The European Commission's Knowledge Centre for Global Food and Nutrition Security

Fisheries and aquaculture contribution to food security

(updated 02/2022)

Headlines

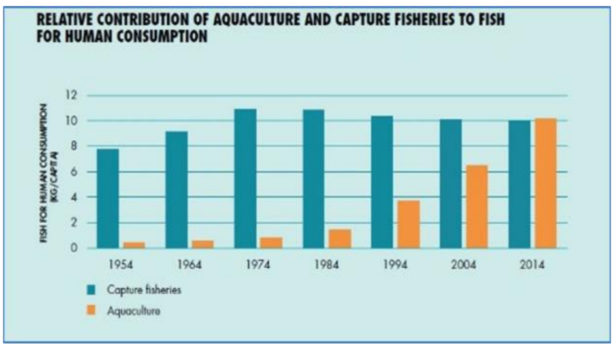
- Aquaculture has recently superseded wild-capture fisheries as the main source of seafood for human consumption worldwide.
- Aquaculture is considered as a major potential source to feed the increasing world population. However, aquaculture production growth is slowing down in the last decades.
- In the EU, aquaculture provides only one fifth of the EU supply of seafood. EU aquaculture production has been stagnated in the last decades, while its value has been increasing. This results from an increase in the production of marine finfish species and a decrease in shellfish production, partly due to environmental factors.
- Fish stock status varies according to sea regions. According to FAO [2], in the Mediterranean and Black Sea, SW Atlantic and SE Pacific the situation is worrisome, as the majority (between 58,5 and 62.2%) of stock is fished at biologically unsustainable level. In other regions, the situation is much better. In general, 33.1% of stocks is fished at biologically unsustainable level. Some fish stocks in the Northeast Atlantic Ocean are recovering, leading to modest increases in capture fisheries' landings and improved economic performance. The situation in the Mediterranean is still poor with most stocks overfished.
- Oceans and their food resources are facing important antropogenic induced challenges such as pollution, plastics, ocean acidification and climate change

The present brief focuses on the contribution of sustainable marine food (i.e. seafood, which includes fish, crustaceans, molluscs and algae) to food security at global level. and the impact on food availability of climate change and other relevant interactions.

Background: Global Situation

The world population is growing rapidly, moving from 7.3 billion in 2015 to a foreseen 9.1 billion by 2050 (Gerland et al., 2014). Such population increase will lead to an increase of the global demand for food (Duarte et al., 2009; Godfray et al. 2010; Garcia & Rosenberg, 2010; Béné et al., 2015). Oceans cover three quarters of the earth's surface and are a major potential source for this additional food requirement, in particular aquaculture.

Global landings from capture fisheries increased to reach more than 90 million tonnes in 1994 and stabilized/stagnated thereafter; while global aquaculture production more than doubled during the 1990s with an annual growth of 10%, falling to 6% over the period 2000–2017 (FAO, 2019). Such increase is mainly due to the intensification of the aquaculture farming production.



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Aquaculture has recently superseded wild-capture fisheries as the main source of seafood for human consumption (FAO, 2016b). While almost all aquaculture production is destined for human consumption, the proportion from capture fisheries now stands at around 78%. Around three quarters of the global seafood production not destined for direct human consumption is reduced to fishmeal and oil (FAO, 2016b). Fishmeal is mainly used as feed in aquaculture, but also for pigs and poultry; while fish oil is used mainly in aquaculture, but in recent years its use as nutritional supplement has raised significantly.

The aquaculture production process is determined by biological, technical, economic, institutional and environmental factors that are largely under human control. The production increase, however, is far from evenly distributed and most of the growth has been in Asian countries, which currently produce more than 90% of the volume and 75% of the value (FAO, 2019).

In terms of environmental sustainability, in particular in the aquaculture farming, fish is one of the most efficient converters of feed into food and its carbon footprint is lower compared to other animal production systems (http://www.fao.org/3/a-i7546e.pdf). Also, the current diversification of aquaculture to lower trophic levels species and the promotion of systems with environmental services (e.g. Integrated Multitrophic Aquaculture or seaweed aquaculture) are key steps to reduce the footprint of marine food production (Barbier et al 2019).

In parallel, we can observe a progressive increase of global food fish consumption in the last 50 years, with an average level which has moved from 9 kg per capita (1960) to 16 kg (1997) to 20 kg (2016) (FAO, 2016b). From the nutritional point of view, depending on the authors, seafood proteins - including also additional, essential nutrients - provide between 13.8% and 16.5% of the animal protein intake of the human population. Seafood protein represents an essential nutritional component in many countries, especially where total protein intake levels are low. In 2013, seafood provided more than 3.1 billion people with at least 20% of their intake of animal protein (FAO, 2016b).

Apart from direct consumption, fisheries contribute to nutrition and food security via income generation. One of the several benefits with regard to capture is, therefore, material or financial benefits by means of food or feed produced or purchased, related employment and income. Another benefit is the support of greater household livelihood strategies, such as via safety nets and seasonal contributions [6] [20] [21] [22] [23]

Through fish-related activities (fisheries and aquaculture but also processing and trading), seafood contributes substantially to the income and therefore to the indirect food security of more than 10% of the world population, essentially in developing and emergent countries. Yet, limited attention has been given so far to seafood as a key element in food security and nutrition strategies at national level and in wider development discussions and interventions."

Fisheries and aquaculture and Nutrition Production Systems in the EU

Marine-based capture fisheries are the main internal source of seafood for the EU-27 with 4.05 million tonnes valued at €6.3 billion (STECF, 2021). There is very little information of the extent of inland fisheries (about 0.1 million tonnes) and recreational fisheries in the EU. Substantially less than the global share, the EU aquaculture provides about one fifth of the EU seafood supply. In 2019, the EU aquaculture production reached almost 1.2 million tonnes, valued at €4.1 billion.

The EU net imports (i.e., imports minus exports) of seafood in live weight equivalents are similar to the EU domestic supply of almost 7 million tonnes.

(Marine-based) Capture fisheries

In 2019, the EU fishing fleet numbered around 73,983 vessels, 57,236 of them being active vessels. The EU fleet generated circa 130,000 direct employments.

Improvements in the sector are largely attributed to the recovery of some important fish stocks and increased fishing opportunities, in particular in fishing regions in the North Sea and Northeast Atlantic, together with increased average first sale prices of some commercially important species and lower operating costs (e.g. fuel). The situation in the Mediterranean is still poor with most stocks overfished.

Steps for a sustainable fisheries are ensured via the implementation of dedicated EU legislation (CFP - Common Fisheries Policy) with a number of measures based on specific scientific advice (provided by JRC via the Scientific, Technical and Economic Committee for Fisheries -STECF). However, the foreseen target (i.e., MSY - Maximum Sustainable Yield) is still to be reached.

The CFP (Regulation (EU) 1380/2013) established the Landing Obligation (LO) (i.e., discard ban). While the objective of the LO is to land all fish from regulated species, there are several exemptions that allow fishers to discard parts of their catch. These include high survival, disproportionate costs, and interspecies flexibility. The regulation also includes a phasing in period, starting in 2015 with a number of pelagic stocks. From 2019 all regulated stocks are subject to the LO.

The European Commission has identified the LO as an important element of its fisheries management policy intended to reduce the quantity of quality fish returned to the sea, often dead or seriously compromised. Fish that previously had to be discarded because regulations (e.g. fish over the quota or undersized fish), now has to be landed but cannot be used for direct human consumption. The Commission has also noted the potential economic impacts of this policy, particularly in those fisheries that traditionally record high levels of discarding.

The short-term impact of the LO on the economic performance of the EU fisheries sector is still unclear, and may vary by fleet (Guillen et al., 2018). Instead, in the long-term, the LO should lead to more abundant fish stocks with larger fish sizes, which should be translated into an increase in the production value and a reduction in the operational costs, leading to further improvements in the economic performance.Results will largely depend on the compliance with the regulation, as enforcement seems rather difficult and costly.

The outbreak of the COVID-19 pandemic and subsequent public health interventions have depressed demand and disrupted supply chains for many fishing businesses. Some fishers even benefited from increases in the demand of certain species and by adapting their commercialisation strategies. Our estimates show that the economic impact of COVID-19 on the catching sector was smaller than initially expected and overall profits remained positive. This was in part due to low fuel prices that reduced operating costs of fishing, and the early response from governments to support the sector. The results vary by fishing fleet, revealing that small-scale fleets and the fleets in the Mediterranean and Black seas have been more impacted than large-scale fleets and the fleets in the Northeast Atlantic.

Aquaculture

The EU aquaculture sector represents about 1% of the world production in volume and about 3% in value. Moreover, EU production has gone from a moderate annual growth rate of 3.4% over the period 1980-2000, to stagnation during the period 2000-2019 (FAO, 2021). On the other hand, the EU aquaculture production of emerging sectors such as seaweeds, slightly increased over the last years (Camia et al. 2018). Although still with a very marginal contribution (less than 1% of the total seaweed production) there has been a raising interest for these resources, currently mainly used as food or for food applications (Barbier et al. 2019).

The EU has around 15,000 aquaculture enterprises with almost 70,000 employees. Production is concentrated in four countries: Spain, France, Italy, and Greece, making up about 2/3 of all the EU aquaculture production in volume and value.

Aquaculture in the EU can be divided into three main sectors: Marine and Freshwater finfish, and Shellfish. The marine (finfish) sector is the most important economically, generating a production value of €1.8 billion in 2018, followed by the shellfish sector with €1.3 billion and then the freshwater sector with €1 million.

Despite the overall decrease in volume, the production value has increased and results from the latest STECF aquaculture report show that the economic performance of the EU aquaculture sector has improved, even if not as much as desired (STECF, 2018). The general low production and lack of growth in the EU aquaculture production has often been explained by strict environmental regulations and a high bureaucracy burden that does not facilitate economic development (STECF, 2018). Despite this, the aquaculture sector has been identified in the EU's Blue Growth Strategy as one of the five sectors that have a high potential for sustainable jobs and growth. The Commission Communication on the Strategic guidelines for a more sustainable and competitive EU aquaculture highlights the potential of low trophic level aquaculture, and of algae in particular.

Even if over the last decade the EU aquaculture production increased in value terms and decreased in volume, these overall figures do not fully express the evolution of the sector. Most of the key EU producers increased their production value. Behind these increases, the production of seabass, seabream and salmon increased by almost 40%; while the production of mussels, the main aquaculture production in volume, declined by 15%. There is not a single cause to explain the mussel production decline in the EU. Mussel production is considered to have declined mainly due to the spread of diseases, algal blooms, lack of mussel seed (spat), predation and low earnings. Such causes may have been exacerbated by local conditions such as the small size of the mussel aquaculture enterprises and the impacts of climate change (Guillen et al., 2019).

Thus, behind the overall production evolution lies a decrease of species with low economic value (e.g. mussels) only partly due to poor economic performance, and an increase of higher valued species (e.g. salmon, seabass and seabream) with a higher degree of control by the farmer in the production cycle (e.g. feeding, medicines, juveniles, broodstock, etc.). This higher degree of control can also lead to the existence of economies of scale (Guillen et al., 2019).

Preliminary estimates for the EU aquaculture sector hint that the impact of the COVID-19 pandemic and subsequent interventions was higher than in the case of wild-capture fisheries. Some of the effects are yet to come as some companies did not refill their stocks as in normal times.

Trade

The EU is highly dependent on external trade to satisfy its high demand for seafood products. The EU imports more than 15 million tonnes of seafood measured in live weight equivalents, while exports almost 9 million tonnes. Thus, net imports of seafood are almost 7 million tonnes.

The globalization of the seafood market makes possible to find seafood from all over the world in almost any developed country (Asche et al., 2015; Gephart and Pace, 2015; Watson et al., 2015, 2016, 2017). In 2014, the share of global capture fisheries and aquaculture production entering international trade was 36% (FAO, 2016b), the highest among food and agricultural commodities and for example, compares with around 10% for meat and 7% for milk and dairy products (Natale et al., 2015). While 78% of the seafood produced is exposed to international competition (Tveteras et al., 2012).

Opportunities and Threats

In a more demanding world population, fisheries and aquaculture are providing a progressively higher amount of valuable protein (which has been reflected in an increase of consumption). However, ocean resources are overexploited, as in the last decades the status of most fish stocks have worsened, and many have become overfished (FAO, 2018).

The EU's CFP conservation policy of fish stocks is starting to pay off. Some fish stocks in the Northeast Atlantic Ocean are recovering, leading to modest increases in capture fisheries' landings and improved economic performance. In the long-term, significant increases in production from capture fisheries can only come from improvements in fish stocks and their sustainable exploitation (Guillen et al., 2016). However, these measures lead to decreases in the production in the short term.

We expect that the EU aquaculture sector will not be able to increase significantly current production levels in the near future. Given the current competition between economic sectors for coastal and marine areas, we do not expect that maritime spatial planning will provide the sector with a sufficient number of new sites. The possibility to take aquaculture sites offshore with the current technology available is still risky and costly to be profitable. In the short-term, recirculating aquaculture systems seem the most feasible strategy to increase production but still face high initial investments (sunk costs) and high operating costs. One possibility to improve the productivity and environmental sustainability of marine aquaculture practices is the integrated multi trophic aquaculture (i.e., the possibility to grow finfish, shellfish and marine plants together). However, the possible implementation has to be considered in the context of the present licensing system, which is still perceived as one of the major obstacles to the development of aquaculture production. Therefore, algae production remains the biggest hope to enhance the EU aquaculture production. In particular, microalgae production facilities do not to be located in coastal areas and so do not compete for space with other activities. The growth of the EU algae production will depend on the consumer demand for its product [27].

Globally, the aquaculture sector has substituted some aquafeed inputs from capture fisheries with cheaper plant-based products (e.g. soybean meal). Thus, aquaculture production has become less dependent on fishmeal and oil from capture fisheries than it was in the past. This should help the aquaculture sector growth without being so much limited to the capture fisheries production. However, despite such developments, the pre-2000 growth rate of global aquaculture production is showing signs of slowing down (Liu and Sumalia, 2008; Asche et al., 2013b). Hence, forecasts indicating that aquaculture production will meet the increasing demand created by an increasing world population may be over-optimistic, at least in the short term.

On the other hand, it is feasible to consider that technological innovations will improve aquaculture productivity and make some of the current inefficient production technologies economically viable in the future. Potential production levels and by when will be achieved are still big unknowns.

An increase in consumption demand for animal products, such as cheap seafood products has been observed together with increases in income and purchasing power in emerging economies (e.g. China and Brazil) (Gerbens-Leenes et al., 2010). Continued increases in income and urbanization in developing countries, may lead to higher seafood prices and changes in traditional trade relations between countries. Consequently, the seafood consumption in areas that currently benefit from high imports (e.g. EU, Japan and USA) may decrease. Moreover, increases in prices are likely to incentivize overfishing and consequently undermine the possibility to achieve sustainable seafood production.

Nonetheless, there remains a general high demand for fish products in the developed world. Consequently, it has also been proposed to promote policy approaches which increase fish consumption in a sustainable way by achieving a shift in consumption to domestic and sustainable species [8]. Unfortunately, very often seafood consumption choices are not driven by taking into consideration marine sustainability [12] [13] [14] (SAM, 2017).

In fact, the switch in the seafood consumption from high trophic level species (e.g. cod and tuna) to lower trophic level species (e.g. seaweed, microalgae and shellfish) would release pressure on overfished stocks and would allow a higher production from the oceans. Any attempt to successfully increase production needs to consider environmental factors, consumer preferences and market demand. Hence, there is the need of promoting sustainable seafood consumption.

Marine food sources face various threats with regards to sustainability. Non-sustainable fisheries and aquaculture practices are part of them. There are other examples of non-sustainable practices connected to marine traffic, mining and other industries, coastal tourism and urban development, introduction and expansion of invasive alien species, pollution and litter including plastics, climate change and ocean acidification, as well as ineffective or poor legislation and policies [9].

Finally, we need also to consider the fish food waste in the more general context of the circular economy and the possible use of fish byproducts (from the industry as well as from the household waste) for further processing of valuable compounds. In fact, fish waste can account from 50% to 70-75% of the total weight. Shrimps and crabs waste can be as high as 60%–80% of the biomass. Squid byproducts can represent 35% of the total mass caught. Such an amount of waste generates an immediate need for disposal (which call for economic and logistic decisions) with all possible environmental problems. However, it must also be considered as an important source of relevant biomaterials, and therefore converted into an economic opportunity for bio-refineries and other similar industries. Waste from fisheries industry can be made of muscle-trimmings (15–20%), skin and fins (1–3%), bones (9–15%), heads (9–12%), viscera (12–18%) and scales (5%). From all those parts, bioactive molecules can be extracted for the production of several compounds for industrial use (feed, nutraceuticals, enzymes, bioceramic, biodiesel, bioplastic, bioactive peptides, etc.)

Impact of Climate Change on Ocean Food Resources

The effects of climate change with respect to marine environments are multiple. Some of the variables concerned are precipitation, temperature, ocean currents, river inflows, storm frequency and intensity, ocean acidification and sea-level rise [6] [24] [25]. Even if fisheries, including their management performance, have always been dependent on the natural climatic oscillations, especially those at a decadal scale [5], the capacity and performance of the marine fisheries sector seems significantly impacted by climate change (Merino et al., 2012) [4] [5].

Changes in marine habitat temperatures impact the growth, metabolism, distribution and reproduction of aquatic organisms, as these are poikilothermic and changes in marine species abundance and geographic range, related to climate change, have already been extensively documented (Yesson et al. 2015, Araujo et al. 2016). Such changes can consequently negatively influence aquaculture and fishing distribution and productivity [4]. For example, studies have found that ocean temperature changes correlate with changes in marine fish species, leading to a subsequent change in geographic distribution of fish species. More specifically, it has been observed that there has been a reduction of subtropical species in the tropics and an upsurge of warmer water species at higher latitudes [4] [5] [19].

According to FAO [18] and [19], far-reached consequences for fisheries and aquaculture can be seen due to various alterations occurring in marine ecosystems,
Four interconnected dimensions related to how climate change may potentially act with regard to food security and marine resources have been identified, namely [5] [26]:

1. *Availability of marine resources:* depends on fluctuations due to climate-induced uncertainties, fishing capacity developments controlled by appropriate governance;
2. *Stability of supply:* depends on changing conditions, including periods of qualitative and quantitative instability in supplies;
3. *Access to food*: depends on species-specific access regulations as well as flexibility in governance with regard to changes in climate;
4. *Utilisation*: depends on food/feed changes induced by climate change.

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