

CHAPTER 4

The Sustainable Development of Fisheries and Aquaculture

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Abstract

The majority of the 500 million people who rely on fisheries and aquaculture as a source of income do so directly or indirectly from these industries. Biologic diversity and social sustainability may conflict. If the ecology of a fishery continues to provide goods that society can utilise, then the fishery is socially sustainable. Aquaculture practices that prioritise environmental, economic, and social sustainability are referred to as sustainable aquaculture practices. This approach aims to enhance capacity building and efficiently manage land for aquaculture operations.

The goal is to develop a supply of aquatic-sourced food and commercial items that will expand availability while minimising environmental damage and safeguarding various aquatic species. There are various types of aquaculture, each with varying degrees of sustainability.

Pure water Aquaculture is practiced in fish ponds, fish pens, fish cages or on a smaller scale, rice paddies. Brackish water aquaculture is primarily practiced in coastal fish ponds. Fish cages or substrates for mollusks and seaweeds such as stakes, ropes, and rafts are used in marine culture.

Keywords: Sustainable Development, Fisheries, Aquaculture, Economic Importance

Introduction

Aquaculture

Aquaculture includes fish farming, prawn farming, oyster farming, mariculture, pisciculture, algaculture (such as seaweed farming), and ornamental fish farming. Aquaponics and integrated multi-trophic aquaculture are two specific systems that combine fish farming and aquatic plant farming. According to the FAO, aquaculture is one of the businesses most immediately impacted by climate change and its consequences. Some forms of

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aquaculture have negative environmental consequences, such as nutrient contamination or disease transmission to wild populations. Commercial fishing on the other hand is the harvesting of wild fish under regulated or semi-natural settings. Mariculture often known as marine farming is aquaculture that takes place in seawater habitats and lagoons as opposed to freshwater ecosystems. Pisciculture is a type of aquaculture that involves raising fish for human consumption.

Monoculture includes fish husbandry, prawn husbandry, oyster husbandry, mariculture, pisciculture, algaculture (similar as seaweed husbandry), and cosmetic fish husbandry¹. Aquaponics and integrated multi-trophic monoculture are two specific systems that combine fish husbandry and submarine factory husbandry. According to the FAO, monoculture is one of the businesses most incontinently impacted by climate change and its consequences. Some forms of monoculture have negative environmental consequences, similar as nutrient impurity or complaint transmission to wild populations. Marketable fishing on the other hand is the harvesting of wild fish under regulated or semi-natural settings. Mariculture frequently known as marine husbandry is monoculture that takes place in seawater territories and lagoons as opposed to brackish ecosystems. Pisciculture is a type of monoculture that involves raising fish for mortal consumption.

Fishery



Since aquaculture includes the breeding, raising, and harvesting of fish and other aquatic plants, it is frequently referred to as "water farming." It serves as both a commercial product and a food supply for the ecosystem, aiding in the restoration of healthier habitats and the repopulation of aquatic endangered species. Technology has improved fish development in open oceans and coastal marine areas due to the growing demand for seafood.

As in the case of fish tanks, ponds, aquaponics, or raceways, aquaculture can be carried out in fully artificial facilities constructed on land (onshore aquaculture), where the living circumstances (such as water quality (oxygen), feed, and temperature) depend on human management.² As an alternative, they can be carried out inshore, in well-sheltered shallow waters close to a body of water. (Off shore aquaculture), where a wider range of natural conditions, including diel vertical migration, nutritional cycles, and water currents (such as ocean currents), are introduced to the species, either in cages, racks, or bags.

Aquaculture is defined by the Agriculture and Food Organisation (FAO) as "the farming of aquatic organisms such as fish, mollusks, crustaceans, and aquatic plants." In order to increase productivity, farming involves some form of raising process intervention, such as consistent feeding, safeguarding against predators, stocking, and so forth. Farming also implies ownership of the stock being raised by an individual or corporation; worldwide aquaculture operations generated over 120 million tonnes valued at \$274 billion.³ The accuracy of the stated data is questioned, though. Additionally, with modern aquaculture practices, several kilograms of items made from wild fish items are needed to produce one kg of salmon or another piscivorous fish. Additionally,

meals based on plants and insects are being developed to help reduce the amount of wild fish utilised as aquaculture feed. Fish farming, prawn farming, oyster farming, mariculture, pisciculture, algaculture (including seaweed farming), and decorative fish farming are all included in the category of aquaculture.

The field of sustainability in fisheries integrates theoretical fields like population dynamics with practical approaches like individual fishing quotas to prevent overfishing, advocating for appropriate legislation and policies to curb illegal and destructive fishing practices, creating protected areas, reviving collapsed fisheries, integrating all externalities associated with harvesting marine ecosystems into fishery economics, and educating fishermen.⁴ Among the main issues with sustainability are the intense fishing pressures, climate change will negatively affect sustainability; ecosystems and their economic infrastructures will cycle between collapse and recovery, with each cycle being less productive than the previous one; stock structure will erode to the point where it loses diversity and resilience to environmental fluctuations; and overexploitation, growth, and recruitment overfishing will result in a significant loss of potential yield.

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Fisheries Management

The goal of fisheries management is to use replenishable aquatic resources to produce long-term benefits for the environment, society, and biology.⁶ When the target organisms—such as fish, shellfish, amphibians, reptiles, and marine mammals—produce an annual biological surplus that may be harvested with cautious management without compromising future productivity, wild fisheries are deemed renewable. Fishing management, which is grounded on fisheries research and may incorporate the precautionary principle, comprises activities that protect fishing resources to enable sustainable exploitation.⁷ A common definition of modern fisheries management is a set of legally binding environmental management regulations based on specified goals and a mix of management techniques implemented through the use of a monitoring, control, and surveillance system. An ecological approach to fisheries management has begun to emerge as, more practical and pertinent approach to fishery management. The Food and Agriculture Organisation of the United Nations states that there are "no clear and generally accepted definitions of fisheries management." are, in fact, a reality.⁸ The FAO's working definition—which is frequently cited and utilized—is the integrated procedure for obtaining, evaluating, planning, consulting, deciding, allocating resources, creating and enforcing regulations or rules that control fishing operations in order to guarantee the resources' continuous productivity and the accomplishment of other fishing goals.

Fish Farming



The commercial breeding of fish in fish tanks or artificial enclosures like fish ponds, usually for food, is called fish farming, or pisciculture. This kind of aquaculture entails the carefully managed rearing and harvesting of aquatic animals in natural or artificial environments, including fish, crustaceans, mollusks, and others.⁹ A fish hatchery is a facility that releases young fish into the wild for fishing fun or to restore the natural population of a species. The four most important fish species raised in fish farms worldwide are tilapia, carp, catfish, and salmon.

The increased demand for fish protein in diets around the world has led to widespread overfishing in wild fisheries, which has severely reduced fish supplies and, in some cases, completely depleted them. While remaining apart from and so not affecting the sustainable yields of wild fish populations, fish farming enables the establishment of artificial fish colonies that are fed appropriately, protected from natural predators and competitive threats, have access to veterinary services, and are easier to harvest when needed.¹⁰ Although fish farming is a global practice, 62% of the fish produced worldwide is farmed. In 2016, aquaculture accounted for over half of all seafood production. Over the previous three decades, aquaculture has been the main driver of the increase in fisheries and aquaculture production. From 2000 to 2018, the industry grew at an average annual rate of 5.3 percent, reaching a record 82.1 million tonnes.

Production of aquaculture and capture fisheries worldwide, broken down by production method, from the FAO's Statistical Yearbook 2021.

However, raising carnivorous fish, like salmon, may not always relieve strain on wild fisheries because these fish are typically fed fishmeal and fish oil that is obtained from forage fish in the wild. According to the FAO, the global returns on fish farming in 2008 were 33.8 million tonnes, or almost US\$60 billion.

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Global catch fisheries and aquaculture production by production method, FAO Statistical Yearbook 2021.¹¹

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However, because farmed salmon and other carnivorous fish are usually fed fishmeal and fish oil generated, farming these fish does not necessarily relieve pressure on wild fisheries. Farming carnivorous fish such as salmon, however, does not always reduce pressure on wild fisheries, such farmed fish are usually fed fishmeal and fish oil extracted from wild forage fish. The 2008 global returns for fish farming recorded by the FAO total 33.8 million tonnes worth about US\$60 billion.

Sustainable Aquaculture

Aquaculture that is sustainable could be the key to feeding the world's growing population. At the moment, 42% of our seafood comes from aquaculture; however the definition of "good" aquaculture is undefined.¹²

Since aquaculture makes a substantial contribution to our food supply, it needs to be carried out sustainably. Closed-system technology including raceways, recirculating tanks, flow-through systems, and inland ponds are of special interest to sustain aquatic organisms.¹³ A wide range of fish, shellfish, and aquatic plants are kept in these systems. While there is no denying the obvious health and environmental benefits of closed-system aquaculture systems, we also support initiatives aimed at mitigating the drawbacks of open-pen aquaculture. Our goal is to support both national and international endeavours.

Sustainable Development Goal 14



"Life below water" is the focus of Goal 14 (SDG 14), one of the 17 Sustainable Development Goals that were endorsed by the UN in 2015.¹⁴ The official language is, "Conserve and sustainably use the oceans, seas, and marine resources for sustainable development." Ten objectives in the goal must be completed by 2030. The advancement of every objective is assessed using a single indicator. diminish marine pollution, safeguard and repair ecosystems, lessen ocean acidification, practice sustainable fishing, preserve coastal and marine areas, do away with incentives that encourage overfishing, and boost the financial gains from the wise use of marine resources. The last three objectives are means of implementation goals: supporting small-scale fishermen; executing and upholding international maritime law; and advancing scientific knowledge, research, and technology for ocean health. One sign the mitigation of the effects of marine plastic pollution falls under Goal 14.



According to the 2020 Progress Report on the SDGs, "current efforts to protect key marine environments and small-scale fishers, as well as invest in ocean science, are not yet meeting the urgent need to protect this vast, fragile resource. According to the 2020 Progress Report on the SDGs, "current efforts to protect key marine environments and small-scale fishers, as well as invest in ocean science, are not yet meeting the urgent need to protect this vast, fragile resource."

Goal 14 of the Sustainable Development Goals is to conserve and sustainably use the oceans, seas, and marine resources for long-term development. Our oceans are currently in decline as a result of climate change and human conduct.

Pollution and coastal eutrophication are both contributing to the deterioration of coastal waters. Climate change is caused by similar processes, which have a negative impact on the oceans and marine biodiversity, which is slowly disappearing. Growing algal blooms and dead zones in the oceans pose a serious hazard; in 2018, it was reported that "without concerted efforts, coastal eutrophication is expected to increase in 20% of large marine ecosystems by 2050."¹⁵

According to a recent analysis, the number of ocean acidification reporting stations has tripled worldwide since 2021. In addition; one in every five fish captured is the result of illegal, unreported, or uncontrolled fishing. Beach clean-ups throughout the beaches are shining a light on the rise in ocean plastic trash, which is suffocating the waters.

Poor resource management decision-making jeopardizes marine conservation, local livelihoods, and resource sustainability measures.¹⁶ Efforts are being made on a regular basis to improve such management. "The sustainable management of our oceans relies on the ability to influence and guide human use of the marine environment", "Swift and coordinated global action is imperative" to counteract slippage in reaching Goal 14.

SDG 14 comprises ten aims and ten indicators, including avoiding and decreasing marine pollution and acidification, safeguarding marine and coastal ecosystems, and regulating fisheries. The aims also call for more scientific understanding of the oceans. Some targets have a 2020 target year; some have a 2025 target year, while some have no end year.

Targets, Indicators and Progress

The ten targets are as follows: reduce marine pollution, protect and restore ecosystems, reduce ocean acidification, sustainable fishing, conserve coastal and marine areas, end subsidies that contribute to overfishing, increase economic benefits from sustainable use of marine resources, increase scientific knowledge, support small scale fishers, and implement and enforce international sea law.

The "Floating Plastic Debris Density" refers to the modelled macro and micro plastics distribution in the ocean. If the quantity of floating micro is below 4.75mm, it is labeled as micro and if it is over 4.75 cm, it is labeled as macro. The amount of plastics in large marine ecosystems are measured based on "a model of surface water circulation and the use of proxy inputs". The final Floating Plastics Debris Density indicators will be ready by 2020.

Reduce Marine Pollution

Despite pervasive global pollution from plastics, there is only one indicator under Goal 14, specifically related to reducing impacts from plastics. For all other sustainable development goals, there is no specific target in decreasing microplastics due to limitations of data. Furthermore, there are no targets in reference to reducing microplastics, thus presenting a large challenge for governments to report and monitor microplastics in the environment. From a pollution standpoint, marine pollution caused by plastic compounds is recognised as a major issue. Up to 90% of the plastic used in people's daily lives is never recycled, and over 8 million metric tonnes of plastic debris is tossed into the ocean each year. If current trends continue, there will be more plastic in

the globe than fish by 2050. More plastic has been manufactured in the first decade of the century than in all of history up until the year 2000, and the vast majority of that plastic is not recycled. There are an estimated 15 to 51 trillion bits of plastic in the globe oceans that extend from the surface to the seafloor.¹⁷ The oceans are the deepest and most extensive basins on Earth, with typical depths of the abyssal plains of around 4 km below sea level. Gravity will naturally flow and transfer items from land to ocean, with the ocean serving as the final destination. One estimate of past plastic production puts the total at 8,300 million metric tonnes (Mt) for global plastic production up to 2015, with 79% accumulating in landfills or the natural environment. Every year, over 8 million tonnes of plastic garbage reach the oceans. This figure has risen to 14 million tonnes of plastic, according to the ICUN. The sheer prevalence of plastic waste in the ocean is amazing. ocean trenches, within deep sea sediment, on the ocean floor and ocean ridges to the ocean surface and coastal borders of oceans. Even distant island atolls might have beaches that are littered with garbage from afar. Plastic trash is collected at the ocean's surface in huge circular structures known as ocean gyres. Ocean gyres arise within all oceans as a result of alternating zonal wind patterns that drive equatorward interior transport in the subtropics and poleward interior transport in the subpolar oceans. Plastic garbage is concentrated within the gyres by ocean currents.

Plastics are rapidly being created due to their flexibility, moulding, and durability, which allows for a wide range of beneficial uses. Plastics are extremely resistant to natural weathering processes, which degrade many other materials at the Earth's surface. Storms, wave action, ocean currents, hydration, and surface exposure to atmospheric weathering processes (e.g., oxidation) and ultraviolet radiation break plastic particles into ever-decreasing sizes (resulting in microplastics), rather than organically digesting or chemically altering plastic substances. Estimates of the total quantity and weight of plastic particles throughout five ocean gyre plastic concentration zones range from 5.25 trillion to nearly 300,000 tonnes. Plastic may now be recycled because of the reduction in particle size to the millimeter and micron ranges to allow plastic to settle in deep sea sediments, with up to four times as much plastic ending up there as in surface ocean waters. Plastics are now ingested by live animals such as cetaceans, seabirds, mammals, and microorganisms, and they form part of intricate biogeochemical cycles.

Protect and Restore Ecosystems

This goal has only one indicator: The indicator "Number of countries using ecosystem-based approaches to managing marine areas" To avoid negative consequences, this indicator attempts to maintain and manage marine and coastal habitats in a sustainable manner. An exclusive economic zone (EEZ) is a sea zone defined by the 1982 United Nations Convention on the Law of the Sea in which a sovereign state has exclusive rights to the exploitation and utilisation of marine resources, including wind and water energy generation.

Conserve Coastal and Marine Areas

By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information" .This goal contains one indicator "coverage of protected areas in relation to marine areas. The term "Marine Protected Areas" refers to marine reserves, totally protected marine areas, no-take zones, marine sanctuaries, ocean sanctuaries, marine parks, locally managed maritime regions, and other similar designations. Each location has a different level of protection and a different set of activities that are permitted. The Swedish government met this indicator in 2017. In the year 2021, it was announced that "mean protected area coverage of marine key biodiversity areas increased globally from 27 per cent in 2000 to 46 per cent in 2022"] There are a number of large marine conservation areas around the world. The Papahānaumokuākea Marine National Monument covers 1.5 million square kilometers' in the middle Pacific Ocean, around Hawaii. Large marine conservation zones can also be found near the Cook Islands, Antarctica, New Caledonia, Greenland, Alaska, Ascension Island, and Brazil. As protected marine biodiversity areas expand, ocean science funding has increased, which is critical for maintaining marine resources. Only about 7.5 to 8% of the worldwide ocean surface is designated for conservation in 2020.

Increase the economic benefits from sustainable use of marine resources management of fisheries, aquaculture and tourism". Indicator is "sustainable fisheries as a proportion of GDP in small island developing states, least developed countries, and all countries."¹⁸ "The contribution of aquaculture and fisheries to GDP is one of the most often cited indicators of the country's economic performance. The FAO estimates that "50 MILLION ALIENS capture fish, the vast majority in small-scale fisheries." Fisheries and aquaculture can help to alleviate poverty, hunger, malnutrition, and promote economic prosperity. Sustainable fisheries contributed approximately 0.1% of global GDP per year.

Challenges



The designation of Large-Scale Marine Protected regions (LSMPAs) (regions of at least 100,000 square kilometers') aims to mitigate the consequences of resource extraction (e.g., overfishing) and to safeguard ocean ecosystems by limiting human interference in specified areas. However, there are some concerns with LSMPAs that must be addressed in order to help ensure that SDG 14 targets are met. These concerns are divided into three categories: resource management, rivalry between countries, and compromises between people's demands and the environment.¹⁹ The resource management problem stems from insufficient monitoring and enforcement of conservation and preservation measures. Rivalries between neighboring countries stem from border disputes over the assignment of LSMPAs. LSMPAs typically involve numerous countries that form diverse adjoined geographic areas. Some countries may employ LSMPAs for diplomatic purposes. People's livelihoods are addressed in an equitable manner by making tradeoffs between their demands and the environment. Protected areas can have a negative impact on local fisheries and people's incomes.

The COVID-19 epidemic has increased the use of single-use plastics such as masks, sanitizer containers, gloves, and other items in many parts of the world, particularly in Africa. Due to informal waste management in many African nations, it is projected that 12 billion single-use face masks are discarded monthly, posing a significant threat to human health and the surrounding environment. By harnessing the ocean's potential and building sustainable blue economies, we can increase prosperity and improve the lives of all, especially the most disenfranchised and disadvantaged groups. SDG 14 receives the least long-term funding of all the SDGs. According to recent estimations, \$175 billion per year is required to accomplish SDG 14 by 2030. The United

Nations Ocean Conference, which took place from June 27 to July 1, 2022, governments and other stakeholders are hoped to work together to overcome the gap.

Conclusion

Fisheries have historically been a vital source of sustenance for millions of people throughout Asia and the Pacific. People in rural areas benefit from inland capture fisheries and freshwater aquaculture, while those along the beaches catch marine fish, shellfish, and seaweed to supply adjacent markets. Early fisheries records, such as those of Siam in 1925, claimed confidently that the aquatic resources were abundant and varied, and were adapted to all of the people's needs, therefore it should not be required to rely on other countries for supply of aquatic food. The abundance of resources emphasises the role of nature in replenishing the supply and lends credence to the notion that in order to restore depleted waters and protect the future, the bare minimum of restrictions may be necessary (Smith, 1925).

Following World War II, the pastoral scene vanished. Cities have moved further inland as a result of advanced technologies and improved infrastructure, and fishing fleets have spread into deeper seas. Newly opened global markets absorbed more fishery goods, forcing developing countries to seek for more raw materials to meet the ever-increasing demand of both home and international markets. Asia and the Pacific production increased dramatically from around 6.5 million tonnes in 1950 to more than 20 million tonnes in 1970 and 41 million tonnes in 1996. In 1996, export earnings were even more impressive, exceeding US\$ 18,535 million.

This success was achieved at alarming costs.²⁰ Many mangrove and coastal areas were destroyed in the search for shrimps. Most coastal resources in Asia and the Pacific were overfished. Urban and industrial development, both inland and onshore, contributed to the serious aquatic pollution that prohibited the replenishing of the supplies. Social conflicts were witnessed in many countries due to high competition for diminishing resources and by the open access regime in fisheries.

The coastal states' proclamation of Exclusive Economic Zones, along with rising expenses in distant-water fishing, resulted in the projected continuous reduction in high sea production.²¹ The Japanese catch, for example, fell from almost 2 million tonnes in the early 1970s to 668,000 tonnes in 1996, the lowest since 1963. With reduced fishing capability, Japan must rely more on imports of fish and fisheries products, which totaled US\$ 17,023 million in 1996. As a result, Asia and the Pacific had a fish trade deficit of nearly \$5 billion in 1996, despite producing 57% of global fisheries and aquaculture production in the same year.

The path of establishing sustainable fisheries and aquaculture development in the Asia-Pacific area will be long and difficult, but not impossible. Such a long-term aim might be reached by the first decade of the next millennium with strong political will to tackle existing difficulties and coordinated action by the region's governments.

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