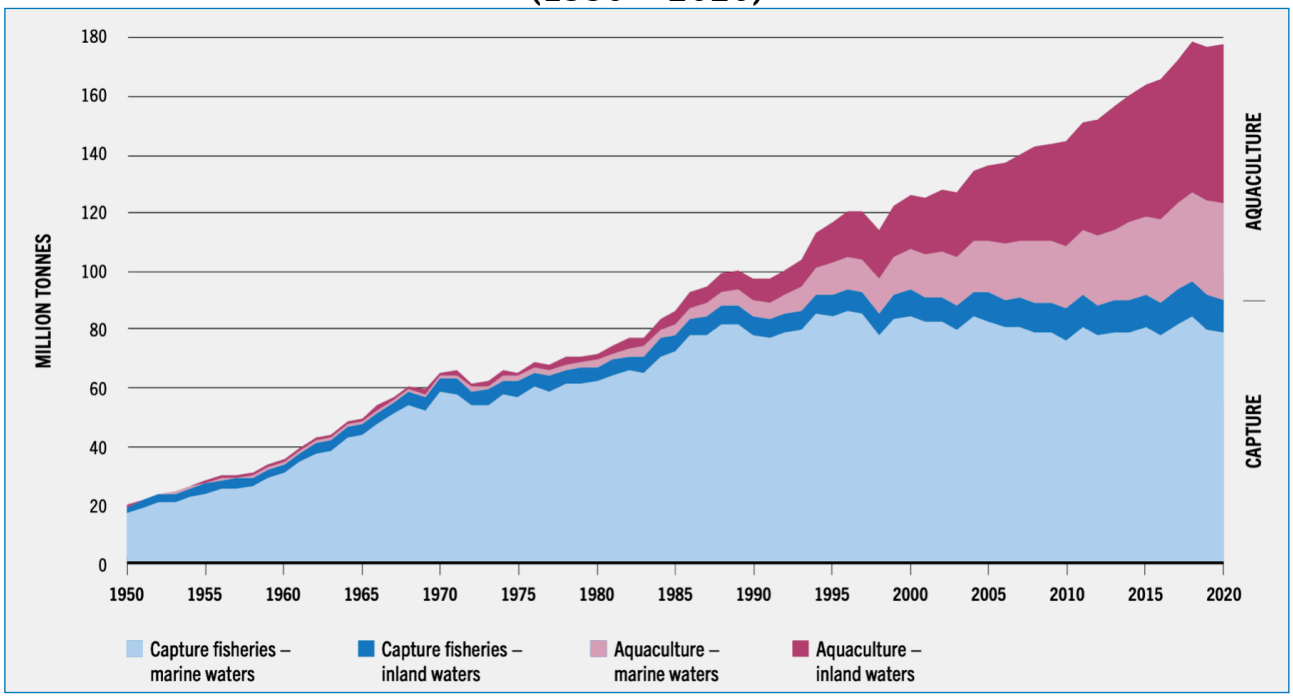
Does aquaculture help make fisheries more sustainable?

An extremely dynamic activity

Aquaculture is the fastest and most spectacularly growing domain in food production.

Between 1950 and 2018, its output has been multiplied by more than **200 times** to reach over 120 million tonnes of live weight. It weighs now **more than half of the global fish production** (see **Figure 1**).

Figure 1: Evolution of global fisheries and aquaculture production (1950 – 2020)



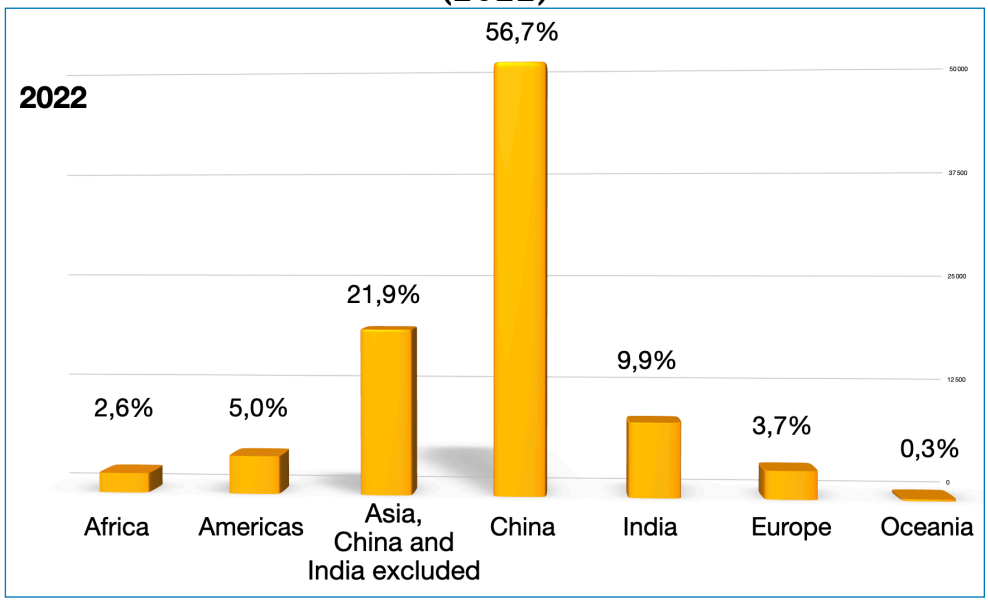
Note: Excluding aquatic mammals, crocodiles, alligators, caimans and algae.
Data expressed in live weight equivalent.
Source: FAO, 2022

It is in Asia that aquaculture is most developed, China being, by far, the main actor with more than half of global production (see **Figure 2** on next page).

The estimate is that between **78** and **171 billion fish were cultivated in 2019** (mortality not included that can be as high as 25% for salmon and up to 50% for

tilapia), which is more than the approximately 80 billion fowl or mammals sacrificed every year for our food [read].

Figure 2: Distribution of global aquaculture production (2022)



Source: data from FAO, 2022.

Aquaculture has often been presented as a way to respond to a rapidly growing food demand while controlling – or even reducing – pressure on marine resources that suffer from overfishing that leads to the depletion of global fish reserves [read].

In reality, however, the situation is much more complex than it seems at first.

What exactly is aquaculture?

Aquaculture groups all the animal and plant production activities conducted in the aquatic environment (as opposed to fisheries which catch 'wild' product in that environment).

It is generally considered that **more than 600 marine and freshwater species** are used in aquaculture.

As in the case of agriculture, production is concentrated mainly on a small number of species: **90% of production comes from 35 species**, while **4 species** alone (grass carp, silver carp, Indian carps and cupped oysters) make up for **30%** of production [read].

This concentration makes is vulnerable to parasites and diseases.

The increasing role of supplementary feed

Aquaculture exists since the most ancient times. For long it was dependent on the use of available resources, but nowadays, it is relying more and more on supplementary feed. In 2000, around 60% of aquaculture production used **supplementary feed**. This proportion reached 72.2% in 2020, according to FAO [read].

Like for livestock production, this supplementary feed comes from crops (soya and cereals – in particular wheat and maize), from livestock rearing (e.g. the waste resulting from production and processing of outputs) and from fisheries. This supplementary feed is largely made of items that are consumable by humans [read].

The use of fisheries catches brings about waste as the transformation is not efficient, similarly to what is observed in industrial livestock production that transforms inefficiently a major share of global grain production. This type of aquaculture is competing with larger fish, marine mammals and birds, as well as with fisheries for human consumption, especially traditional fisheries [watch the documentary].

In a way, **industrial aquaculture is to fisheries what industrial livestock production is to agriculture**, as it uses up a non-negligible part (almost 10%) of fisheries products, in the shape of fishmeal or fish oil. It therefore adds to the pressure exerted on global fish reserves.

In **rich countries**, aquaculture consists mainly in the rearing of **carnivorous species** such as salmon, sea bass, sea bream, tuna and trout that are highly appreciated by consumers. These are high-value goods placed at a high level of the food chain and one third of their feed is made of outputs of industrial fisheries (e.g. anchovies, sardines, herring and mackerel).

In **China**, aquaculture continues to use herbivorous fish that are lower in the food chain, such as carp and tilapia. There is also some rearing of carnivorous fish such as croaker, sea bass, cobia and grouper.

As for fisheries products, outputs from aquaculture may be of a mediocre quality due to the presence of antibiotics, heavy metals (particularly for carnivorous fish high in the food chain) and plastic [read here and here].

Various impacts of aquaculture

Its rapid growth, its concentration on a small number of species whether herbivorous or carnivorous, and its growing reliance on supplementary feed have made it possible to realise that, in addition to creating jobs, producing a large mass of food and generating huge profits for those who invested in this area, aquaculture has considerable negative economic, social and environmental consequences that should be mentioned.

- On water quality

Aquaculture is being conducted in a very intensive way in basins (for freshwater) and net pens (in marine conditions) where very large numbers of animals are concentrated, similarly to what happens in chicken factories, industrial piggeries or cattle enclosures.

Water, in those basins and cages is often polluted because full of **feed left overs** that are found in what is discharged into the environment. It also contains **droppings** and **dead animals** (mortality can be quite high). Remains and waste contribute to contaminate the water and create eutrophication of some aquatic ecosystems, with sometimes serious consequences on preexisting biodiversity.

Aquaculture also uses large amounts of **veterinary pharmaceuticals** to combat parasites and diseases. For instance, aquaculture is a major user of antibiotics that, later, can be detected in the water, thus participating in the development of resistant microorganisms.

- On aquatic ecosystems

By degrading water quality and disturbing the environment close to the basins and cages, aquaculture contributes to change (destroy) the **habitat** of living organisms preexisting in the ecosystem.

The concentration of large number of animals that are genetically uniform increases, as in the case of industrial chicken factories, the risks of **diseases** that may be transmitted to organisms living in the environment around the aquaculture sites, including to predators. It also generates stress, suffering and

aggressivity among the animals reared. Pharmaceutical used (in particular antibiotics) can have effects on ecosystems in which production sites are located, creating opportunities for the development of **resistance**.

Finally, the use of fisheries outputs as feed in aquaculture adds more **pressure on marine ecosystems**, either because of direct exploitation (by harvesting species like anchovies, herrings and mackerels) or by competing with fish, birds, whales and krill that live in them [watch the documentary].

- On climate

Aquaculture emits greenhouse gases in two main ways

- **directly** by disturbing and destroying coastal ecosystems that have fixed over long periods of time in their sediments what is designated as **blue carbon** in mangroves, salt marshes, seagrass beds or seagrass prairies, as well as in micro- and micro-algae,
- **indirectly** by consuming grains produced by agriculture, the production of which generated greenhouse gas emissions.

- On human rights

Aquaculture is sometimes associated with working conditions that violate human rights:

- **directly**, for instance when security rules are not respected when employees are left without any assistance when diving [watch the documentary],
- **indirectly** in the case of industrial fisheries seamen working on boats fishing sea products for manufacturing supplementary feed used in aquaculture [read].

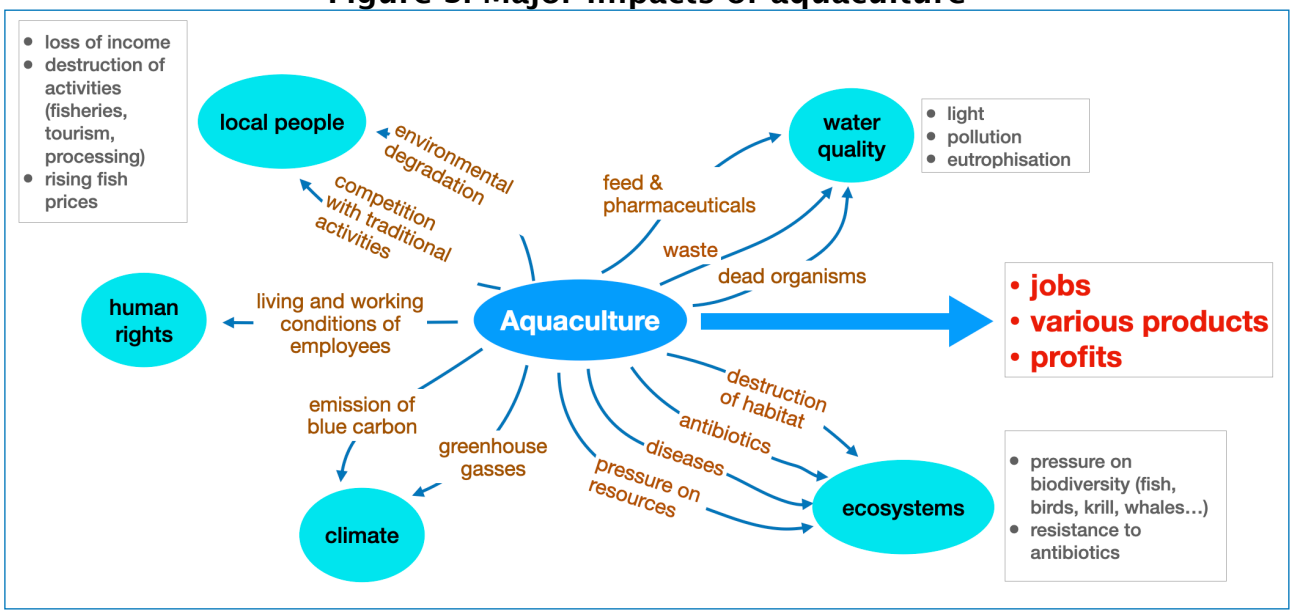
- On some population groups

Aquaculture can have consequences for people living near its facilities. For example, by degrading the environment, it can impact negatively on **tourism**.

It may also impact people settled near where fishing takes place and where fish products are being processed for use in aquaculture (or other types of purposes). It can then disturb **traditional fisheries** when industrial fishing ships fishing products used for manufacturing supplementary feed in aquaculture plunder marine resources of which they are dependent.

It may also destroy **traditional artisanal processing activities** of sea products (smoking and salting), with consequence in terms of considerable **income loss** as well as **increase of local prices** for sea products [watch the documentary]. Finally, it can also **create jobs** in the processing of fishmeal and fish oil that will be used in aquaculture (**Figure 3**).

Figure 3: Major impacts of aquaculture



Several ideas that could lead to a more sustainable aquaculture

A number of methods have been envisaged to make aquaculture more sustainable [read pp. 178–181]:

- instead of raising only one species, **several species are raised simultaneously** to benefit from their complementarity, particularly from the point of view of waste management. Thus, **integrated multi-trophic aquaculture** benefits from **symbiotic interactions** existing among species, for instance by combining fish, algae and filtering shellfish. Traditionally, in South-East Asia and China, associations like **fish-paddy** and **pig-duck-fish-vegetables** have been widely used.
- other producers developed **closed systems** isolated from their environment, so as to limit their impact. However, this method is quite expensive, requires large investments and is characterised by high risks of mortality,
- to increase the efficiency of supplementary feed and limit waste and losses, some have adopted an approach relying on **molecular and precision nutrition** techniques that had initially been designed for humans. The idea is to **optimise nutrition** based on the analysis of the **genome** of raised animals, the knowledge of their performance regarding certain feeds at different stages of their development. This allows the identification of the **species and strains** that are the most efficient, as well as the design of **feeding schedules** that limit wastage of feed,
- others yet envision the development of a regenerative aquaculture that intends to manage a healthy environment by adopting techniques using little or no inputs, fixing carbon and nitrogen, and beneficial for marine ecosystems and their biodiversity. It relies on the use of local **low-impact species located at the bottom of the food chain** such as herbivorous fish, shellfish and algae that, furthermore, can have a positive impact on human health because of their high content in food fibres, omega-3 rich

polyunsaturated fatty acids[1], essential amino acids, and vitamins A, B, C and E.

Conclusion

The answer to the question found in the title of this article[2] is rather negative, as aquaculture, as currently developing in a spectacular way during the last four decades, has tended to exert a greater pressure on fish reserves by using a share of them as an input.

In addition, it has a series of negative impacts on water quality, aquatic ecosystems, climate, human rights and local people.

There is, however, some hope to see the emergence of a more sustainable aquaculture in the future, provide, contrarily to what is happening today, those who will invest in it, will not do so only to make big money.

To know more :

- Boyland, N. and E. Lara, Aquaculture in regenerative farming, dans D'Silva, J. and C. McKenna ed., 'Regenerative Farming and Sustainable Diets - Human, Animal and Planetary Health', p. 175-182. Earthscan Food and Agriculture/Routledge, 2024.
- Mizuta, D.D et al., The changing role and definitions of aquaculture for environmental purposes, Reviews in Aquaculture, 2023.
- Bu, X. et al., Innovation and development of the aquaculture nutrition research and feed industry in China, Reviews in Aquaculture, 2023.
- FAO, The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation, 2022.
- Naylor R et al., A 20-Year Retrospective Review of Global Aquaculture. *Nature*, 591(7851): 551–563, 2021.

Listen :

- France culture, Le saumon d'élevage, trop de sushis ? Des poissons et des hommes, Culture Monde, 2024 (in French).

Watch :

- De Augustinis, F., Until the end of the world, 2024.

Earlier articles on hungerexplained.org related to the topic:

- Fisheries: Can the world face a growing demand for fish while stocks are being depleted and environmental degradation accelerates? 2022.
- Fisheries and aquaculture in troubled waters, 2018.

As well as other articles grouped under our 'Fisheries' theme.

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[1] anti-inflammatory and anti-thrombotic fatty acids that reduce heart-related risks.

[2] Does aquaculture help make fisheries more sustainable?