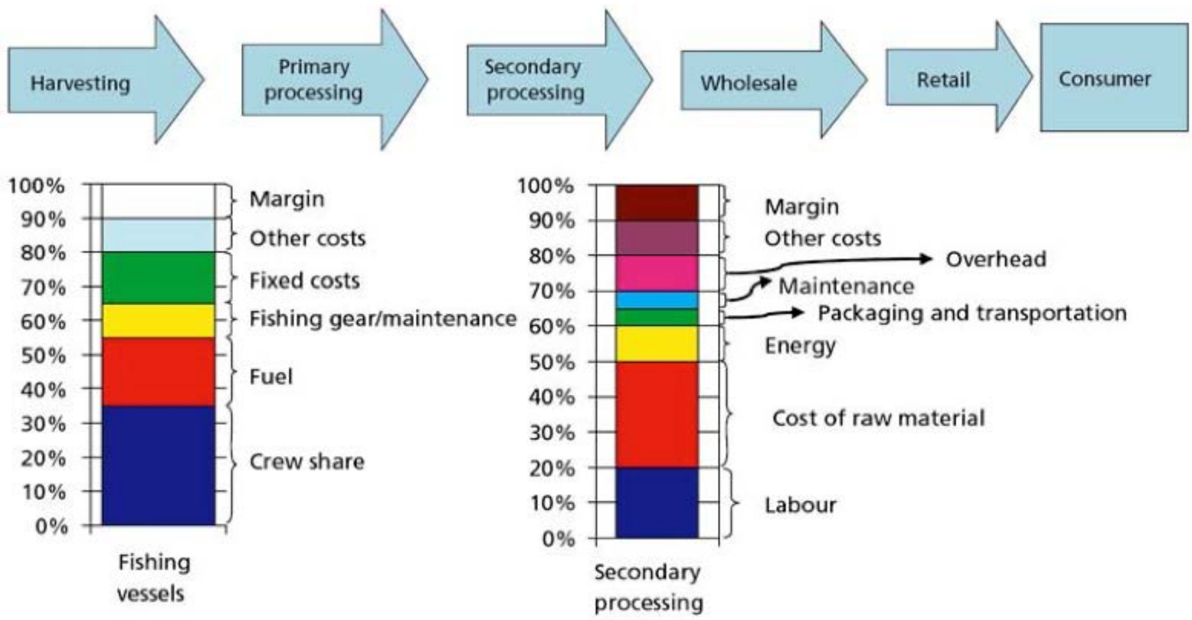
Interest in the application of the value chain approach to fisheries and aquaculture has gained momentum at the beginning of the millennium, with many studies and projects that looked at opportunities in developing countries, such as Gambia (UNCTAD, 2014), Cambodia (UNIDO, 2015a) or Cabo Verde (UNIDO, 2015b) to cite only few. However, some of these studies pioneered the work in terms of methodology and analysis. For the purpose of this manual we report in with some details on the following two studies.

2.3.2 Study by Gudmundsson et al., 2009

The first study measured the distribution of costs and benefits along 4 seafood value chains. It developed a methodology that is robust, yet simple, easily accessible and comparable to studies from sectors other than fisheries or aquaculture. The theoretical seafood value chain used is presented in figure 4.4 with six steps, although in reality, there could be fewer or more step, but each step serves as a function which is vital key for the entire value chain, i.e. each step adds value to the final product. Each step in the value chain is analyzed in terms of cost items and profit margin. This allows for calculation of the relative weight of each cost item in the overall chain. Figure 4.5 shows also an example of the cost items used in the analysis for the harvesting segment and for secondary processing. In order to make the comparison simpler the number of cost items has been kept to a minimum.

Each segment can then be evaluated as a share of the total consumer value. This allows direct comparison between domestically produced agricultural products, in particular animal products, and internationally traded seafood products. The comparison is interesting because one would expect significantly different outcomes since the value chain for international trade is considerably longer than for products traded domestically. Vertical integration has also been a major issue in the production and marketing of agricultural products, something which is increasingly seen in the seafood industry.

Figure 4.5. Value chain and examples of distribution of costs and benefits during fishing and secondary processing



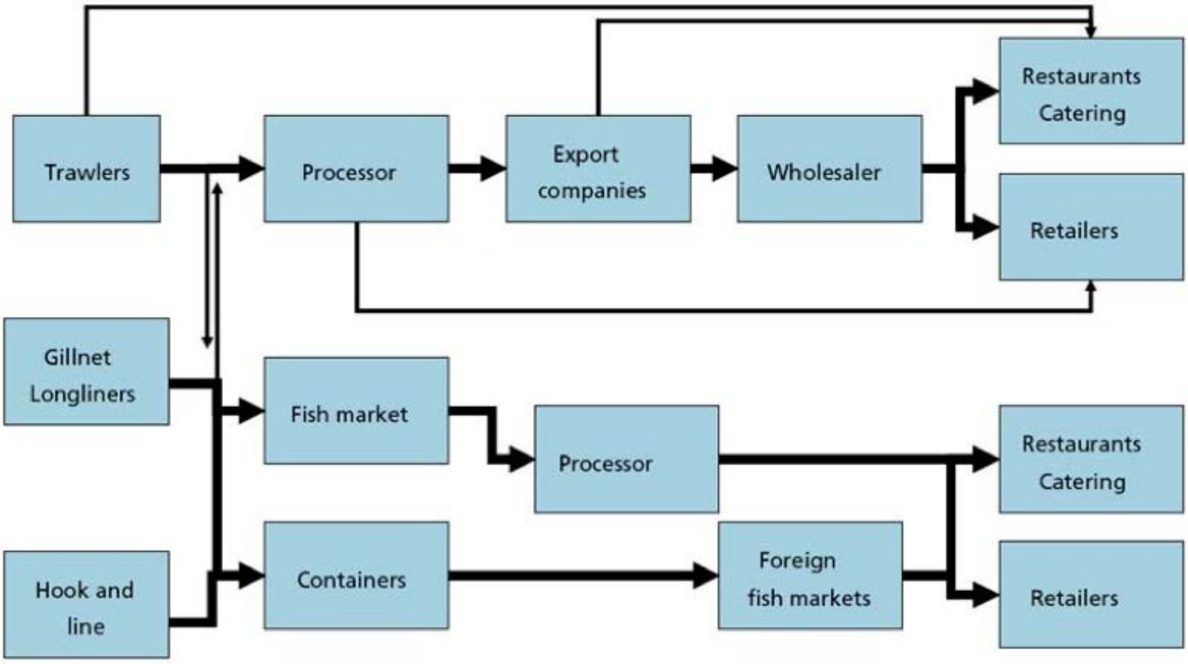
Source : Author

The methodology was applied to 4 seafood value chains that were comparable in pairs in terms of process and market segments. They were frozen cod from Iceland and frozen Nile perch from Tanzania, salted anchovies from Morocco and pickled herring from Denmark. Figure 4.6. shows illustrates the value chain of Icelandic cod.

The study confirmed that the seafood value chains had similar characteristics to value chains for agricultural products where the primary sectors receive a relatively lower share of the retail value of highly processed products and a higher share in less processed and fresh products.

The study also revealed that the developing countries (Morocco and Tanzania) seemed to control a relatively lower share of the overall value chain than developed countries (Iceland and Denmark). An example is the Icelandic owned companies which control as much as 70 percent of the entire value-chain while Tanzanian and Moroccan companies controlled less than 50 percent. This was perhaps the most important lesson to be learned. The Icelandic and Tanzanian products were very similar (frozen white fish fillets), going into the same market segments in Europe and the United States. The Icelandic export sector has been developing over the past 60 years and started with state monopolies on exports, ending with completely free trade of seafood products in the early 1990s. This has been a long process for the Icelandic companies, but it created few but strong export companies which strategically marketed their products under their own brand names.

Figure 4.6. Seafood value chain of Icelandic cod in 2009



Source : Author

The Danish companies in this study seemed to control a larger share of the value chain than their Moroccan counterparts, but this did not ensure higher profitability of the harvesting sector, mainly because of the drastic EU low fishing quotas within an oversized fleet and overcapacity for herring at the time of the study. The study confirmed that good fisheries management is a necessity for fishermen to reap the benefits from higher export prices. Without proper management in place increased demand on international markets leads to higher fishing pressures threatening the sustainability of the resource and profitability of the fishing companies.

This was also shown in the Icelandic and Moroccan fisheries where in both cases good management practices are in place, limiting the total catch to sustainable yields. Changes in price and demand then do not threaten the resource but simply have a direct impact on the income fishermen receive. In Morocco increased prices force the processors to import anchovies from other countries but when prices drop they buy only from domestic sources. This shows how international trade of raw material can actually help in relieving the pressure on resources when locally prices and demand increase or if catches decline through natural fluctuations. Fishing is based on a natural resource which can fluctuate dramatically between years. International trade helps seafood companies in diversifying these risks by opening up access to different sources of raw material. This again helps stabilize markets and increased stability helps in operating seafood businesses.

2.3.4 Study by Bjorndal et al., 2014

The study was conducted to achieve a better understanding of the dynamics of small-scale fisheries and aquaculture value chains by identifying how the benefits were being distributed along the chain and the linkages between the relative benefits obtained and the design of the chain. In addition, the analysis aimed to recognize opportunities for the small-scale sector to obtain more value for their products. It involved value chains within aquaculture and capture fisheries in both domestic and international markets in 14 countries, of which 9 are developing (Bangladesh, Cambodia, Ghana, Honduras, Kenya, Maldives, Peru, Thailand and Uganda) and 5 are developed countries (Japan, Canada, Iceland, Norway and Spain). Countries were chosen to achieve global representation and the study analyzed both the small-scale and large-scale sectors in order to demonstrate differences between the two.

In each country, price data were collected from fishers, fish farmers, wholesalers, processors, exporters and retailers and for as long periods and with as much frequency (monthly, weekly, etc.) as possible. While some value chains were solely export driven, others were only for domestic consumption and still others targeted both. Moreover, production methods represented a wide spectrum of scales and employed a range of boats and gear types, from traditional canoes to modern industrial trawlers. Similarly, for aquaculture, production systems ranging from very small-scale to commercial large-scale operations were included. Although there was some overlap in terms of species analyzed, most species were unique to their country. Last, each country had its own data limitations, which made the depth of findings to vary. Following is a summary of the main cross cutting conclusions and policy recommendations. Those interested in specific countries should consult the report for the country specific analysis.

Despite innate differences in the value chains themselves and the distinct datasets available for the countries, recurring themes related to the distribution of benefits in the small-scale value chain emerged. First and foremost, the case studies found that, relative to other players in the value chain, small-scale fishers and fish farmers are receiving the least economic benefits for their products. Processors and retail markets were found to be receiving more of the benefits of the value chain owing to their stronger bargaining power. In some cases, the disparities in terms of earnings were considerable. In Kenya for example, the average earnings for exporters of Nile perch were found to be an average of 250 percent more than the fishers' earnings.

It is often argued that export markets would offer small scale enterprises better prices and consistent demand and access. As a result, domestic markets have not often received enough attention. The study showed that domestic and international markets are composed of a mix of local and imported fish and fishery products and are made up of a complex array of agents, enterprises and institutions, although they vary in scale and scope. Retail chains or supermarkets play an important role in fish and seafood retailing in developed countries while direct fishers' markets or individual fishmongers are vital for markets in developing countries. Institutional markets (hospitals, the armed forces, schools, etc.) and the hospitality sector play an important role in most countries, both developed and developing. The study highlighted the weaknesses of institutions, regulation and facilitation mechanisms in developing countries. Most lacked access to a well-functioning market, anti-trust authority, regulations, standardized contracts, market information, and a well-functioning banking system.

Based on these overall findings, the study made policy recommendations focused on how to provide more support for small-scale fishers and fish farmers and how to help them obtain more and equitable value for their products.

Policy recommendation 1: Small-scale fisheries and aquaculture need training, technical assistance, research and infrastructure upgrade to improve market penetration, value addition and more equitable distribution of benefits. Areas for training include value chain dynamics and the small-scale sector, international market requirements and certification, GHP and reduced post-harvest losses. Research and development for new value-addition or value creation is also highly needed, especially in countries where growing economies are opening up new opportunities for seafood products.

Policy recommendation 2: Organizational models and arrangements should be introduced and supported to help the small-scale sector increase its negotiation power, both in relation to price and access to resources. This requires support from governments, protection by legislation and incentivizing (or even mandating) participation in organizational models such as selling desks, cooperatives or private/public partnerships such as the shrimp farmers' clustering model in Andra Pradesh (India).

Policy recommendation 3: The study showed that in many cases, fish price is dependent on a wide range of variables beyond the control of fishers, such as bargaining power and market conditions. Adopting standard pricing methods locally or even regionally could help producers understand how to bargain for a fair price for their products, help establish more consistency in the distribution of benefits over time and achieve more equal negotiating power between sellers and buyers.

Policy recommendation 4: Develop a policy in support of financial incentives conducive to establishing new small-scale fish farms and adopting appropriate and sustainable farming methods. This could entail access to low-interest loans, access to insurance schemes and to micro-credit and/or micrograncts to foster investment and start-up farms while encouraging sustainable farming methods by providing funds to help alleviate the cost.

Policy recommendation 5: Expand market opportunities for the small-scale sector, assessing the pros and cons of export vs. domestic markets. Marketing infrastructure is key and often lacks for distribution on the domestic market, where emerging middle-class consumers and tourism has boosted demand for fish and seafood.

Policy recommendation 6: Facilitate promotion and marketing of fish and fishery products, by conducting market surveys, upgrading marketing infrastructure such as cold storage and ice supply facilities. Lack of marketing was one of the major barriers to domestic market expansion.

Policy recommendation 7: Improve fisheries and aquaculture management regimes to ensure sustainable fisheries, aquaculture and aquatic eco-systems. Good practices for fisheries co-management should be developed and promoted along small-scale value chains where it yielded success over top-down management regimes.

The findings also highlight the following areas where further research and analysis are needed:

- The role of trade in local food security and sovereignty;
- The viability of domestic markets;
- Possibilities for innovative domestic value chains;
- The costs and benefits of certification schemes and other marketing tools;
- Organizational models for organizing the value chain with an emphasis on the first-hand market;
- Institutional models to support and monitor sustainable fisheries and aquaculture production; and
- Methods of good governance in national and international management of fish stocks and areas for aquaculture, including methods and models for co-management.

Equally important was the strengthening in Vietnam of linkages between R&D facilities, higher institutions of education, farms and processing firms to cross-fertilize each other's role in enhancing value addition from fisheries and aquaculture.

2.2.5 Seafood value chains and Blue economy/ Ocean's economy

Achieving the trade related targets of SDG 14 requires innovative approaches stimulated by recent significant development in technology and logistics. Integrating best practices for management, harvesting, value addition and distribution can benefit greatly from opportunities offered around the concepts of oceans economy/blue economy, integrating value chain and seafood clusters.

The oceans economy, also referred to as the blue economy/blue growth, has its origins in the green economy concept endorsed at the Rio + 20 UN Conference on Sustainable Development in 2012 . At its core, the oceans economy refers to the de-coupling of socio-economic development from environmental degradation. It includes traditional sectors such as marine fisheries, tourism, maritime transport and water desalinization, but also new and emerging activities, such as offshore renewable energy, marine aquaculture, seabed extractive activities, and marine biotechnology and bioprospecting. The oceans economy recognizes the fundamental role of the services provided by ocean ecosystems and for which markets do not exist yet. These include carbon sequestration, coastal protection, waste disposal and the protection of biodiversity (see table 2.1).

The oceans economy is relevant to all coastal countries and can be applied on various scales, from local to regional to global. In particular, it represents a unique opportunity for coastal LDCs and SIDS, with oceans and seas representing much larger geographic area (over 10,000 fold) than their inland territory. UNCTAD promotes the Oceans economy along five key pillars encompassing science, governance, economic, social and environmental protection (Figure 4.7).

While stimulating growth in individual oceanic sectors can be comparatively straightforward, it is not always clear what a sustainable oceans economy should look like and the conditions under which it is most likely

[34] https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf

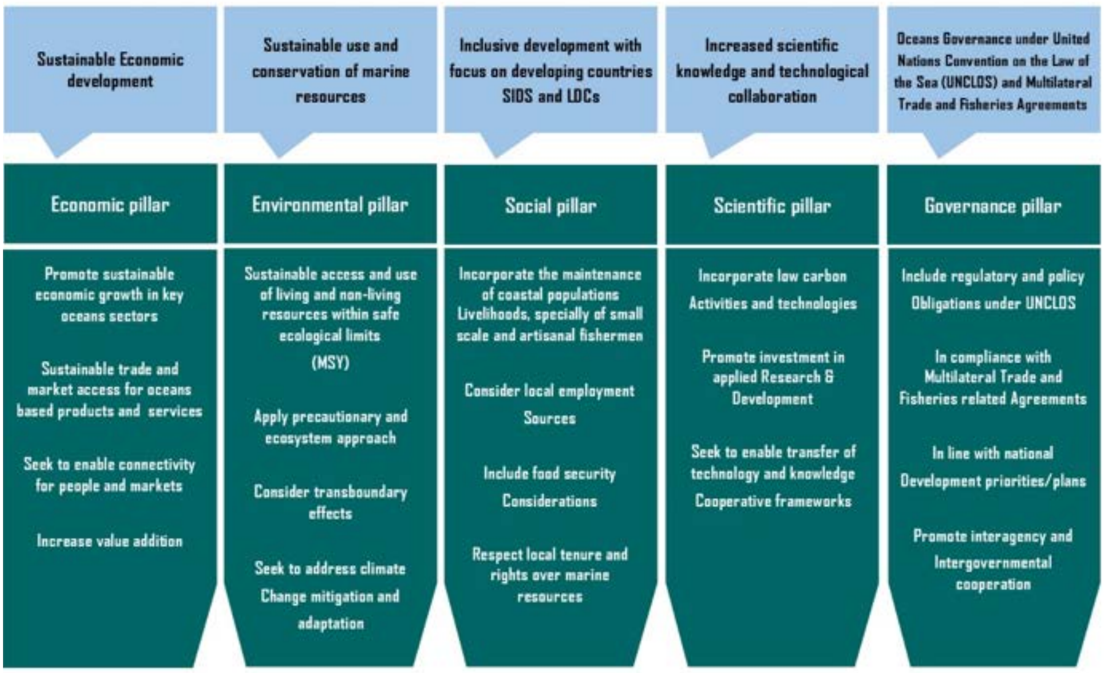
to develop. Each country should weigh the relative importance of each sector of the oceans economy and decide, based on its own priorities and circumstances, which ones to prioritize. The contribution of natural oceanic capital to welfare must be properly valued in order to make the right policy decisions, including with regards to trade-offs amongst different sectors of the oceans economy. The Blue economy has been promoted by the African Development Bank (AfDB) (Ababouch, 2015) to better harness marine fisheries and aquaculture resources within an integrated approach taking into consideration other users of the Oceans. The UN Economic Commission for Africa (2016) has prepared a comprehensive policy handbook for blue economy and a recent conference held in Nairobi reiterated the commitment of African states to advance the global bleu economy .

Investment in, and use of the best available science, data, and technology is critical to underpinning governance reforms and shaping management decisions to enact long-term change. Ensuring ocean health will require new investment, and targeted financial instruments—including blue bonds, insurance and debt-for-adaptation swaps. For example, during COP 21 in Paris (2015) , the Seychelles completed a first of its kind debt-for-adaptation swap to enhance marine conservation and climate adaptation activities. The debt-swap was designed to create a sustainable source of funding to support Seychelles in the creation and management of 400,000 square kilometers of new marine protected areas (the second largest in the Indian Ocean) to improve resiliency of coastal ecosystems. The landmark agreement reached between Seychelles and its Paris Club creditors, was designed to enable Seychelles to redirect a portion of their current debt payments to fund nature-based solutions to climate change through the newly established Seychelles Conservation and Climate Adaptation Trust (SeyCCAT).

The private sector can and must play a greater role in the oceans economy. Trade in the sectors of the oceans economy can be boosted by introducing sound regulatory and institutional frameworks to develop ancillary services needed to undertake these activities, including financial, insurance, communications, testing and certification, and research and development activities.

An emerging area of the blue economy is marine bioprospecting. Oceans and seas are the source of a variety of living aquatic resources that have huge

Figure 4.7 The pillars of Ocean's Economy promoted by UNCTAD in LDCs and SIDS



Source : UNCTAD

[35]http://www.blueeconomyconference.go.ke/wp-content/uploads/2018/12/Nairobi-Statement-of-Intent-Advancing-Global-Sustainable-Blue-Economy.pdf
[36] http://www.glispa.org/glispa-bright-spots/191-innovative-debt-swap-to-finance-climate-adaptation-in-seychelles

potential for new food, biochemical, pharmaceutical, cosmetics and bioenergy applications. UNCTAD (2018c) reports that over 18,000 natural products have been developed to date from about 4,800 marine organisms, and the number is growing at a significant rate every year, driven by increased investments in marine biotechnology research and growing demand for natural marine ingredients. The UNCTAD Biotrade initiative (BTI) offers promising prospects to promote sustainable bioprospecting. The term Biotrade is understood to include activities related to the collection or production, transformation, and commercialization of goods and services derived from native biodiversity (genetic resources, species and ecosystems) according to criteria of environmental, social and economic sustainability. The objective of the UNCTAD BTI is to contribute to the conservation and sustainable use of biodiversity through the promotion of trade and investment in BioTrade products and services in line with the objectives and principles of the Convention on Biological Diversity (CBD).

Whatever the organizational model, it should be conducive to upscaling circular economy approaches in fisheries and aquaculture, especially in Africa (e.g. Nigeria) and Asia (e.g. India) where recycling has been a second nature for years in many sectors, making effective use of materials and energy.

This can be further catalyzed in an environment increasingly enabled digitally to support organized groups of small scale fishers and farmers, interconnected and symbiotic in sharing knowledge, adopting sustainable practices and significantly decreasing requirements and costs for energy, maintenance of gear and equipment, resources such as seed, feed and fertilizers and veterinary drugs and reducing seafood waste and loss across the supply chain. For example, PPP in Vietnam supported research that enabled the production of environment friendly fertilizers from fish and shrimp by-products.

Finally, fishing ports have represented a nodal place for creating seafood clusters that promote sustainable fisheries and aquaculture, improved logistics and services and generates value for the communities. Examples of such seafood clusters have been launched in several developed countries (Norway, Iceland, etc.) and emerging and developing states (Mauritius, Mauritania). Creating a seafood cluster requires building the capacity of stakeholders to plan, design, organize, and promote a cluster that integrates sustainable management of fisheries resources in the development of competitive seafood value chains with the participation of local actors. It requires a public-private dialogue (PPD) to develop a common vision for a sustainable seafood cluster and accelerate reforms for its development and to generate and channel investments. It requires improving the handling and processing of the harvest and promoting value addition for export at the seafood cluster and building local suppliers' and vulnerable groups' capacities to capture greater benefits from productive and inclusive seafood value chains.

Chapter 5: Standards and certification in international fish and seafood trade

Key messages:

• Public and private standards and certification schemes cover a wide range of issues that are key to enter lucrative and higher end market segments.

• Public standards are mandatory have evolved food safety and consumer protection to include fisheries resources sustainability environmental and social protection

• Implementation of public and private standards is pre-requisite to enter international and lucrative markets and can be achieved through public private partnership supported by adequate institutional and human capacity and resources

1. INTRODUCTION

The previous chapters have has demonstrated the great potential of the fisheries and aquaculture sector, the constraints and challenges that need to be overcome to enable full exploitation of this potential. They highlighted the important increase in fish and seafood trade and its relevance for the economy of many developing countries. They demonstrated clearly the importance of market access/entry requirements, in particular the NTMs that has gained significantly in importance and influence.

Development of international trade and globalization of fish supply chains means that a significant amount of fish and seafood is caught or farmed in one part of the world, processed in the country of harvesting or another country and finally consumed in the same or yet another country. Consequently, systems to enable entry to international markets and to ensure fish and seafood safety and quality that function across national borders are therefore vital.

For this purpose, a range of national and international regulatory frameworks has been developed to ensure consumer protection and to meet international markets requirements. Consumers expect their fish and seafood:

• to come from well (sustainably) managed fisheries and aquaculture farms;

• to be legally fished, farmed and harvested; and

• to be safe and of acceptable quality regardless of how and where it is produced, processed or ultimately sold.

While safety and quality are of primary concern – consumers' interests tend to be strongest where the potential impact (such as a threat to their personal and family's health) is most direct – although consumers in developed countries have been also increasingly interested in the social or environmental impacts of the food they consume, mainly as a result of the media coverage and activism of conservation NGOs and social welfare CSOs. This trend has also started to take hold in emerging and developing countries. In terms of fish and seafood, this means that more and more consumers are concerned that capture fish stocks are managed sustainably, that wider ecosystems and related plant and animal life are protected, that aquaculture is environmentally sustainable and that social responsibility is exercised throughout the fish and seafood value chain, from production through to distribution (Washington and Ababouch, 2011).

A key element of food safety and quality that is often overlooked is food fraud. Food fraud is committed when food is illegally placed on the market with the intention of deceiving the customer, usually for financial gain. This involves criminal activity that can include food mislabeling, substitution, counterfeiting, misbranding, dilution and adulteration. While food fraud primarily results in cheating customers, it can also lead to significant food safety risks for consumers. Public health is endangered when fish species that are toxic are substituted for non-toxic varieties. Public health is also put at risk when farmed or freshwater species from polluted watercourses are substituted for marine fish. The impacts of food fraud include loss of consumer confidence in both the seafood industry and in the effectiveness of government food control programmes. Some high-profile food fraud incidents in the past decade have also damaged national reputations, with unwanted attention focused on the safety, quality and authenticity of all foods exported to the global market.

In addition to the range of public regulatory frameworks for fish and seafood safety and quality and for the protection of natural aquatic resources, a whole range of related standards has been introduced by retailers, groups of producers/industry, public certification schemes, non-governmental organizations (NGO)- and the private sector. All these so-called voluntary standards have become key to enter lucrative markets. Despite some noticeable success stories, most exporting developing countries, in particular LDCs, currently supply market segments that occupy the lower end of the international market, and these have been largely unaffected by private standards, but mainly public standards and regulations.

The lack of capacity to comply with private standards means that such exporting countries cannot engage in the higher value-added processing activities that yield greater prices in lucrative markets and are less vulnerable to fluctuations in demand (UNCTAD, 2018). These importing firms have significant influence over other businesses in the fish and seafood value chain, including in terms of setting social, environmental, quality and safety standards. These standards are particularly prevalent where they relate to a firm's "private label" or house brand products, a growing trend in fish and seafood marketing. Moreover, some private standards are in essence becoming international standards as they come to define the relationships between these globalized firms and their suppliers (Washington and Ababouch, 2011).

From the perspective of the firm, private standards and the certification sitting behind them can serve as mechanisms for safety and quality assurance, traceability, standardization of products from a range of international suppliers, and transparency of production and distribution processes. The standards relate to a range of objectives including sustainability of fish stocks, environmental protection, food safety and quality, as well as to aspects such as animal health, animal welfare and social development. They are increasingly linked to private firms' corporate social responsibility (CSR) strategies.

The proliferation of private standards is partly a response to perceptions that public regulatory frameworks have been inadequate to ensure the sustainability of fisheries and aquaculture and to provide assurance to consumers on the safety of food and its social and environmental soundness. However, they can be also a result of attempts by private firms to differentiate themselves and their products in increasingly competitive markets. They also serve as a means of protecting corporate reputations from negative publicity driven by civil society such as the Give the Swordfish a Break campaign in the USA.

Chapter two describes the typology of standards and certification schemes that govern international trade in fish and seafood. It is important to remember that almost 65 percent of fish and seafood exports are destined to three major markets: The EU, the USA and Japan. These markets and their companies are major players in setting standards but most importantly market entry requirements and procedures. In other words, these three markets shape the modus operandi of how internationally accepted standards are translated into audit, verification/inspection and certification approaches. At the same time, over 56 percent in volume of the trade comes from developing countries who need to meet these requirements in order to take advantage of these high end and lucrative market segments.

The issue of food safety and quality management has been addressed extensively in publications and manuals produced by UNCTAD and FAO and referenced in this manual (Ababouch et al., 2005; Washington and Ababouch, 2011; Ryder et al., 2014; UNCTAD, 2018). It is highly advised to consult these publications as and when needed to expand on the knowledge provided here. Other organizations, universities and food control authorities of many countries, active in the import or export of fish and seafood, publish regular updates on their rules and regulations for standards and certification governing consumer and environmental protection. References to these updates are provided throughout this manual. This chapter 5 has been prepared to complement these reports and sources of information in the following key areas:

- International framework for standards and certification;
- Publics standards and certification schemes;
- private standards and certification schemes;
- Ways and means of implementation.

2. PUBLIC VS. PRIVATE STANDARDS

Standards, and related certification systems, are developed by a variety of public and private organizations, target variety of objectives and cover a variety of industrial activities. Consequently, the terminology is varied and rich and can lead to confusion. Therefore, it is important to define clearly the context and scope of standards and certification schemes as they apply to fisheries and aquaculture.

2.1. Key definitions

In fisheries and aquaculture, relevant international definitions and terminology derive from:

- The International Organization for Standardization (ISO) Guide 2: Standardization and related activities – General vocabulary (ISO, 2004);
- Binding agreements of the WTO – the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement, Annex A), and the Agreement on Technical Barriers to Trade (TBT Agreement); and
- Relevant food standards, guidelines and codes of practice issued by the Codex Alimentarius Commission (Codex or CAC) and the OIE.

According to the ISO (2004), a standard is: "A document established by consensus and approved by a recognized body, that provides for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at the achievements of the optimum degree of order in a given context." It also notes that: "Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits."

The TBT Agreement distinguishes mandatory standards (or technical regulations) from voluntary standards as: "A standard is a document approved by a recognized organization or entity, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory under international trade rules. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method."

In contrast, a technical regulation is defined as: "a document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method."

The SPS Agreement defines sanitary or phytosanitary measure — Any measure applied: (a) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;(b) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; (c) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or (d) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests. Sanitary or phytosanitary measures include all relevant laws, decrees, regulations, requirements and procedures including, inter alia, end product criteria; processes and production methods; testing, inspection, certification and approval procedures; quarantine treatments including relevant requirements associated with the transport of animals or plants, or with the materials necessary for their survival during transport; provisions on relevant statistical methods, sampling procedures and methods of risk assessment; and packaging and labelling requirements directly related to food safety.

Harmonization: The establishment, recognition and application of common sanitary and phytosanitary measures by different Members. International standards, guidelines and recommendations (a) for food safety, the standards, guidelines and recommendations established by the Codex Alimentarius Commission relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice; (b) for animal health and zoonoses, the standards, guidelines and recommendations developed under the auspices of the International Office of Epizootics; (c) for plant health, the international standards, guidelines and recommendations developed under the auspices of the Secretariat of the International Plant Protection Convention in cooperation with regional organizations operating within the framework of the International Plant Protection Convention; and (d) for matters not covered by the above organizations, appropriate standards, guidelines and recommendations promulgated by other relevant international organizations open for membership to all Members, as identified by the Committee.

Risk assessment: The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences; or the evaluation of the potential for adverse effects on human or animal health arising from the presence of additives, contaminants, toxins or disease-causing organisms in food, beverages or feedstuffs.

Appropriate level of sanitary or phytosanitary protection The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. NOTE: Many Members otherwise refer to this concept as the "acceptable level of risk".

Equivalence: Members shall accept the sanitary or phytosanitary measures of other Members as equivalent, even if these measures differ from their own or from those used by other Members trading in the same product, if the exporting Member objectively demonstrates to the importing Member that its measures achieve the importing Member's appropriate level of sanitary or phytosanitary protection. For this purpose, reasonable access shall be given, upon request, to the importing Member for inspection, testing and other relevant procedures. Members shall, upon request, enter into consultations with the aim of achieving bilateral and multilateral agreements on recognition of the equivalence of specified sanitary or phytosanitary measures.

2.2. Public vs. private standards

Standards set by public authorities, usually referred to as "technical regulations or simply regulations", are typically mandatory. Private standards by definition are voluntary, although they are in practice de facto mandatory where compliance with their criteria is required for entry into certain markets. Private standards and certification schemes have emerged for a number of reasons. In the food safety area, private certification schemes emerged to verify compliance with government-mandated requirements for firms to apply Good Practices and HACCP food safety management systems.

In fisheries and aquaculture, the proliferation of private standards schemes is most evident in areas where there is a perception that public standards or regulatory frameworks are failing to achieve given outcomes such as sustainability and responsible fisheries management, food safety assurance, social responsibility, traceability and/or where there is a desire to differentiate certain products or operators in the market (Washington and Ababouch, 2011).

Standards and the certification systems sitting behind them, whether public or private, are a means of assuring buyers of the safety and quality of products or the conformity of processes and production methods to social and environmental criteria. Quality aspects can be related to the product itself or the process by which it was produced. Standards and certification are especially useful where there is information asymmetry, that is, where buyers and consumers cannot easily judge certain quality aspects of products or production processes. These quality aspects include what are termed credence goods. Food safety and the environmental friendliness of products are both examples of credence goods because consumers cannot practically assess either aspect and use that assessment to inform their purchasing decisions. Standards, and certification against those standards, are a way of compensating for information asymmetry. Certification (and related labelling of certified products) offers verification or a "burden of proof" that given standards have been complied with.

3. INTERNATIONAL FRAMEWORK FOR FISH AND SEAFOOD STANDARDS AND CERTIFICATION SCHEMES

The increasing global demand for fish and seafood, coupled to technological developments in production, processing, transportation and distribution and the increasing awareness and demand of consumers for safe, high quality and socially and environmentally friendly food have put standards and certification high in the agenda of international organizations, public and private decision makers, CSOs and NGOs and the media. Amidst the expansion of globalization, internationally traded fish and seafood have been subject to scrutiny for consumer protection, environment and social responsibility. For example, the European Union Alert System for Food and Feed (RASFF) indicated that fish and fishery products have often been responsible for a large proportion, and sometime being the largest (up to 25 percent), of food safety and quality alerts during the period 2009 – 2017. They caused the largest number (135) of alerts in 2017 as compared to 96 for poultry and 89 for fruits and vegetables (RASSF, 2018) . All other food products had lower incidence of alerts. Similar market entry problems have been encountered by exports from developing countries in other major markets such as the USA and Japan.

On the other hand, one of the most serious difficulties faced by exporters is that different standards and regimes are being imposed by importing countries on producing countries to ensure that products meet the requirements of the target market. The differences between importing countries regulations, standards, organization and function of control services, and the modus operandi of such services are among the most important practical difficulties of compliance faced by developing countries. A key problem is the border control where products are rejected or put in detention awaiting resolution or destruction. Developing countries have often complained that they are penalized by the complexity of standards and certification rules of importing countries. It is regularly suggested that these standards and rules are used as non-tariff barriers. There is no doubt that the lack of consistency in their implementation has inhibited trade in fish and seafood.

Consequently, effective international harmonization of standards and equivalence of certification systems can facilitate international fish trade, increase transparency and prevent the use of these requirements as disguised barriers to trade. On the other hand, these market entry requirements should be based on sound science to provide the appropriate level of consumer, social and environmental protection. Reconciling both objectives requires an international framework to support the development of harmonized standards and equivalence recognition systems.

Following is a review of the key international organizations that have developed international instruments, guidelines and codes of best practices that sustain the international framework for food standards and certification. Elaboration of standards and certification schemes at the national levels should be based on this international framework to ensure conformity at the international level. The instruments of relevance to food safety have been developed in the previous Manual (UNCTAD, 2018). They are consolidated in this chapter and complemented with other instruments of relevance to environmental and social protection issues.

3.1. The SPS and TBT agreements of the world trade organization (WTO)

The WTO was established in 1995 as the successor to the General Agreement on Tariffs and Trade (GATT) founded after World War II. The WTO was established as the final Act of the Uruguay Round of negotiations, which began in Punta del Este, Uruguay in September 1986 and concluded in Marrakech, Morocco in April 1994. The Uruguay Round was the first to deal with the liberalization of trade in agricultural products, an area excluded from previous rounds of negotiations.

Significant implications for food standards and certification arise from the Final Act of the Uruguay Round, especially from two binding agreements: the Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures and the Agreement on Technical Barriers to Trade (TBT) . The SPS agreement confirms the right of WTO member countries to apply measures necessary to protect human, animal and plant life and health. This right was included in the original 1947 GATT as a general exclusion from the provisions of the agreement provided that "such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade". Despite this general condition for the application of national measures to protect human, animal and plant life and health, such measures had become effective trade barriers, whether by design or accident.

The purpose of the SPS Agreement is to ensure that measures established by governments to protect human, animal and plant life and health, in the agricultural sector, including fisheries, are consistent with obligations prohibiting arbitrary or unjustifiable discrimination on trade between countries where the same conditions prevail and are not disguised restrictions on international trade. It requires that, with regard to sanitary and phytosanitary measures, WTO members base their national measures on international standards, guidelines and other recommendations adopted:

- by the Codex Alimentarius Commission (CAC) for food safety;
- by the International Animal Health (Organisation Internationale des Epizooties OIE) for animal health; or
- by the International Plant Protection Convention (IPPC) for plant protection, where they exist.

This does not prevent a member country from adopting stricter measures if there is a scientific justification for doing so, or if the level of protection afforded by the Codex standards is inconsistent with the level of protection generally applied and deemed appropriate by the country concerned.

The SPS Agreement states that any measures taken that conform to international standards, guidelines or recommendations of CAC, OIE or IPPC are deemed to be appropriate, necessary and not discriminatory. Furthermore, the SPS Agreement calls for a programme

[38] https://www.wto.org/english/docs_e/legal_e/15-sps.pdf
[39] https://www.wto.org/english/docs_e/legal_e/17-tbt.pdf

of harmonization based on international standards. This work is guided by the WTO Committee on SPS measures. Membership includes representatives of CAC, OIE and IPPC, in addition to representatives of WTO Members.

Finally, the SPS Agreement requires that SPS measures shall be based on an assessment of the risks to humans, animal and plant life and health using internationally accepted risk assessment techniques. Risk assessment should take into account the available scientific evidence, the relevant processes and production methods, the inspection/sampling/testing methods, the prevalence of specific illnesses and other matters of relevance.

The Agreement on TBT is a revision of the agreement of the same name, first developed under the Tokyo Round of trade negotiations (1973 – 1979). The objective of the TBT Agreement is to prevent the use of national or regional technical regulations and standards as unjustified technical barriers to trade. The agreement covers standards relating to all types of products including industrial products and quality requirements for foods (except requirements related to SPS measures). It includes numerous measures designed to protect the consumer against deception and economic fraud.

The TBT Agreement basically provides that standards and technical regulations must have a legitimate purpose and that the impact or the cost of implementing the standard must be proportional to the purpose of the standard. It also states that if there are two or more ways of achieving the same objective, the least trade restrictive alternative should be followed. The agreement also places emphasis on international standards, WTO members are being encouraged to use international standards or parts of them except where the international standard would be ineffective or inappropriate in the national situation. Aspects of food standards that TBT requirements specifically cover are quality provisions, nutritional requirements, labelling, packaging and product content regulations, and methods of analysis. Unlike the SPS Agreement, the TBT Agreement does not specifically name international standard setting bodies, whose standards are to be used as benchmarks for judging compliance with the provisions of the Agreement.

Both the SPS and TBT Agreements call on WTO member countries to:

• Promote international harmonization and equivalence agreements;

• Promote the use of scientifically sound risk assessment to develop SPS measures;

• Facilitate the provision of technical assistance, especially to developing countries, either bilaterally or through the appropriate international organizations; and

• Take into consideration the needs of developing countries, especially the least developed countries, when preparing and implementing sanitary and phytosanitary and measures and standards.

3.2. The Codex Alimentarius Commission

The Codex Alimentarius or Food Code was created in 1962. Since then, it has been responsible for implementing the Joint FAO/WHO Food Standards Programme. The Codex Alimentarius Commission (CAC) primary objectives are the protection of the health of consumers, the assurance of fair practices in food trade and the coordination of the work on food standards. The CAC is an intergovernmental body with a membership of 188 member countries and one-member organization (the EU), as of January 2019. In addition, 228 observers from international intergovernmental organizations (e.g. OIE, WTO and the International Atomic Energy Agency and international non-governmental organizations (i.e. scientific organizations, food industry, food trade and consumer associations) may attend sessions of the Commission and of its subsidiary bodies. An Executive Committee, six Regional Coordinating Committees and a Secretariat assist the Commission in administering its work programme and other related activities.

The work of the Codex Alimentarius is divided between three basic types of committees:

• General subject Committees that deal with general principles, hygiene, veterinary drugs, pesticides, food additives, contaminants, labelling, methods of analysis and sampling, nutrition and foods for special dietary uses and import/export inspection and certification systems;

• Commodity committees that deal with a specific type of food class or group, such as dairy and dairy products, fats and oils, or fish and fishery products; and

• Ad hoc intergovernmental task forces (whose number is variable) that are established to deal with specific issues within a limited time frame (usually 5 years).

[40] www.codexalimentarius.org

The work of the Committees on food hygiene, food contaminants, fish and fishery products, veterinary drugs and import/export inspection and certification systems are of paramount interest to the fisheries and aquaculture.

In the environment of the WTO Agreements, the work of the CAC has taken on unprecedented importance with respect to consumer protection and international food trade. Codex standards, guidelines and codes of practice are specifically recognized by the WTO SPS Agreement, including the maximum residue limits for pesticides and veterinary drugs, the maximum limits of food additives, the maximum levels of contaminants, and food hygiene requirements of Codex standards.

Of relevance to fisheries and aquaculture, CAC has revised its main Code on food hygiene to incorporate the principles of risk analysis and to include specific references to HACCP. Likewise, the Codex Committee for Fish and Fishery Products has revised and updated the Code of Practice for Fish and Fishery Products (CPFFP), using risk analysis principles, merging and updating the previous individual codes. This code of practice aims at providing a user-friendly document with background information and guidance and comprises the following sections:

- SECTION 1: Scope
- SECTION 2: Definitions
- SECTION 3: Prerequisite Programme
- SECTION 4: General Considerations for the Handling of Fresh Fish and Shellfish and other Aquatic Invertebrates
- SECTION 5: Hazard Analysis Critical Control Point (HACCP) and Defect Action Point (DAP) Analysis
- SECTION 6: Aquaculture Production
- SECTION 7: Live and Raw Bivalve Molluscs
- SECTION 8: Processing of Fresh, Frozen and Minced Fish
- SECTION 9: Processing of Frozen Surimi
- SECTION 10: Processing of Quick-Frozen Coated Fish Products
- SECTION 11: Processing of Salted and Dried Salted Fish
- SECTION 12: Smoked Fish
- SECTION 13: (a) Lobsters (b) Crabs
- SECTION 14: Processing of Shrimps and Prawns
- SECTION 15: Processing of Cephalopods
- SECTION 16: Processing of Canned Fish and Shellfish
- SECTION 17: Transportation
- SECTION 18: Retail

This Code is designed to assist all those who are engaged in the handling and production of fish, shellfish and their products, or are concerned with their control, storage, distribution, export, import and sale to:

- Attain safe and wholesome products, which can be sold on national or international markets; and
- Meet the requirements of the Codex Standards, both in terms of health and safety requirements and essential quality, composition and labelling provisions.

In addition, the CAC has produced a number of product standards: such as those for dried fish, salted fish, quick frozen fish, and canned fish, just to name a few. Codex has also adopted a Model Certificate for Fish and Fishery Products (CAC/GL 48-2004) .

3.3. The Code of Conduct for Responsible Fisheries

At the request of the International Conference on Responsible Fishing, held in 1992 in Cancún (Mexico), FAO was mandated to negotiate a global Code of Conduct for Responsible Fisheries (CCRF) which would be consistent with international instruments and, in a non-mandatory manner, establish principles and standards applicable to the conservation, management and development of all fisheries. The CCRF, which was unanimously adopted on 31 October 1995 by the 28th Session of the FAO Conference, provides the necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment .

The CCRF sets out international principles and standards of behavior to ensure effective conservation, management, and development of both marine and freshwater living aquatic resources. It accounts for the impact of fishing on ecosystems, the impact of ecosystems on fisheries, and the need to conserve biodiversity. The CCRF is voluntary, although parts of it are based on relevant international laws.

The CCRF is global and comprehensive in scope. It is directed toward members and non-members of FAO; fishing entities; sub-regional, regional, and global organizations (governmental and nongovernmental); everyone concerned with conserving fishery resources, managing fisheries, and developing fisheries; and other users of the aquatic environment in relation to fisheries.

In addition to the scope, objectives, relation with other

[41]http://www.codexalimentarius.net/download/standards/10127/CXG_048e.pdf
[42] http://www.fao.org/docrep/005/v9878e/v9878e00.htm

instruments, implementation, monitoring and reporting and the special case of developing countries, the CCRF addresses the following seven areas:

- General principles;
- Fisheries management;
- Fishing operations;
- Aquaculture development
- Integration of fisheries into coastal area management;
- Post- harvest practices and trade; and
- Fisheries research

The CCRF provides a reference framework for national and international efforts, including the formulation of policies and other legal and institutional frameworks and instruments, to ensure sustainable exploitation of aquatic living resources in harmony with the environment. In order to assist member countries in implementing the CCRF, FAO has developed a wide range of supporting instruments that can be classified into 4 major groups:

- Five International Plans of Action (IPoA seabirds, sharks, fishing capacity and IUU);
- Two Strategies to improve information and trends, respectively in capture fisheries and in aquaculture;
- Eight International Guidelines;
- Twenty-nine Technical Guidelines.

In 2016, the FAO Conference adopted an FAO binding instrument: The Agreement on Port states Measures to combat IUU fishing (PSMA). Of relevance to standards and certification in fisheries and aquaculture, are the 2 strategies for improving information and trends, respectively in capture fisheries and in aquaculture, the Guidelines for ecolabelling of fish and fishery products from capture fisheries (2009), the Guidelines for certification in aquaculture, the Guidelines for responsible fish trade.

After almost twenty years since its adoption, the CCRF remains a key reference for achieving sustainable fisheries and aquaculture. Although the CCRF is a voluntary instrument, its provisions have been taken up into policy and legislative frameworks of international organizations, RFMOs and RFBs, NGOs, CSOs and all coastal States. The effective implementation of the Code and related instruments by all stakeholders of the fisheries and aquaculture sector, translates into securing adequate supplies of fish and fisheries products for current and future generations, as well as sustained income-earning opportunities.

3.4. The World Organization for Animal Health (OIE)

The World Organization for Animal Health, previously known as OIE (Office International des Epizooties), was founded in 1924. Its objective is to improve animal health and welfare. Its areas of work cover:

- Informing on the global animal-health situation;
- Collecting, analysing and disseminating veterinary scientific information; and
- Developing standards for international trade in animals and animal products.

Standards developed by the OIE concern terrestrial and aquatic animals, respectively, with one set of codes and one manual for each category. The purpose of the Aquatic Code (2018) is to ensure the safety of trade in aquatic animals and their products. It does so by providing veterinary authorities and/or other competent authorities of Member States with details on animal-health measures that can be applied to ensure safe imports and exports of aquatic animals and of aquatic animal products (Ababouch, 2012) . The Code also includes model international aquatic animal-health certificates to facilitate safe trade.

The purpose of the Aquatic Manual (2016) is to provide laboratory technicians with information on diagnosing diseases listed in the Aquatic Code. The Aquatic Code is voluntary, but the OIE is – like the CAC – referred to in the SPS Agreement. WTO members therefore do take into account the Aquatic Code when elaborating SPS measures.

The OIE aims to ensure transparency in the global animal disease and zoonosis situation by each member country undertaking to report the animal diseases that it detects on its territory. The information, which also includes diseases transmissible to humans, is disseminated by OIE to other countries, immediately or periodically depending on the seriousness of the diseases, so that countries can take the necessary preventive actions. The latest scientific information on animal disease control is also collected by OIE and such information is then made available to member countries and territories to help improve the methods used to control and eradicate these diseases. Technical support is provided by OIE to member countries requesting assistance with animal disease control and eradication operations. The OIE Aquatic Animal Health Code (the Aquatic Code)

[43]http://www.rr-africa.oie.int/docspdf/en/Codes/en_csaa.pdf

sets out standards for the improvement of aquatic animal health and welfare and veterinary public health worldwide, including through standards for safe international trade in aquatic animals (amphibians, crustaceans, fish and molluscs) and their products.

The health measures in the Aquatic Code should be used by the veterinary authorities of importing and exporting countries to provide for early detection and reporting and to control agents pathogenic to aquatic animals and, in the case of zoonotic diseases, to humans, and to prevent their transfer via international trade in aquatic animals and aquatic animal products, while avoiding unjustified sanitary barriers to trade.

The Aquatic Code deals with general obligations related to certification and certification procedures during trade (import and export) and movement of aquatic animals and animal products. An international aquatic animal health certificate is a document, drawn up by the exporting country in accordance with the Aquatic Code, describing the aquatic animal health requirements for the exported commodity.

The assurance given to the importing country that diseases will not be introduced through the importation of aquatic animals or aquatic animal products depends on the quality of the exporting country's aquatic animal health infrastructure and the rigor with which international aquatic animal health certificates are issued in the exporting country.

These international aquatic animal health certificates are intended to facilitate safe trade and should not be used to impede it by imposing unjustified health conditions. In all cases, the exporting country and the importing country should refer to the health conditions recommended in the Aquatic Code before agreeing on the terms of the certificate. They should also respect their rights and obligations under the SPS Agreement. The Aquatic Code also provides guidance for Members to appropriately address the selection and spread of resistant micro-organisms and antimicrobial resistance genes due to the use of antimicrobial agents in aquatic animals. The Aquatic Code also provides principles on the responsible and prudent use of antimicrobial agents in aquatic animals, with the aim of protecting both animal and human health.

3.5. The International Standards Organization (ISO)

Differently from FAO, WHO and OIE, the ISO is not an Intergovernmental Organization. It is a network of 167 national standards bodies, based in Geneva, Switzerland. It is an NGO that is the product of collaboration between public and private sector bodies.

Its members include national standardization bodies as well as industry associations. The WTO recognizes the ISO as providing internationally recognized standards.

In late 1980s, the ISO developed the ISO 9000 series for quality management in all sectors. Although ISO 9000 helped food companies to improve the organizational and operational aspects of quality management, it lacked food safety specifics, especially reference to HACCP requirements. Subsequently, ISO 22000 was developed in 2005, building on previous food-safety-related standards, with the aim to establish one internationally recognized standard for food safety management systems.

In 2007, ISO established the Technical Committee ISO/TC 234, Fisheries and Aquaculture. The ISO/TC 234 was set up to develop standards that will:

- Promote the sustainable development of the fisheries and aquaculture sectors;
- Develop specifications for technical equipment adapted to the local environment;
- Improve surveillance and management of marine resources;
- Enable international agreement on sampling methods;
- Improve the safety of employees; and
- Establish a common terminology.

The scope of ISO/TC 234 ranges from terminology to technical specifications for aquaculture farms and equipment, characterization and monitoring of aquaculture sites, environmental monitoring, resource monitoring, data reporting, traceability and waste disposal. Its work is designed to complement the ongoing international cooperation on fisheries and aquaculture within the International Council for the Exploration of the Sea (ICES), OIE, CAC and FAO. The secretariat of ISO/TC 234 has been allocated to Standards Norway, which made the proposal to set up this committee. So far, 11 ISO member countries have registered to participate in the work. In addition to Norway, they are: Canada, France, Iceland, India, Malaysia, South Africa, Thailand, United Kingdom, USA and Viet Nam. Another 13 countries have observer status. The following Working groups operate under ISO/TC 234:

- Traceability of fish products;
- Environmental monitoring of seabed impacts from marine finfish farms;
- Aquaculture technology;
- Food safety for aquaculture farms;
- Methodology for sea lice counts;
- Calculation of "fish-in, fish-out" (FIFO); and feed conversion ratios (FCRs);
- Aquaculture advisory group.

3.6. Standards and certification schemes of major importing countries

Several papers and manuals (Ababouch et al., 2005; Ryder et al., 2014; UNCTAD, 2018) have described and analyzed the rules and regulations for implementing standards applied by major importing countries. These should be consulted for further information. Following is a summary description of the market entry requirements in application by the three major markets (EU, USA and Japan). Table 5.1 summarizes the salient components of the certification schemes of these 3 markets.

3.6.1 The European Union

The principle behind assuring the safety and quality of imported fish and seafood to the EU is that of certifying Competent Control Authorities in the third countries exporting to the European Union. The EU delegates the control of food safety and quality to a Competent Authority in each exporting country, who in turn ensures that exporting farms, vessels and processors are producing safe food under a system equivalent to that in the EU– the principle of equivalence. For this, national laws of exporting countries should be "harmonized" with those in place within the EU.
When the laws of any third country are harmonized and systems to monitor and control fish processing establishments and vessels are deemed equivalent, the exporting country is approved for export to the EU.

Individual companies are checked by the Competent Authority and, if deemed appropriate, are listed as approved in a national register, with a certification number. This register is passed to the European Commission (EC) who makes the information public via its website and other public documents. These are the so-called List I countries. Other countries that are in the process of gaining approval but are deemed to be producing safe foods are shown in List II. Shipments from List II countries are, however, subject to 100 percent border checks.

Unfortunately for exporting companies, these are the only routes by which they can export to the EU market. Even if a company is meeting international standards of safety and quality, it can only export if the country in which it operates is recognized and certified by the EC on List I or List II. This has caused problems in the past for qualified companies in several countries who then must wait for the government to complete the process of recognition by the EC.

In addition to the certification requirements from exporting countries, the European Union operates a border inspection system to verify regularly that the European Union requirements are effectively implemented in the exporting country.

During last decade, the European Union has completed a recast of the legislation governing food hygiene and laying down specific hygiene rules for food of animal origin. This legislation includes EC Regulation 178/2002 and a hygiene package (Table 5.1), which is a set of 5 regulations designed to consolidate the many fragmented and redundant rules in application at the time.

EC Regulation 178/2002 is of very broad scope; it establishes the general principles and requirements of food law, lays down procedures on matters of food safety, and establishes the structure and role of European Food Safety Authority (EFSA). It also covers the basic concepts of equivalence and traceability. Regulation 178/2002 applies to all stages of production, processing and distribution of food and animal feed, setting the basic principle of "the farm to table" approach. It lays down the general principles of food law including risk analysis, the precautionary principle and protection of consumers' interests plus the general obligations of the different bodies in the food chain and their consequent liabilities. It also lays down the requirement for transparency rules (for public access to information), systems for data analysis, the rapid alert system and establishment of an organizational framework including the audit and control systems applicable to the European Food Safety Agency (EFSA). EFSA's function is to provide the EU with independent scientific and technical advice to underpin policymaking and legislation in the area of food safety and in related areas of plant health, animal health and environmental protection. The Regulation also states that third countries with which the European Union has concluded agreement might participate in EFSA.

3.6.2 The US Food and Drug Administration

The USA has a decentralized system for food safety and quality regulation. There are seventeen Federal Government agencies involved in food regulation. The two most important agencies are the Food and Drug Administration (FDA) of the Department of Health and Human Services which regulates all food except meat and poultry and the Food Safety Inspection Service (FSIS) of the Department of Agriculture which is primarily responsible for meat and poultry. The Environmental Protection Agency (EPA) regulates the safety of water. The Agricultural Marketing Service offers product quality and grading services for a fee to all food commodity groups except seafood. Seafood quality and safety services for a fee are provided by the Seafood Inspection Program of National Oceanic and Atmospheric Administration (NOAA) Fisheries within the Department of Commerce. The Department of Homeland Security is involved in assuring that intentional product adulteration does not occur.

In the USA, imported fish and seafood are subject to the regulatory oversight of FDA. Any consignment offered for entry into the United States of America is subject to inspection by FDA import officers. These officers use a digital system for selection of seafood products that is based on the relative risk of the product to the consumer. Theoretically a cooked-ready-to-eat product should be sampled and analyzed at a much higher rate than raw products with no inherent hazards.

Once a consignment is targeted for inspection and analysis it may be subject to a visual examination or more rigorous analytical testing for contaminants. If the officer sees any discrepancy with the product that constitutes an "appearance of adulteration" the importer then assumes the burden of proof that the product is not adulterated and it may be tested at the expense of the importer or denied entry. In any case, the product will be placed in expensive bonded warehouse until the matter is resolved. An appearance can be mis-labelling, inadequate packaging protecting the product or anything that seems to be non-compliant to the regulations and laws. If contaminants are found and there is a reasonable way to eliminate them e.g. cooking raw product with microbiological contamination then the importer may petition FDA to do so with specific explanations about how the processing will eliminate the hazard (Ryder et al., 2014).

If FDA believes that product imported from a particular firm, country or region has a high probability of adulteration, they may issue an import alert. An import alert will list all the affected firms, countries or regions and it will require appropriated analytical testing on each lot offered for importation into commerce of the United States of America. Firms, countries or regions will have to show that the root cause of the problem that created the adulteration has been eliminated. For seafood firms that are subject to the Seafood HACCP Regulation, this usually requires that FDA or a reliable third party has verified that the correction has occurred. This may cause problems if there are many affected firms as it may take FDA a significant period to verify the corrections.

Importers must give prior notice to Customs and Border Protection (CBP) that a shipment is going to be offered for entry under the food protection provisions of the Bioterrorism Act. The time limitations vary according to what conveyance the product is transported. Importers also must comply with the "21 Code of Federal Regulation 123.12 ‚Special requirements for imported products". The purpose of this provision in the HACCP regulations is to ensure that products entering into US commerce are in compliance with the Seafood HACCP Regulation similar to domestically produced seafood.

In January 2011, President Barack Obama signed The Food Safety Modernization Act (FSMA) into law. This is a very significant new law that enables the Food and Drug Administration to implement much stronger enforcement of food safety measures to better protect public health. This includes new regulatory tools and enforcement authorities. FDA has finalized eight major rules and produced guidance documents and tools to implement FSMA, recognizing that ensuring the safety of the food supply is a shared responsibility among many different points in the global supply chain for both human and animal food. The FSMA rules are designed to make clear specific actions that must be taken at each of these points to prevent contamination. Of relevance to fish and seafood export to the USA, is The FDA FSMA rule on Foreign Supplier Verification Programs (FSVP) for Importers of Food for Humans and Animals which is implemented since May 30, 2017.It requires that importers perform certain risk-based activities to verify that food imported into the USA has been produced in a manner that meets applicable U.S. safety standards.

FSVP is a program that importers covered by the rule must have in place to verify that their foreign suppliers are producing food in a manner that provides the same level of public health protection as the US suppliers and to ensure that the foreign supplier's food is not adulterated and is not misbranded with respect to allergen labeling. Importers are responsible for:

• Determining known or reasonably foreseeable hazards with each food;

• Evaluating the risk posed by a food, based on the hazard analysis, and the foreign supplier's performance;

• Using that evaluation of the risk posed by an imported food and the supplier's performance to approve suppliers and determine appropriate supplier verification activities;

• Conducting supplier verification activities; and

• Conducting corrective actions.

Importers must establish and follow written procedures to ensure that they import foods only from foreign suppliers approved based on an evaluation of the risk posed by the imported food and the supplier's performance or, when necessary on a temporary basis, from unapproved suppliers whose foods are subjected to adequate verification activities before being imported. The FDA updated rules and guidance for fish and seafood are available on its website .

Similar to the EU RASFF, FDA maintains an import alert system that inform FDA field staff and the public that the agency has enough evidence to allow for Detention Without Physical Examination (DWPE) of food products that appear to be in violation of FDA laws and regulations. These violations could be related to the product, manufacturer, shipper and/or other information .

3.6.3 Japan

In Japan the administration of fish and food safety inspection is based on the Food Safety Basic Law (enacted in May 2003) and the Food Sanitation Law.
The Food Sanitation Law covers two major areas:

• The establishment of standards/ specifications for food, food additives, apparatus, and food containers/ packages, standards for food establishments and good hygienic practice and specific manufacturing standards for certain foods; and

• Inspections to see whether these established standards are met; the hygiene control programme from primary production to retail sale of food; business licenses, and advice to food-related businesses.

Health departments of local provinces are mainly responsible for domestically produced food, in contrast the border inspection for imported food is conducted by the central government (Ministry of Health, Labor and Welfare MHLW).

Food safety is ensured by a preventative approach, centered around product and process design and the application of GHP and GMP. In addition to specification and standards, including microbiological criteria and standards for the methods of manufacture, processing, preparing, or preserving food or food additives intended for sale, and specifications for food utensils or containers/packages for sale or for use in business were established by the MHLW under the Food Sanitation Law to ensure public health. Once it is recognized that a food and or food additive is not compliant with the Specification and Standards, the sale, distribution, import, use, preparation, and/or holding of the food is prohibited. Specifications and standards have been established for various seafood categories (Article 11 of the Food Sanitation Law).

All food importers shall submit import notifications to the MHLW of Japan through quarantine offices upon arrival of cargo. At the quarantine office, the food safety inspectors examine the notification and supporting documents to determine the necessity for on-site, organoleptic, chemical, physical or microbiological examination. If the inspector does not identify potential violation of the Food Sanitation Law, e.g. there have been no past history of safety hazards in the food or for the company, the inspector accepts the notification. Around 10 percent of the cargo is subject to testing, which are planned to monitor the prevalence and concentration of chemical residues, indicator microorganisms and pathogens in food. If the notified food is under the category of 100 percent mandatory testing, the food shall be examined to make sure it complies with the Law, standards and specifications, and will be held in warehouses around the port of entry until the test result indicates that the food complies with the Law and regulations.

Table 5.1 Comparison of fish import systems in the European Union, United States of America and Japan (Ryder et al., 2014)

Importing country or region			
Import requirement	European Union	USA	Japan
Role of exporting government for export to the importing country/region	EU certifies an exporting competent authority in the exporting country	Can voluntarily create an agreement with the US-FDA	Can voluntarily create an agreement with the MHLW
Role of exporters for export to the importing country/region	Apply GHP/HACCP (own checks) to be certified by their own country's Competent Authority following physical inspections, documentation review and final product checks	Have SSOP/ HACCP based programme and make necessary documentation available to FDA through importer	Have a GHP/HACCP based programme but it is not clear whether and how it is implemented aboard. Major importing companies have their QC staff work with exporting companies
Can export take place without the existence of a Competent Authority in the exporting country	No	Yes	Yes
Role of importers in the importing country	Run inspection system to ensure European Union legal and technical requirements are met	Run inspection system to ensure United States legal and technical requirements are met, but not mandatory as for European Union	Run inspection system to ensure Japanese legal and technical requirements are met, but to a much lesser extent than European Union
Frequency of paper and imports identity checks at the border at the border of the importing country or region	All imports	All imports	All imports
Frequency of physical checks at the border at the border of the importing country or region	Variable frequency depending on the status of the country of origin and company's history	Variable frequency depending on the status of the country of origin and company's history	Variable frequency depending on the status of the country of origin and company's history

Frequency of microbiological and chemical analyses at the border of the importing country or region	At discretion of inspector given evident quality, product type, species, country of export and company's history	At discretion of the inspector or depending on the yearly targeting program	At discretion of the inspector or depending on the yearly targeting program
Any requirement or guidance for microbial testing	Yes. For ready-to-eat seafoods, live molluscs and cooked crustacea and molluscan shellfish	Yes	Yes
Types of microbiological tests	At discretion of inspector E. coli, Salmonella, S. aureus, Vibrio spp.	The U.S. FDA conducts Microbiological tests and microbial toxins analysis in food as per the BAM guide.	Tests for indicator organisms and total counts
Types of chemical tests	At discretion of inspector but includes histamine, heavy metals, veterinary drugs, pesticides	Includes histamine, heavy metals, veterinary drugs, pesticides	Antioxidants, preservatives, veterinary drugs, coloring and bleaching agents and biotoxins
Specific requirement for LACF/AF	Can integrity and thermal process performed by companies and checked by competent authority	Specific requirements under BPCS and/or addressed under HACCP	Not available

Source: (Ryder et al., 2014)

4. PRIVATE STANDARDS AND CERTIFICATION SCHEMES

In parallel with increasingly strict national requirements on fish safety and quality, there has been a mushrooming of private standards and certification schemes. It is enough to browse the more than 170 sustainability standards listed on the International Trade Centre's Standards Map website to appreciate the abundance of private standards in the world. For fish products, a study by Washington and Ababouch (2011) provided an illustrative list of more than 40 standards, codes of conduct, guidelines, labels, and certification schemes relevant to food safety, animal health, social and ethical issues, the environment, and food quality (Table 5.2).

[48] http://www.standardsmap.org/identify

Table 5.2 Main private standards and certification schemes operating in fisheries and aquaculture

			Market entry issues addressed				
	Type[1]	Main market orientation	Food safety	Animal health	Environment	Social/ ethical	Food quality
GLOBAL G.A.P	S, CS	Europe	√	√	√	–	√
Global Aquaculture Alliance (GAA)	CS, L	USA	√	–	√	√	–
Naturland	CS, L	Europe	√	–	√	√	√
Friend of the Sea	C, S	Global	–	–	√	–	–
Alter-Trade Japan (ATJ)	C, L	Japan	–	–	√	√	?
Safe Quality Food (SQF)	S, L, CS	Global	√	–	–	–	√
British Retail Consortium (BRC)	S, L, SC	Global	√	–	–	–	√
Fairtrade	L	Global	–	–	–	√	–
Marine Stewardship Council (MSC)	C, S, L	Global	–	–	√	–	–
International Social and Environmental Accreditation and Labelling Alliance (ISEAL)	S, C, L	Global	–	–	√	√	–
COC-certified Thai shrimp, Thailand	S, L	Europe, USA	√	√	√	√	–
Soil Association	S, L	U.K	√	√	√Organic	√	√
KRAV, Sweden	C, L	Europe	√	√	√ Organic	–	–
BioSuisse	C, L	Switzerland	√	√	√ Organic	–	–
Label Rouge,	C, L	France, EU	√	–	–	–	√
Norway Royal Salmon	S, L	Europe	√	√	–	–	√
Shrimp Seal of Quality, Bangladesh	S, L	Global	√	–	√	√	√
China GAP	C, CS	Global	√	√	–	–	√
Fishmeal and fish oil (IFFO) Standard for responsible supply	C, CS	Global	√	–	√ Sustainability	–	√

[1] S = standard, C = Code, G = guidelines, L = label, CS = certification scheme.

Source: (FAO, 2014b)

The role of private standards in the fish and seafood trade has increased in conjunction with their proliferation. Many retailers in developed countries have their own standards or require certification based on NGO-driven schemes. For instance, the United States-based retailer Whole Foods Market sells its own range of farmed fish and seafood with specific requirements that must be met by suppliers, while food retailers in Switzerland work closely with the World-Wide Fund for Nature (WWF) to source sustainable fish.

Likewise, Table 5.3. presents a compilation of the main eco-labels and consumer guides for fish and seafood.

Table 5.3 Main eco-labels, retail labels and consumer guides for fish and seafood (FAO, 2014b)

Fishery Ecolabels and Guides	Website
Blue Ocean Institute	www.blueocean.org/Seafood/
EcoFish	www.ecofish.com
Environmental Defense	www.environmentaldefense.org
Fair-Fish	http://www.fairtradefish.org/
FishOnLine	www.fishonline.org/information/
FishSource	www.fishsource.org
Forest and Bird Society	www.forestbird.org.nz
Friend of the Sea	http://www.friendofthesea.org/fisheries.asp
Global Trust - Use FAO Guidelines	http://www.gtcert.com/fao-based/
INCOFISH	www.incofish.org/ISFG.php
KRAV	www.krav.se/krav-standards
Leibniz Institute of Marine Sciences	www.seafoodguide.org
Marine Ecolabel Japan	http://www.melj.jp/eng/index.cfm
Marine Stewardship Council	http://www.msc.org/
Monterey Bay Aquarium Seafood Watch	www.mbayaq.org/cr/seafoodwatch.asp
Naturland Wildfish	http://www.naturland.de/naturlandwildfish.html
Norge Seafood	http://en.seafood.no/About-us
Proposed Japanese ecolabel for capture fisheries, MEL (marine ecolabel)	http://www.melj.jp/eng/index.cfm
Seafood Choices Alliance	www.seafoodchoices.com
The Australian Department of Environment guidelines for the ecological sustainable management of fisheries	http://www.environment.gov.au/coasts/fisheries/
Marine Aquarium Council to certify fisheries for the aquarium trade	http://www.aquariumcouncil.org/
The Responsible Fishing Scheme	http://rfs.seafish.org/
Unilever: 'Fishing for the Future'	www.unilever.com/Images/es_Unilever_FSI_brochurell_tcm13-13238.pdf
Wal Mart	www.walmartstores.com/GlobalWMStoresWeb/navigate.do?catg=665
Young's Seafood 'Fish for Life'	www.youngsseafood.co.uk/web/ffl_policies.asp

Source: (FAO, 2014b)

4.1. Product and process standards

In terms of content, standards can relate to products themselves (specifications or criteria for product attributes) or to processes (outlining criteria and practices for the way products are made). After many years on end-product inspection, food safety standards nowadays typically focus on process aspects with the overall goal of improving the safety of final products by preventing hazards from entering the supply chain. However, they can also define product standards related to residues of additives, contaminants or in terms of microbiological criteria. Ecolabels focus on where fish and seafood come from and how they are harvested or farmed (and/or the impact of that harvest on related fauna and flora) rather than on aspects of the products themselves. Process standards might relate to performance criteria that establish verifiable requirements for the production process, or management criteria relating to monitoring, verification and reporting.

In the fish and seafood area, some schemes are concerned with marine capture fisheries, some with aquaculture, and some with both. The IFFO standard has been developed to deal exclusively with fishmeal (and includes both safety and environmental considerations).

4.2. Focus linked to standard developers

Some standards and certification schemes cover various aspects, but their primary focus is to a large extent determined by the interests of the developer. Standards developers include a range of actors:

- Buyers (individual retailers, processors, food service operators, etc.) – standards are internal to the company and might simply reflect product and process specifications required of suppliers and/or requirements for certification to an independent third-party certification scheme;
- Groups of producers and/or industry bodies – usually reflecting their quality claims, sometimes based on geographical origins, and often referred to as codes of conduct or codes of practice;
- Coalitions of retail firms – GFSI for food safety standards; and
- Independent non-profit organizations or non-governmental organizations (NGOs).

In general, standards developed by retailers or groups of retailers primarily focus on quality and safety aspects, those developed by producers (harvest or aquaculture) concentrate on quality assurance, while those developed by NGOs are more directed at their environmental implications for fisheries and aquaculture. That is not to say that retailers, for example, are not interested in environmental issues. As discussed before, the fisheries procurement policies of most large retailers and processors now include a significant sustainability component, but in that case, they are more likely to associate themselves with an existing ecolabel than to develop their own. Some corporations have been involved in partnerships to help fund the development of certification schemes (such as Unilever's involvement in setting up the Marine Stewardship Council MSC). Carrefour is one of the few retailers to have set up its own ecolabel: "Pêche responsable" for wild-capture fish.

4.3. Certification and compliance

Certification is the procedure by which a certification body or certifier gives written or equivalent assurance that a product, process or service conforms to certain standards. There are three main types of certification:

First-party certification: by which a single company or stakeholder group develops its own standards, analyses its own performance, and reports on its compliance, which is therefore self-declared;

Second-party certification: where an industry or trade association or NGO develops standards, compliance is verified through internal audit procedures or by engaging external certifiers to audit and report on compliance;

Third-party certification: where an accredited external, independent, certification body, which is not involved in standards setting or has any other conflict of interest, analyses the performance of involved parties, and reports on compliance.

Private standards in fisheries and aquaculture are usually underpinned by certification schemes. Where standards are established by individual companies and based on their own product specifications, compliance is typically verified by internal audit procedures. However, where buyers require certification against a wider standard, third-party verification of compliance, by bodies independent of the standard setter and the organization to be audited, is the norm. This is also the case for the main ecolabelling schemes.

There have been attempts in various fora to define the determinants of a credible certification scheme. Some relate to certification schemes in general, like for example the International Social and Environmental Accreditation and Labelling (ISEAL) guidelines for certification programmes Others are specific to fish and seafood. FAO has defined guidelines for the ecolabelling of fish and fishery products from marine and inland capture fisheries, and for aquaculture certification (discussed below).

In any case, the independence of certification is seen as a proxy for credibility – being audited by an independent body clearly offers a more credible judgment than a self-assessment: "For credence goods, one may rely on producer claims, but generally there is more trust in an independent third party to provide truthful information and evaluation. In this case, either a third-party private certification may be used, or there may be government regulations requiring that certain product characteristics be revealed by means of testing or inspections, often in government laboratories.

[50] https://www.isealalliance.org/

4.4. Business-to-business versus business-to-consumer models

Private standards related to food safety and quality, are typically business-to-business (B2B) arrangements, whereas those related to sustainability or environmental protection, or directed to other niche markets such as organics, typically follow a business-to-consumer (B2C) model. In the former case, certification is a tool for communicating assurance to buyers that the supplier is in compliance with the food safety and quality standard (although sometimes a quality mark is marketed directly to consumers). In the latter case, certification is marketed to consumers at point-of-sale, often through the medium of a label attached to the product. The B2B aspect of ecolabels and the certification process sitting behind them are becoming increasingly important.

5. MEETING FISHERIES AND AQUACULTURE STANDARDS AND CERTIFICATION REQUIREMENTS

Public and private standards and certification schemes are key to enter lucrative international markets of fish and seafood. Unfortunately, they can represent major hurdles for fish exporters in developing countries, in particular LDCs, as they go beyond the public requirements imposed by importing countries. On the other hand, meeting such requirements can also provide opportunities, for example by attracting consumers in quest of higher quality and credence through eco-labelling or by appealing to environmental or social conscience through fair-trade schemes.
Developing countries, with technical and financial assistance from international organizations such as UNCTAD, FAO and others, have improved significantly their capacity and infrastructure to address public standards for market entry, especially in relation to fish and seafood safety. These achievements need consolidation, through investment in capacity building and infrastructure maintenance. Further consolidation and capacity building is necessary to confront the emerging market entry issues, whether environmental, social or ethical, in particular the private standards that can open the door for entry to highest end market segments. Following is an update of the current approaches to meet public and private standards for fish and seafood markets.

5.1. Meeting public standards and certification in fisheries and aquaculture

5.1.1 Fish and seafood safety

Fish and seafood safety remains a basic requirement to enter any market, whether domestic, regional or international. Modern food safety management approaches stress that the responsibility for consumer protection is shared among all stakeholders of a food value chain, from primary producers and distributors to caterers and consumers. It highlights the value of an integrated approach from production to consumption covering all sectors of the food chain. In this era of globalization of fish and seafood production, processing and trade, there can be many links in the food chain, which is only as strong as its weakest link. Experience gained at national and international levels over the past three decades shows that effective fish and seafood safety control at national level can be undermined by the existence of fragmented legislation, multiple jurisdictions, inconsistencies in enforcement, and weaknesses in food surveillance and monitoring. Governments have a pivotal role in ensuring that the required resources are available and used in a coherent and coordinated manner. Aquaculture farmers and seafood operators are responsible for applying good practices and HACCP and for demonstrating it through proper record keeping.

As a consequence, credible food safety and sanitary measures that meet the provisions of international standards and those of major international markets for the protection of consumers and the environment rely on the application of preventative approaches along the fish and seafood value chain. These approaches aim at preventing the hazard from entering the fish and seafood value chain at the source or reducing its likelihood to acceptable levels reflecting proper application of codes of good practices and sanitary measures. The fish and seafood value chain approach is recognition that the responsibility for the supply of food that is safe, healthy and nutritious, with due consideration to animal and plant health protection, is shared along the entire value chain - by all involved with the production, processing, trade and consumption of food.

International guidelines for food safety provide advice to national authorities on strategies to strengthen food control systems to protect public health, prevent fraud and deception, avoid food adulteration and facilitate trade. They assign to national food control systems the following objectives:

- Protecting public health by reducing the risk of foodborne illness;
- Protecting consumers from unsanitary, unwholesome, mislabeled or adulterated food; and
- Contributing to economic development by maintaining consumer confidence in the food

system and providing a sound regulatory foundation for domestic and international trade in food.

Five building blocks are needed to build robust national fish and seafood control systems:

1. Food Law and Regulations: The development of relevant and enforceable food laws and regulations is an essential component of a modern food control system. Modern food laws not only contain the necessary legal powers and prescriptions to ensure food safety, but also allow the competent food authority or authorities to build preventive approaches into the system. In preparing food regulations and standards, countries are advised to take full advantage of Codex standards and food safety lessons learned in other countries. Considering the successful experiences of in other countries while adapting approaches, concepts and requirements to the national context is the only sure way to develop a modern regulatory framework that will both satisfy national needs and meet the criteria of the international standards and those of trading partners.

2. Food Control Management: Effective food control systems require policy and operational coordination at the national level. While the detail of such functions will be determined by the national legislation, they would include the establishment of a leadership function and administrative structures with clearly defined accountability for issues such as:

- The development and implementation of an integrated national food control strategy;
- Operation of a national food control programme;
- Securing funds and allocating resources;
- Setting standards and regulations;
- Participation in international food control related activities;
- Developing emergency response procedures;
- Carrying out risk analysis.

Core responsibilities include the establishment of regulatory measures, monitoring system performance, facilitating continuous improvement, and providing overall policy guidance.

3. Inspection Services: The administration and implementation of food law and regulations require a qualified, trained, efficient and honest food inspection service. The food inspectors are is a key functionaries who have day-to-day contact with the food industry, trade and often the public. The reputation and integrity of the food control system depends, to a very large extent, on their integrity and skills.

4. Laboratory Services: Laboratories are an essential component of a food control system. The establishment of laboratories requires significant capital and human investment and they are expensive to maintain, calibrate and operate. Therefore, careful planning is necessary to achieve optimum results. All food analysis laboratories may not be under the control of one agency or ministry, and different laboratories a number could be under the jurisdiction of the states, provinces and or local authorities. The Food Control Management should, however, lay down the standards for food control laboratories and monitor their performance. The laboratories should have adequate facilities for physical, microbiological and chemical analyses. The qualification and skills of the analysts and the reliability of the methods used are key to determine compliance with regulations and standards. It is therefore necessary that utmost care is taken to ensure the efficient and effective performance of the laboratory. Implementation of analytical quality assurance programmes and accreditation of laboratories by an appropriate accreditation agency within the country or from outside, enables the laboratory to improve its performance and to ensure reliability, accuracy and repeatability of its results.

5. Information, Education, Communication and Training: An increasingly important role for food control systems is the delivery of information, education and advice to stakeholders across the sea/farm-to-table continuum. These activities include:

- The provision of balanced factual information to consumers;
- The provision of information packages and educational programmes for key officials and operators in the food industry;
- Development of train-the-trainer programmes; and
- Provision of reference literature to extension workers in the agriculture and health sectors.

Food control agencies should address the specific training needs of their food inspectors and laboratory analysts as a high priority. These activities are an important means of building food control expertise and skills of in all interested parties, and thereby serve an essential preventive function.

As a consequence, the implementation of a food value chain approach for fish and seafood safety requires:

- An enabling policy and regulatory environment with clearly defined rules, responsibilities, safety criteria (physical, biological and chemical) and standards;

- Establishment of an appropriate food control system, sanitary measures and infrastructure at national and local levels; and
- Provision of appropriate training and capacity building to ensure proper development and implementation of GAP, GHP and HACCP.

Government institutions should develop:

- An enabling policy and a regulatory framework,
- Organize the control and certification services, train personnel;
- Upgrade the control facilities and laboratories; and
- Develop national surveillance programs for relevant hazards (pesticides residues, veterinary drugs, mycotoxins).

Farmers and food operators should:

- Upgrade facilities, equipment and practices;
- Train personnel and implement GAP, GHP and HACCP.

The support institutions (academia, training; and research, trade associations, certification and analytical services, development institutions, etc.) should:

- Provide technical support and training;
- Conduct research on quality, safety, SPS and risk assessments; and
- Provide credible analytical and certification services

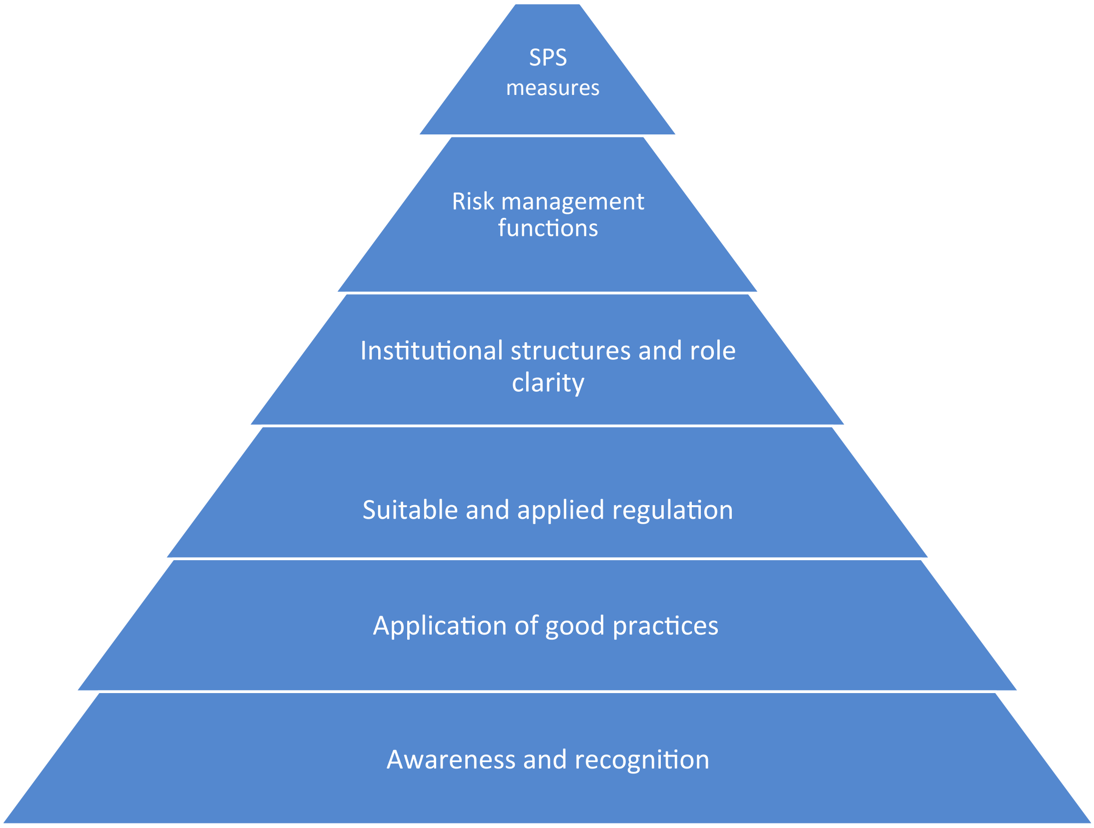
Priority setting at the country level: Priority-setting in fish and seafood safety and sanitary management can be a complex task, as many developing countries have multiple deficiencies in their legal/regulatory systems, weak capacities in an array of food safety management areas, and unclear or overlapping responsibilities among public agencies and between these and the private sector (World Bank, 2005). Food safety management involves an agglomeration of basic and more sophisticated technical and administrative functions, seemingly requiring a broad range of skills, physical infrastructure, institutional structures and procedures, and financial resources. These functions are:

- Application of GAP, GMP and HACCP, at farm and seafood enterprise levels;
- Development of appropriate legislation and standards;
- Registration /control of feed, veterinary drugs, etc;
- Conduct of basic research, diagnosis, and analysis;
- Accreditation of laboratories/veterinarians/other third-party entities for official duties;
- Development/application of quarantine procedures, including for emergency situations;
- Carrying out epidemiological surveillance and information management;
- Inspect/license food establishments;
- Testing aquatic environment and products for residues, contaminants and microbiological content;
- Verification /certification of imported/exported products related to established risks;
- Establishment/maintenance of the identity of products (for example traceability);
- Reporting possible hazards to treaty/trading partners;
- Notifying WTO/trading partners on new food safety measures; and
- Participation in international standard-setting processes.

To simplify this task, the World Bank proposes to cluster these functions into a pyramid-shaped hierarchy of functions (World Bank, 2005). Functions/actions toward the base of the pyramid represent the foundation stones, while those toward the top add value and robustness to the entire system of food safety and sanitary management and gain in importance as the industry matures and encounters increasingly complex technical, administrative, and even political challenges (Figure 5.1).

The bedrock of the system is broad awareness among participating stakeholders about the relevance and importance of food safety to the competitiveness of their country/industry/supply chain/firm and recognition of their own role in this system. Where this awareness is especially weak, regulatory enforcement system is likely to be overwhelmed. Awareness is needed among senior fisheries and aquaculture and trade officials in order to assign appropriate priorities for public programs and expenditures. Awareness is needed among the owners and managers of processing and trading companies, and industry organizations that represent them. These people make investment, engage and train personnel—and engage in self-policing activities— which strongly determine the willingness and capacity of operators/firms to meet emerging standards. Awareness is critical—and perhaps most difficult to build—among the large numbers of fishers and farm and industry workers who produce and handle fish and seafood on a day-to-day basis.

Figure 5.1. Hierarchy of trade-related SPS management functions (World Bank, 2005)



Source : (World Bank,2005)

Another core set of building blocks that proceed from broad awareness is the application of basic risk-management good practices at the farm and enterprise levels—namely, GAP, GHP/GMP and HACCP. This mostly involves training staff in best practices, basic hygiene, HACCP, proper use and storage of potentially hazardous substances, and in record-keeping.

With broad awareness and common application of good practices, many potential fish and seafood safety risks can be effectively managed. Yet other risks cannot be fully managed on such a decentralized basis. They are more systemic in nature and require broader oversight or collective action, requiring basic research, surveillance systems, and quarantine and emergency management systems. Even if individual boats or aquaculture farms and processing enterprises apply good practices, they may not be able to control all hazards—thus the need for scientific testing and verification systems. Many of these higher-order functions require particular technical skills, equipment, well-defined procedures, and recurrent funding. Some need to be mandated by law and regulations to enforce their implementation.

A proper legal and regulatory framework and transparent institutional structures is therefore placed in the middle of the pyramid. At the top of the pyramid is something called SPS Diplomacy, which includes the international obligations of individual WTO members but also relates to a strong engagement in the technical and political realm of international standard setting (both official and private), negotiations with bilateral trade partners and with regional integration partners on matters dealing with harmonization, equivalence, joint programs, special considerations, etc.

This specific hierarchy of functions controverts not only the experience of the many international institutions but also the dominant responses of countries with regard to capacity building This is illustrated by the priorities frequently identified in questionnaires submitted by countries to the WTO SPS/TBT Committees. Much of the focus of developing country–donor interaction has been at the top parts of the pyramid, covering laboratory facilities and equipment, technical assistance and equipment for surveillance systems, and training in negotiating skills. Although these capacities undoubtedly need strengthening in many countries, the effective use of such capacities depends enormously on the strength of the low (foundation) and mid-level functions, the clarity of institutional roles, and the effectiveness and suitability of legislation. Where the foundation is weak, the return on investment in laboratories and participation in international standards-setting meetings of Codex and OIE is substantially reduced.

Cost implications differ according to the level in the hierarchy. Elements at the bottom half of the pyramid require decentralized efforts that can reach potentially large numbers of farmers, employees, businesses, etc. The costs associated with implementing these functions are generally not especially high (although sometimes they might require certain infrastructure), yet the challenge here is reaching potentially dispersed stakeholders in a cost-effective way.

Elements in the top half of the pyramid typically involve interactions with participants/stakeholders in national ministries (fisheries, commerce, and health) and in the provincial/local institutions. These items tend to be more expensive, and some entail rather "lumpy" investments in hardware, for which cost-benefit considerations are generally needed.

5.2. Meeting the requirements of private standards

Private standards in fisheries and aquaculture are usually underpinned by certification schemes. For standards established by individual companies and based on their own product specifications, compliance is typically verified by internal audit procedures. However, where buyers and importers require certification against a wider standard, third-party verification of compliance, by bodies independent of the standard setter and the organization to be audited, is the norm. This is the case for many food safety private standards and the main ecolabelling schemes. In both cases, the independence of certification is seen as a proxy for credibility – being audited by an independent body clearly offers a more credible judgment than a self-assessment.

After decades of sacrifices, investment and international cooperation, many exporting developing countries have acquired the capacity to meet food safety standards to enter more lucrative markets. They require vigilance to consolidate this advantage and build on it to meet higher standards of niche international buyers. Ecolabeling is of great relevance for entry to these international lucrative markets for developing countries. Most importantly, it has become a major driver for improved fisheries management, a promising area for public private partnership and a way to reward responsible behavior and best practices in fisheries and aquaculture management. It is described here in more details to illustrate the complexity of the challenges but also the opportunities it offers.

5.2.1 Ecolabeling in capture fisheries and aquaculture

Concern with the pace of regulatory measures to curb overfishing and to improve fisheries and aquaculture sustainability has led environmental groups and industry to develop alternative market-based strategies for protecting aquatic eco-systems and promoting sustainability. These private market mechanisms are designed to influence the purchasing decisions of consumers and the procurement policies of retailers selling fish and seafood products, as well as to reward producers using responsible fishing and aquaculture practices. Ecolabels are one such market-based mechanism.

Definition: Ecolabelling is a market-based tool to promote the sustainable use of natural resources. Ecolabels are seals of approval given to products that are deemed to have fewer impacts on the environment than functionally or competitively similar products. The ecolabel itself is a tag or label placed on a product that certifies that the product was produced in an environmentally friendly way. The label provides information at the point of sale that links the product to the state of the resource and/or its related management regime.

Sitting behind the label is a certification process. Organizations developing and managing an ecolabel set standards against which applicants wishing to use the label will be judged and, if found to be in compliance, eventually certified. The parent organization also markets the label to consumers to ensure recognition and demand for labelled products. The theory is that ecolabels provide consumers with sufficient information to enable them to recognize and choose environmentally friendly products.

A brief history of ecolabels: The first fisheries ecolabelling initiatives appeared in the early 1990s and were largely concerned with incidental catch, or bycatch, during fishing. For example, the "Dolphin Safe" label was based on standards developed by the NGO "Earth Island Institute" and is focused on dolphin bycatch in the tuna industry (rather than the sustainability of tuna stocks). Other mechanisms used by NGOs include:

- Publicity campaigns or organized boycotts of certain species deemed to be threatened such as the "Give Swordfish a Break" campaign in the USA in the late 1990s, or the "Take a pass on seabass" campaign;

[51] www.montereybayaquarium.org/cr/seafoodwatch.aspx.

• Consumer guides to influence consumers purchasing decisions. For example, WWF produces consumer guides on sustainable seafood for a range of countries or the Monterey Bay Aquarium's "Seafood Watch" in the USA. Some of these guides take the form of applications that consumers can consult at the point of purchase. They give information about which species to avoid (referring to "red lists") and those that are deemed environmentally safe to purchase;

• Putting pressure on retailers to introduce sustainable procurement policies for fish and seafood. This has taken the form of "league tables": Ranking the sustainability of supermarkets' seafood. Some NGOs have also used "naming and shaming" strategies by staging protests outside retail outlets deemed to be selling unsustainable products.

A range of ecolabelling and certification schemes exists in the fisheries sector, with each scheme having its own criteria, assessment processes, levels of transparency and sponsors. What is covered by the schemes can vary considerably: bycatch issues, fishing methods and gear, sustainability of stocks, conservation of ecosystems, and even social and economic development. The sponsors or developers of standards and certification schemes for fisheries sustainability also vary: private companies, industry groups, NGOs, and even some combinations of stakeholders. A few governments have also developed national ecolabels.

Table 5.1 above has compiled the most active ecolabeling schemes operating currently in fisheries and aquaculture.

Fish and seafood value chain stakeholders (exporters, processors, buyers, retailers) have expressed concerns about the range and diversity of ecolabels that, when coupled with the other private standards and certification schemes in fisheries and aquaculture, complicate their fish and seafood export or procurement models. Market research suggests that consumers are also confused about the various messages and labels confronting them as they make choices about which fish and seafood to purchase. In reality, two schemes (MSC and Friends of the Sea) appear to stand out as the most internationally significant, on the basis of the number of fisheries certified and the resulting volumes of certified fish and seafood products entering international markets.

International response to ecolabeling: When the MSC was first launched in 1997, the reactions of countries and industry groups were quite diverse. Early reports showed a generally negative reaction on the part of many international industry groups (e.g. the International Coalition of Fisheries Associations ICFA, the Groundfish Forum). Developing countries were particularly concerned that certification might create additional barriers to trade. FAO was requested to develop eco-labelling guidelines taking into consideration limitations of developing countries, poor data fisheries and other aspects of relevance to small scale fisheries.

The FAO Guidelines were adopted in 2005 and updated in 2009 . They cover three main sections:

• General principles and definitions;

• Minimum substantive requirements and criteria; and

• Procedural and institutional aspects.

Briefly, the General principles and definitions state that any ecolabelling scheme should be:

• Consistent with relevant international law and agreements including: the 1982 United Nations Convention on the Law of the Sea (UNCLOS), the FAO Code of Conduct for Responsible Fisheries (the Code) and World Trade Organization (WTO) rules and mechanisms;

• Voluntary, market-driven, transparent and non-discriminatory, including by recognizing the special conditions applying to developing countries.

The minimum substantive requirements and criteria of any ecolabelling scheme should include the requirements that:

• The fishery is conducted under a management system that is based on good practice including the collection of adequate data on the current state and trends of the stocks and based on the best scientific evidence;

• The stock under consideration is not overfished; and

• The adverse impacts of the fishery on the ecosystem are properly assessed and effectively addressed.

The procedural and institutional aspects require that any ecolabelling scheme should encompass:

• The setting of certification standards;

• The accreditation of independent certifying bodies; and

• The certification that a fishery and the product chain of custody CoC are in conformity with the required standard and procedures.

Governments have the ultimate responsibility to ensure food security and sustainable aquatic resources for current and future generations. The protection of the public goods of fish stocks and related ecosystems is an important part of that equation. On the other hand, governments must ensure that the conditions are right for their fishing industries to compete in international markets, where ecolabels are increasingly a part of importers' specifications and a factor for entry into lucrative markets.

Currently, policy makers of coastal states have taken quite diverse approaches to the ecolabelling question. A few (Iceland, Alaska, Australia for capture fisheries; Thailand and Vietnam for aquaculture) have supported the development of a public ecolabel, some (including in developing countries such as Indonesia, Morocco, Mauritania) have made funds available to industry to offset the costs of certification, some have allocated resources to help improve the administrative, science or management conditions required for industry-funded certification to be successful, while others have taken a conscious hands-off approach.

Ecolabels and developing countries: bonus or barrier?: To date, fisheries in developing countries represent a small minority of eco-labeled fisheries. Most of those fisheries are large-scale, such as the South African hake fishery. The underrepresentation of developing countries' is due to three main factors:

• The lack of an economic imperative for certification. Developing countries have a limited presence with species, types of products, and supply chains in the markets where pressure to be certified is greatest;

• Ecolabelling schemes do not translate well into the typical conditions of the fisheries environment in developing countries (weak fisheries management regimes, data deficiencies, small-scale multispecies fisheries); and

• The high costs of certification are often prohibitive for developing countries and their small-scale or resource-poor fishers and operators.

An important issue relates to the asymmetric distribution of the costs and benefits of ecolabelling and certification. To date, exporting countries and their producers meet the main costs of ecolabelling and certification but importers and retailers appear to reap many of the rewards. A better and hopefully equitable distribution of the costs and benefits of ecolabelling as they accrue to the various stakeholders would be useful.

Recognition of good fisheries management without certification to a private scheme:

As stated earlier, private standards, including ecolabeling have emerged because of the perception that public governance has failed to properly manage fisheries leading to overfishing. However, many have questioned the value of certification to an independent scheme, arguing that their reputations for good management of several fisheries – either national or regional – are well established and that there should be another way to "prove" it without resorting to costly third party certification to a private ecolabelling scheme.

Fishery improvement Projects (FIP): Most importantly, it can be argued that since only 10 to 15 percent of the internationally traded fish is certified to an eco-label, there is a need to engage the other less performing fisheries on a path of improvement, that can be recognized by the market, although they do not meet the certification criteria for ecolabeling (figure 5.2). For more than a decade now, many developing countries have engaged in Fisheries Improvement Programmes or Projects (FIP), with support from organizations such as UNCTAD, FAO, UNDP and others, with the view to motivate and move fisheries towards sustainability. Implementation of FIPs is especially relevant in developing countries where small to medium scale fisheries operate under systems of weak governance. They need however to be operated in a credible manner: meaning that FIP actions are should be transparent and lead to real and measurable improvement in fishery performance. Ultimately, these fisheries can demonstrate their sustainability through a robust, independent assessment process. A credible FIP should be characterized by:

• An initial gap analysis against a set of performance indicators reflecting for example the substantive criteria of the FAO ecolabeling guidelines;

• An action plan inclusive of activities, budgets, roles and responsibilities, that is linked to the performance indicators, preferably with scoring guideposts that can show improvements;

• Regular reporting of progress against the action plan

• Use of a mechanism to verify and provide assurance about the robustness of the process and progress being made in the FIP; and

• In the case of FIPs supported by MSC, an upfront commitment to enter full MSC assessment and achieve MSC certification through a transparent, third party process, to verify the success of the FIP.

FIPs with robust plan of action for their implementation, including monitoring and reporting are being recognized and rewarded by the market, through importers, retailers and NGOs such as WWF or the Sustainable Fisheries Partnership (SFP).

[52] http://www.fao.org/3/a-i1119t.pdf

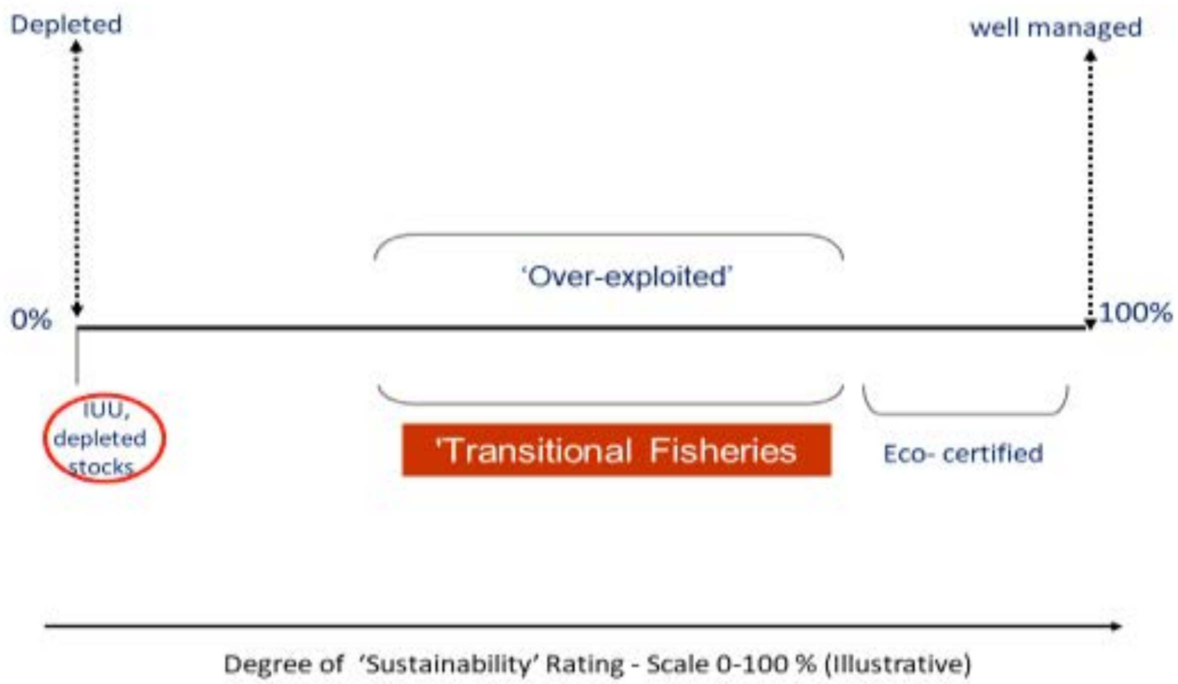
5.3. Integrated traceability

According to the Codex Alimentarius Commission, traceability is "The ability to follow the movement of a food through specified stage(s) of production, processing and distribution". In ISO 9000 (2005), traceability is defined as "The ability to trace the history, application or location of that which is under consideration". When considering a product, traceability can relate to a) the origin of materials and parts, b) the processing history; c) the distribution and location of the product after delivery.

For ISO 22005 (ISO, 2008) traceability is "The ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution". Movement can relate to the origin of the materials, processing history or distribution of the feed or food but should be confined to one step forward and one step backward in the chain.

From the major fish and seafood markets, the European Union (EC, 2002) defines traceability as "The ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution".

Figure 5.2: Justificatiion for a fishery improvement project



Source: Author's elaboration

Concretely, these definitions are quite similar, although the ISO 9000 definition covers all products in general whereas the three others only apply to food and/or feed. Likewise, the term "trace" or "tracing" is used when the history of product origin is searched (upstream) and the term "track" or "tracking" is used for searching its history after delivery (downstream). It is also useful to differentiate internal versus external traceability. Global implementation of HACCP systems for safety management and ecolabelling for fisheries and ecosystems management has increased the need for information throughout the value chain. Fish and seafood companies already have effective internal traceability systems as part of their HACCP systems or for combatting IUU. In many cases, however, traceability is lost before the raw materials enters the premises or/and after the products leave the premises. Productivity and efficiency can be improved significantly if external traceability, the so-called chain traceability, and the information attached to it is established and reliable. Chain traceability is key to transparency and cooperation between the chain' stakeholders.

In summary. Chain traceability is the ability to track the origins of a product, the processes it went through, and where it ended up; in the case of fish and seafood – from boat or farm to consumer. Chain of custody is a more specific concept and guarantees not only the ability to trace products but also the ability to ensure their integrity throughout the value chain. In terms of certified fish and seafood, chain of custody includes guarantees that certified product is not mixed with non-certified product. It is arguably the traceability aspects of private standards schemes that retailers and brand owners find most compelling – they provide valuable guarantees and risk-management functions when there is a lack of confidence in public systems and when governance in some exporting countries is perceived to be weak.

Traceability is especially important in today's context of increasingly complex supply and distribution systems and where fish and seafood products pass through multiple hands and even multiple countries before reaching the final retailers' shelves. Robust traceability and chain-of-custody mechanisms also prevent fraud, or non-certified products (of inferior quality or different origins) being passed off as certified product.

There is a multiplicity of drivers for traceability in the food sector generally: mandatory food safety requirements, private safety and quality certifications, sustainability claims, and business-related drivers such as inventory control, promoting efficiencies, and communication along the supply chain. Table 5.4 indicates a range of those drivers and where they overlap (FAO, 2016c).

5.3.1 Multiple traceability requirements

Multiple mandatory traceability systems already operate in the fisheries and aquaculture sector. International traceability norms for food safety assurance are well established. Codex document CAC/GL 60-2006 outlines a set of principles for competent authorities to develop traceability systems able to "identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward)." Other mandatory public traceability systems relate to catch certification, country of origin, and mechanisms to combat IUU fishing. Following are some examples of this.

Food safety: The European Union (EU) mandatory traceability requirements for food and feed, including fish and seafood products, are encapsulated in European Commission Regulation 178/2002 Article 18, which also requires adequate labelling. Traceability is generally required on a "one step backwards, one step forwards" basis.

The FDA requires importers of seafood into the USA to notify the FDA prior to receiving shipment. Both the FDA and the Bureau of Customs and Border Security (BCBS) require a variety of product data. The Food Safety MOdernization Act enables the FDA to require each person along the value chain to "maintain the full pedigree of the origin and previous history of the food and link that history to the subsequent distribution of the food", which is a significant change to the "one up, one down" traceability that was required.

Table 5.4 Traceability systems: purpose/driver, objective, attributes, standards and examples

Purpose/driver	Objective	Attributes	Standard	Example
Food safety	Consumer protection (through recall and withdrawal)	Specified in food fish safety regulations	Mandatory	EU regulation
			Voluntary (1)	US regulation
Security	Prevention of criminal actions (through verifiable identification and deterrence)	Specified in security regulations	Regulatory (2)	US prevention of bioterrorism regulation
		Verification of selected attributes on package and/or	Voluntary (no common standard)	Brand and product protection
Regulatory quality	Consumer assurance (through recall and withdrawal)	Specific attributes included in regulations	Regulatory (3)	EC labelling mandatory consumer information
Non regulatory quality and marketing	Creation and maintenance of credence attributes	Specific attributes included in public standards	Voluntary (common standards (4)	Pubic quality seals (e.g. Label Rouge, France) Organic fish, eco-labeling
Food chain trade and logistics management	Food chain uniformity and improved logistics	Specific attributes required to food and services suppliers by contract	Private standards (4)	Own traceability system (e.g. Walmart)
			Public standards for encoding information	EAN.UCC 128 (5) (e.g. TRACEFISH standard (6) SSCC (7)
Plant management	Productivity improvement and costs reduction	Internal logistics and link to specific attributes	Voluntary (internal traceability; own or public standards	From simple to complex IT systems
Documentation of sustainability	Natural resource sustainability	Specified in environmental protection	Mandatory	EU regulation
			Voluntary	FAO IPoA to eliminate IUU fishing (8)

Source: Author's elaboration

(1) Recall and withdrawal compulsory if a responsible company does not take action;
(2) Includes the possibility of mandatory disposal, recall and withdrawal, legal and police actions, but primary purpose is prevention.
(3) Includes the possibility of mandatory disposal, recall and withdrawal, and administrative actions, but primary purpose is consumer assurance.
(4) Could include voluntary (contractual) recall and withdrawal and agreed (contractual) sanctions.
(5) GS1 System standardizes bar codes (www.GS1.com).
(6) EAN.UCC: European Article Numbering-Uniform Code Council.
(7) TRACEFISH, "Traceability of Fish Products" (EC-funded project) (www.tracefish.org)
(8) SSCC: Serial Shipping Container Code (UCC)
(9) IPOA-IUU: International Plan of Action to Prevent, Deter and Eliminate IUU Fishing

[53]http://www.fao.org/fao-who-codexalimentarius/sh-proxy/ru/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCAC%2BGL%2B60-2006%252FCXG_060e.pdf

[54]https://www.fda.gov/food/guidanceregulation/fsma/

IUU fishing: Several RFMOs require that certain fish caught under the authority of member flag states be accompanied by catch or trade documentation when traded. For example, the International Commission for the Conservation of Atlantic Tunas (ICCAT) requires this for all Atlantic tunas and tuna-like species.

The European Union IUU Regulation 1005/2008 came into force on 1 January 2010 and requires imported wild-caught fish and fish products to be accompanied by a catch certificate (Article 12) validated by the competent authority of the flag state of the vessel where the fish was caught. Where fish is processed in a country other than the flag state, the re-exporter must provide a certificate that identifies the re-exported fish and provide the original or copies of the original catch certificates (validated by a control authority in the re-exporting state). However, these requirements are not linked to the food-safety traceability and certification requirements applying to the same products.

5.3.2 Emerging aspects of traceability

Technological tools for traceability: IT tools have become central in building integrated traceability systems. These include for example standardized product numbering using barcodes or inventories, or standardized electronic product coding (EPC) and radio frequency product identification (RFID). The latter enable products to be traced as they pass along the supply chain. These tools could be used for public, private or public private purposes to enable cost-efficiencies and transparency. Significant work is conducted to design one system that would meet multiple requirements: food safety, catch certification, IUU and the chain-of-custody aspects of various private and voluntary certification schemes. Adoption of such an approach will need a multi-stakeholders' consultation on user requirements and whether or not the public and private agents currently requiring various levels of traceability would be prepared to give up their own systems in favor of an integrated multipurpose system. Moreover, any solutions would have to consider the risk of "overkill" (systems designed for the highest possible risk – food safety assurance – posing an increased burden for operators with relatively low risk) as well as the impacts on developing country and small-scale operators, which would find the data and technological requirements problematic.

Traceability and transparency: Transparency of a supply chain is the degree of shared understanding of, and access to, product-related information as requested by a supply chain's stakeholders without loss, delay, or distortion. However, it is traceability that sets the framework for transparency. Depending on whether traceability is aimed at the past, present or future, it can be divided in three types: history-, operations- and strategy transparency. When it comes to products, traceability can enable the first two types of transparency, since it addresses the past and the present of the product. In addition to transparency, traceability needs some system to verify the conformity of data. One measure to improve transparency is to establish or identify authoritative data sources, for example a global record of fishing vessels for combatting IUU.

Traceability and catch/trade documentation schemes: There are numerous mandatory and voluntary catch documentation schemes (CDS) in use in capture fisheries, and while they have properties in common with a traceability system, they do not by themselves constitute traceability systems. CDSs involve key relevant recorded information, but the set of recorded data is limited and often selected for one purpose only (e.g. customs control, documenting legal provenance of captured fish, reporting catch data), and CDSs do not apply throughout the entire value chain. A traceability system is "live" in that one can keep adding data as they develop. A CDS provides snapshots of a subset of the information at a certain time and place; typically when a harvest is landed, during first (auction) sale or when the product passes a border.

Traceability and Chain of Custody: FAO ecolabeling guidelines define chain of custody (CoC) as: "The set of measures which is designed to guarantee that the product put on the market and bearing the ecolabel logo is really a product coming from the certified fishery concerned". These measures should thus cover both the tracking/traceability of the product all along the processing, distribution and marketing chain, as well as the proper tracking of the documentation (and control of the quantity concerned). This means that while traceability and CoC to some degree have the same goal, that is a well-documented supply of fish products, their approaches are quite different.

Traceability is generic and non-discriminatory. The company receives trade units (or fish from the ocean where the catch is identified in a similar way as a trade unit), splits, joins or merges trade units into raw material batches (e.g. by grading), makes production batches based on the raw material batches, and finally splits the production batches into outgoing trade units. At each stage a spilt, join or merge can take place, and this will be recorded in the traceability system so that all transformations and dependencies are documented. With ecolabel-type CoC, there is one particular set of properties that one wants to protect, retain and document (e.g. ecolabels such as dolphin-safe; organic or MSC), while not being concerned about the rest.

6. CONCLUSION

Fisheries and aquaculture should play an increasing role to feed a population expected to reach 10 billion by 2050. However, previous ways of exploitation of wild fisheries resources and production of aquaculture fish and seafood are not sustainable. A major shift of paradigm for harvesting, aquaculture production, handling, processing and marketing is needed to implement internationally recognized best practices along the fish and seafood value chain. Needless to recall this chain is as strong as its weakest link.

The need for a paradigm shift has been recognized by all major stakeholders of the fish and seafood value chain. Unfortunately, fisheries institutions in many developing countries have lagged behind in enforcing the rules and regulations for best practices of sustainable management of fisheries and aquaculture. This has raised concern with the slow pace of regulatory measures to curb overfishing, to combat IUU fishing and to improve fisheries and aquaculture sustainability. As a result, environmental groups and industry have developed alternative market-based strategies for protecting consumers, aquatic eco-systems and promoting sustainability. These private market mechanisms are designed to influence the purchasing decisions of consumers and the procurement policies of retailers selling fish and seafood products, as well as to reward producers using responsible fishing practices. The relevant standards and certification schemes address food safety and quality, sustainability and social responsibility. As such, they can complement other government led systems to improve fisheries and aquaculture sustainability. However, several issues remain to be solved.

Are there too many standards and labels?

Many reports have referred to the "proliferation" of standards and labels. Seafood buyers, importers, retailers and commercial brand owners in particular have expressed concerns about the range and diversity of ecolabels that, when coupled with the other private standards and certification schemes in fisheries and aquaculture (e.g. safety and/or quality schemes), complicate their fish and seafood procurement models. Market research suggests that consumers are also confused about the various messages and labels confronting them as they make choices about which fish and seafood to purchase. Fishers and aquaculture producers too have to decide which certification schemes have the most credence in the market and offer the most returns on investment. Mechanisms for evaluating certification schemes and ecolabels, to ensure that they are transparent and consistent with international guidelines, are needed. These should explore the potential for mutual recognition between schemes, including the public certification schemes.

Responses and implications for governments and industry associations:

Governments have the ultimate responsibility to ensure food and nutrition security for current and future generations. The protection of the public goods of fish stocks and related ecosystems is an important part of that equation. At another level, governments have to ensure that the conditions are right for their fishing industries to compete in international markets, where standards and certification schemes are increasingly a part of buyer specifications and a key factor to enter niche and high value markets.

Governments have taken quite diverse approaches to the question of private labels and certification schemes. Some have supported the development of a public ecolabel, some have made funds available to industry to offset the costs of certification, some have allocated resources to help improve the administrative or management conditions required for industry-funded certification to be successful, while others have taken a hands-off approach. Likewise, industry associations have taken different approaches in different developing countries. The successful experiences demonstrate clearly that this is an important area for Public Private Partnership.

Standards and certification of fish and seafood from developing countries:

To date, fisheries of developing countries represent a small minority of certified fisheries. The reasons for this low representativity have been explained in this chapter. On the other hand, developing countries might also be missing out on the opportunities certification can offer, including more opportunities for export of value-added products, more direct and stable supply relationships and pressure for improved fisheries management. To do this, developing countries need appropriate support for institutional and capacity building to implement fisheries improvement projects, based on internationally recognized best practices for fisheries and aquaculture management. Likewise, the distribution of the costs and benefits of labelling and certification need special attention. To date, it appears that producers meet the main costs of ecolabelling and certification but that retailers appear to reap many of the rewards. Further inquiry into the costs and benefits of ecolabelling as they accrue to the various stakeholders and how they could be more equitably distributed would be useful.

Glossary

Abundance data—A measure, or relative index, of the number or weight of fish in the stock. Data ideally come from a statistically-designed, fishery-independent survey (systematic sampling carried out by research fishing vessels separately from commercial fishing operations) that samples fish at hundreds of locations throughout the stock's range.

Actionable subsidies: bounty an exporter gets but is challenged by the importer if injuries occur. It can also be denied if it prejudices interests in a country. They can be subject to countervailing duties or WTO Dispute settlement mechanism.

Appropriate level of sanitary or phytosanitary protection is the level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. NOTE: Many Members otherwise refer to this concept as the "acceptable level of risk".

Aquaculture refers to the Farming, during part or all of the life cycles of aquatic animals, intended for human consumption, with the exception of mammalian species, aquatic reptiles, and amphibians.

Biology data—Provides information on fish growth rates and natural mortality. Biological data include information on fish size, age, reproductive rates, and movement. Annual growth rings in fish ear bones used by biologists to assess fish age. The samples may be collected during fishery-independent surveys or be obtained from observers and other fishery sampling programs. Academic and research programs with the fisheries agencies and fishing industry are other important sources of biological data.

Biotrade is understood to include activities related to the collection or production, transformation, and commercialization of goods and services derived from native biodiversity (genetic resources, species and ecosystems) according to criteria of environmental, social and economic sustainability.

Catch data—The amount of fish removed from a stock by fishing under its different forms (recreational, artisanal, coastal or industrial fishing).

Certification is the procedure by which a certification body or certifier gives written or equivalent assurance that a product, process or service conforms to certain standards.

Chain of custody is defined in the FAO ecolabeling guidelines as: "The set of measures which is designed to guarantee that the product put on the market and bearing the ecolabel logo is really a product coming from the certified fishery concerned". Chain of custody is not only the ability to trace products but also the ability to guarantee their integrity throughout the value chain. In terms of certified fish and seafood, chain of custody includes guarantees that certified product is not mixed with non-certified product.

Chain traceability is the ability to track the origins of a product, the processes it went through, and where it ended up; in the case of fish and seafood – from boat or farm to consumer.

Depuration is the reduction of micro-organisms to a level acceptable for human consumption by the process of holding live bivalve molluscs for a period of time under approved, controlled conditions in natural or artificial seawater suitable for the process, which may be treated or untreated.

Ecosystem approach to fisheries: An Ecosystem Approach to Fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries (FAO, 2003).

Equivalence. Members shall accept the sanitary or phytosanitary measures of other Members as equivalent, even if these measures differ from their own or from those used by other Members trading in the same product, if the exporting Member objectively demonstrates to the importing Member that its measures achieve the importing Member's appropriate level of sanitary or phytosanitary protection.

Export diversification: An increase in the variety of exports in one of three ways: (i) geographically, by exporting the same good or goods to new markets; (ii) sectorally, by exporting a new product or products to established markets; or (iii) exporting new products to new markets.

Export strategy: A country's overall plan for developing its exports. Such strategies often include policies for upgrading and/or diversifying exports.

Export upgrading: "Economic upgrading is defined as firms, countries or regions moving to higher value activities in GVCs (global value chains) in order to increase the benefits (e.g. security, profits, value-added, capabilities) from participating in global production." Export upgrading refers to the same concept, but stresses the higher value activities that are associated with exports.

First-party certification: A certification by which a single company or stakeholder group develops its own standards, analyses its own performance, and reports on its compliance, which is therefore self-declared.

Fisheries management: the integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives".

Fish Stock- a biological fish stock is a group of fish of the same species that live in the same geographic area and mix enough to breed with each other when mature. A management stock may refer to a biological stock, or a multispecies complex that is managed as a single unit.

Food chain: as defined by food safety experts, is the sequence of operations where hazards and defects can enter the chain and where they can be controlled by implementing appropriate control measure(s) to prevent the hazard or defect from occurring.

Food fraud is committed when food is illegally placed on the market with the intention of deceiving the customer, usually for financial gain. This involves criminal activity that can include food mislabeling, substitution, counterfeiting, misbranding, dilution and adulteration.

Harmonization is the establishment, recognition and application of common sanitary and phytosanitary measures by different Members.

Illegal fishing refers to fishing and related activities conducted in contravention of national, regional and international law. Fishing without a license in prohibited areas, with prohibited gear, on prohibited species, or extracting over the allowed quota.

Illegal, unregulated and unreported (IUU) fishing: IUU fishing refers to fishing by "Stateless" vessels, fishing in convention areas of Regional Fisheries Management Organizations (RFMOs) by non-party vessels or fishing activities which are not regulated by States and cannot be easily monitored and accounted for.

Least developed countries: A UN designation based on three criteria: per capita income, human assets, and economic countries (LDCs) vulnerability. Currently there are 47 LDCs.

Maximum Sustainable Yield (MSY): The surplus production of a stock varies according to diverse factors, including the biological characteristics of the species, the environmental conditions in the stock distribution area and the size of the stock relative to the ecosystem carrying capacity. The maximum sustainable yield (MSY) is defined as the highest catch that can be continuously taken from a stock under existing environmental conditions.

Niche market: A segment of a regional or global value chain that is highly distinctive and constitutes a market in its own right. Examples include organic food, eco-labelled products, and fair-trade-labelled products.

Prohibited subsidies: Subsidies that are linked to export performance

Recruitment can be defined as the number of fish surviving to enter the fishery or to some life history stage such as settlement or maturity.

Recruitment overfishing: A situation in which the rate of fishing is (or has been) such that annual recruitment to the exploitable stock has become significantly reduced. The situation is characterized by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year. If prolonged, recruitment overfishing can lead to stock collapse, particularly under unfavorable environmental condition.

Reference point: Management reference points are agreed values of indicators of the desirable or undesirable state of a fishery resource or the fishery itself. Reference points could be biological (e.g. expressed in spawning biomass or fishing mortality levels), technical (fishing effort or capacity levels), or economic (employment or revenues levels). Biological reference points are usually estimated from models in which they may represent critical values or thresholds.

Relaying is the removal of bivalve molluscs from a microbiologically contaminated growing area to an acceptable growing or holding area under the supervision of the competent authority and holding them there for the time necessary for the reduction of contamination to an acceptable level for human consumption.

Risk assessment is the evaluation of the likelihood of entry, establishment or spread of a pest or disease within the territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences; or the evaluation of the potential for adverse effects on human or animal health arising from the presence of additives, contaminants, toxins or disease-causing organisms in food, beverages or feedstuffs.

Sanitary or phytosanitary measure is any measure applied: (a) to protect animal or plant life or health within the territory of the Member from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;(b) to protect human or animal life or health within the territory of the Member from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; (c) to protect human life or health within the territory of the Member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or (d) to prevent or limit other damage within the territory of the Member from the entry, establishment or spread of pests.

Second-party certification: A certification where an industry or trade association or NGO develops standards, compliance is verified through internal audit procedures or by engaging external certifiers to audit and report on compliance.

Special and differential treatment: LDC Members with a GNP per capita of less than $1000 per year which are listed in Annex VII to the SCM Agreement are exempted from export subsidies prohibition.

Stock assessment: is the process of collecting, analyzing, and reporting demographic information to determine changes in the abundance of fishery stocks in response to fishing and, to the extent possible, predict future trends of stock abundance.

Standard: According to ISO, a standard is a document established by consensus and approved by a recognized body, that provides for common and repeated use, rules, guidelines, or characteristics for activities or their results, aimed at the achievements of the optimum degree of order in a given context. Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits. The TBT clarifies that a standard is a document approved by a recognized organization or entity, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory under international trade rules. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.

Subsidies countervailing measure agreement (SCMA): A financial contribution by a government or any public body that confers a benefit in the form of direct transfers, fiscal incentives, provision of goods and services, and price support.

Supply chain is a network of product-related operators (business enterprises) through which products move from the point of production to consumption, including pre-production and post-consumption activities.

Technical regulation is a document which lays down product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.

Third-party certification: A certification where an accredited external, independent, certification body, which is not involved in standards setting or has any other conflict of interest, analyses the performance of involved parties, and reports on compliance.

Traceability is defined by Codex as the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.

Traceability is defined in ISO 9000 (2005) as the ability to trace the history, application or location of that which is under consideration. When considering a product, traceability can relate to a) the origin of materials and parts, b) the processing history; c) the distribution and location of the product after delivery. For ISO 22005 (ISO, 2008) traceability is the ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution. Movement can relate to the origin of the materials, processing history or distribution of the feed or food but should be confined to one step forward and one step backward in the chain.

Traceability is defined by the European Union (EC, 2002) as the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution.

Unreported fishing refers to any fishing operations or catch that is not recorded or that is misreported to proper authorities, any withholding of catch type, size, and location.

Unregulated fishing refers to catch from areas of the sea, including the high seas, not under jurisdiction of a state or a RFMO.

Value chain can be defined as the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final customers, and final disposal after use. The chain actors who actually transact a particular product as it moves through the value chain include input (e.g. seed suppliers), farmers, traders, processors, transporters, wholesalers, retailers and final consumers (FAO, 2006).

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BUILDING CAPACITY IN THE LEAST DEVELOPED COUNTRIES TO FULLY HARNESS THE POTENTIAL OF FISHERIES AND AQUACULTURE **Training Manual**

UNITED NATIONS