

The Economic Impact of Sustainable Marine Development on The Aquaculture Industry

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Abstract. With the growth of the global population and economic development, aquaculture has become an important source to meet the increasing demand for food. However, this industry also faces many challenges, including environmental pollution, resource shortage, biosecurity, and other issues. Therefore, achieving sustainable Marine development is crucial for the future development and survival of the aquaculture industry. This paper aims to investigate the economic impact of sustainable Marine development on mariculture. First, we will introduce the sustainable development of the ocean, and at the same time explain the impact of global warming and seawater pollution on the ocean, highlighting the need for sustainable development of the ocean. Then we will introduce the concept and definition of the aquaculture industry, and mariculture industry with the highest correlation with the ocean, and analyze the economic impact of ocean changes on mariculture based on the research status. Finally, based on the problems revealed above, the development mode and prospects are put forward. Through this study, we can draw the following conclusions: the sustainable development of the ocean is positive for both the economy of the aquaculture industry and the overall ecological environment of the ocean, but the joint efforts of the government, enterprises, and individuals are needed to achieve the long-term sustainable development of the ocean.

Keywords: Sustainable development; marine; aquaculture industry.

1. Introduction

The oceans provide a wealth of natural resources and ecosystem services, but at the same time face many challenges. Global warming, overfishing the overexploitation of marine resources, marine pollution, and other phenomena are seriously affecting marine biodiversity and impacting, and thus posing a threat to, the stability and sustainable development of marine ecosystems.

Aquaculture is inextricably linked to the sustainable development of the oceans, it is one of the important ways of utilizing marine resources, which has a significant impact on the economy, but it also hurts the marine environment, which in turn affects its normal development and operation, and may form a vicious circle if not handled properly. Global warming, sewage discharge, and other pollution and changes in the marine environment have brought a serious crisis to the aquaculture economy.

Therefore, aquaculture plays an important role in the sustainable development of the oceans, and it is necessary to ensure its continuous and stable development economically and to implement appropriate plans for the sustainable development of the oceans.

The purpose of this paper is to understand the characteristics of marine sustainable development and aquaculture, display the impact of changes in the marine environment and pollution on aquaculture, analyze the economic impacts of changes in the marine environment on aquaculture over the past two decades, and finally propose appropriate solutions based on the results of the analysis in combination with the actual situation as well as expectations for the future development of the industry.

Yang Rongtao pointed out in his study that the pollution of marine aquaculture includes feed pollution, fishing medicine pollution, heavy metal pollution, equipment pollution, tail water pollution, and so on, and it is mainly due to unscientific aquaculture mode, non-standardization of tailwater discharge, and backwardness in the construction of environmental protection facilities and so on [1]. Wen Zhiliang and Wen Yanmao pointed out that 76% of the carbon and 76% of the nitrogen of the bait of mariculture will enter into the seawater environment in the form of particulate and dissolved state, and also a large number of biological excretions, feces is also an important factor that causes the pollution of the aquaculture itself [2].

In the marine environment, Deng Feng and, Cui Zhendong pointed out that global warming, and glacial melting accelerated the rise in sea level, increasing the chances of all kinds of marine disasters, which in the future will lead to the inundation of some coastal low-lying areas by seawater, increasing the threat of marine disasters in coastal countries and regions and other situations causing large economic losses [3]. Zhao Xin and Gao Lu evaluated the losses caused by storm surge disasters on fisheries by constructing a factor analysis data model and concluded that storm surges caused the highest overall economic losses in fisheries in coastal provinces [4]. Wang, Zhixia, and Li, Tao et al. pointed out that marine oil spills caused serious ecological damage and huge economic losses [5]. And Li Bo, Liu Tong highlighted that oil spills can cause great economic losses to mariculture by constructing a model [6]. Jiang Zhihao and Cai Qinyu analyzed China's marine disaster data from 1949 to 2020 and pointed out that storm surge wave disasters are the most destructive, and the frequency of storm surges, catastrophic waves, and red tide events have increased in this period, while the direct economic loss caused by coastal erosion due to marine geologic disasters is very serious, and also revealed that the direct economic losses, however, gradually increased with the economic development of coastal areas [7].

2. Sustainable Development of the Oceans and Seas

2.1. Advantages of Sustainable Development of the Oceans and the need for its Implementation

In today's society, the sustainable development of the oceans and seas has become one of the focuses of global attention. The implementation of this concept is crucial to protecting the Earth's environment, maintaining the ecological balance of the oceans, and ensuring sustainable human development.

First and foremost, sustainable development of the oceans and seas is essential for the conservation of biodiversity. By formulating and implementing sustainable fisheries management policies and adopting environmentally friendly technologies, we can ensure that human needs are not only met but that marine biodiversity is also protected.

Secondly, the sustainable development of marine ecosystems contributes to the maintenance of the global ecological balance. By adopting a sustainable development approach, adverse impacts such as overfishing and marine pollution are prevented.

In addition, the sustainable development of oceans and seas is closely linked to sustainable global economic and social development. By promoting sustainable fisheries, ocean energy development, and other measures, we can create more employment opportunities and promote economic growth.

In conclusion, the sustainable development of the oceans and seas not only contributes to the maintenance of the global ecological balance and biodiversity but is also crucial to the sustainable development of the global economy and society.

2.2. Impact of global warming on the Oceans

Global warming, caused by increasing greenhouse gas emissions, is having a profound impact on our planet, and one of the most vulnerable ecosystems affected by such changes is the world's oceans.

The most direct impact of global warming on the oceans is an increase in seawater temperature. This warming poses a major threat to marine life, especially coral reefs, which are highly sensitive to

temperature changes. In addition, the melting of polar ice caps and glaciers has led to a rise in sea level, exacerbating the effects of global warming while exposing coastal areas to a greater risk of flooding and erosion, jeopardizing populations and coastal ecosystems.

Ocean acidification is another consequence of global warming. A more acidic ocean environment poses a serious threat, especially to marine organisms with calcium carbonate shells, such as mollusks and certain types of plankton.

2.3. Impacts of seawater pollution on the oceans

Seawater pollution not only has a serious impact on marine ecosystems and biodiversity but also affects the economic development of human societies, especially for seaside aquaculture.

Seawater pollution can lead to the destruction of marine habitats and affect the survival and reproduction of marine life. Some chemical substances and hazardous wastes, such as oil, fertilizers, pesticides, and radioactive wastewater, may have toxic effects on marine organisms when they enter the ocean, and even cause bioaccumulative effects, threatening the stability of the entire food chain and ultimately endangering human health.

At the same time, the reduction of fishery resources due to pollution and the increased cost of inspection and treatment affect the production value of marine aquaculture and the upstream and downstream enterprises of the relevant industrial chain.

3. Impacts on the aquaculture Economy

3.1. Aquaculture

Aquaculture is the human use of waters available for aquaculture, by the ecological habits of aquaculture objects and the requirements of the environmental conditions of the waters, the use of aquaculture technology and facilities, engaged in aquatic economic animals and plants. We are here to discuss mainly marine aquaculture, in the mudflat, shallow sea, and harbor, artificial control of breeding and raising fish, shrimp, shellfish, algae, and other plants and animals, and the formation of the production industry.

Mariculture has very high requirements for water quality, with high standards for temperature, salinity, pH, and so on. These high standards are the embodiment of scientific and ecological production, which can maximize the quality and safety of products and promote the sustainable development of mariculture.

3.2. Economic impacts of ocean change on aquaculture

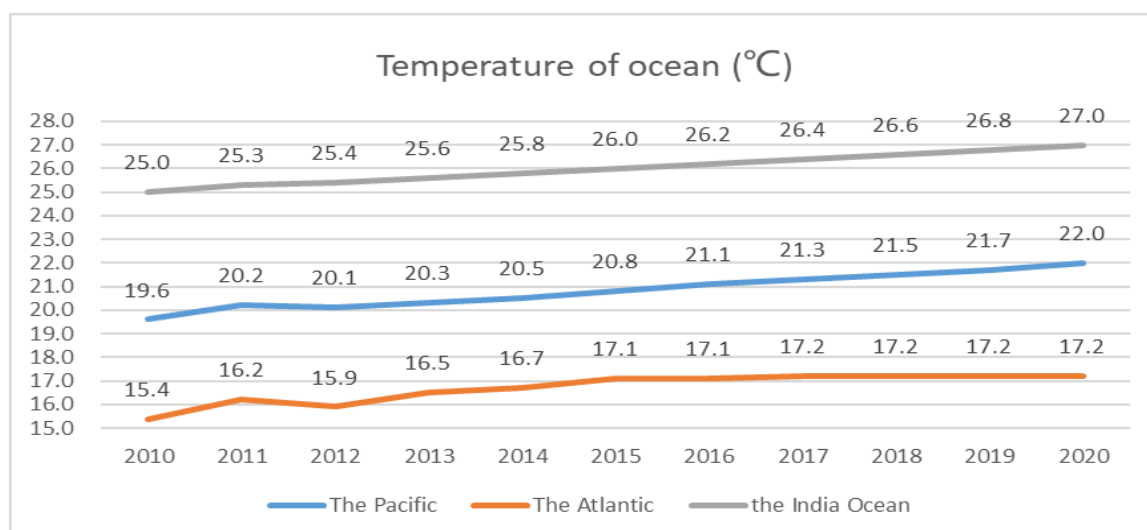


Fig. 1 Sea temperature from 2010 to 2020 in Three Ocean (Photo credit: Original)

Data sources: NOAA (<https://oceanservice.noaa.gov/>)

According to Figure 1 data from the U.S. National Oceanic and Atmospheric Administration (NOAA), average seawater temperatures in all three oceans have shown year-on-year increases over this period, all rising by nearly 2°C, with the Pacific and Indian Oceans experiencing larger increases. The data in Figure 1 show a similar upward trend in global and U.S. mariculture output from 2010 to 2020, with global mariculture output increasing by about \$160 billion and U.S. output roughly doubling over the 11 years.

Moreover, NOAA's monitoring data report that the average PH of the Pacific, Atlantic, and Gulf of Mexico has declined by about 0.1 units over the past few decades, indicating that seawater has become more acidic. Of these, the Pacific coast has seen the fastest rate of seawater acidification, with a decline of about 0.02 units per year.

Meanwhile, quite a few news stories such as a shrimp farm near Mumbai, India in November 2020 that was hit hard by the effects of excessive sewage and chemical discharges, a shellfish farming company in Maine, USA that lost a lot of money due to red tides in October 2017, and the closure of some farms along the Gulf Coast in December 2016 due to the effects of oil spills are all examples of how oceanic pollution is affecting neighboring mariculture with untold direct and indirect economic impacts.

From the data in Figure 1, the impact of factors such as the increase in demand for marine food and the increase in production efficiency due to technological innovations have overshadowed the economic losses caused by global warming and the increase in seawater temperature. Moreover, according to Jiang Zhihao and Cai Qinyu, it can be concluded that the increase in the output value of the global and U.S. mariculture industry simultaneously reflects the dramatic expansion of the scale of the industry, coupled with the fact that the frequency of marine disasters is gradually becoming greater with global warming, and the losses suffered by the mariculture industry will also become greater [7].

Therefore, the implementation of marine sustainable development is of great significance for the survival and development of the marine aquaculture industry.

4. Approaches to Achieving Sustainable Development of the Oceans and Seas and Prospects for the Future

4.1. Ways to Achieve Sustainable Development of the Oceans and Seas

In today's world, human society is facing serious environmental challenges, one of which is the sustainability of marine ecosystems. To maintain the Earth's ecological balance, protect marine biodiversity, and ensure sustainable human development, it is essential to adopt a scientific and effective approach to the sustainable development of the oceans and seas, including measures in the areas of fisheries management, the establishment of marine protected areas and the development of renewable energy.

4.1.1 Sustainable fisheries management

Marine fisheries are a major source of food for hundreds of millions of people, yet overfishing has brought many marine fish species to the brink of extinction. To guarantee the sustainability of fishery resources, scientific fisheries management measures must be adopted.

4.1.2 Establishment of marine protected areas

Marine protected areas are one of the effective means of protecting marine ecosystems; marine nature reserves are mainly used to protect specific marine ecosystems, such as coral reefs and marine grass beds; while fisheries reserves can restrict fishing activities and help marine fisheries resources to recover. In addition, the establishment of oceanic protected areas to protect migratory large marine organisms in the oceans helps to maintain a global ecological balance.

4.1.3 Renewable energy development

To reduce dependence on traditional energy sources, the promotion of the development of renewable energy sources occupies an important place in the sustainable development of the oceans and seas. Marine energy resources include tidal, wave, and current energy, the utilization of which not only reduces the demand for limited fossil energy but also reduces environmental pollution and greenhouse gas emissions.

4.1.4 International cooperation and regulatory development

Through international cooperation in scientific research, share the results of marine scientific research, strengthen monitoring and early warning of changes in the marine environment, and improve global awareness and response capacity for sustainable development of the oceans. Formulate and enforce international laws and regulations to regulate marine activities and prevent illegal fishing and environmental damage by multinational enterprises: formulate more tax policies, such as a carbon tax and a pollution discharge fee, to limit the emission of greenhouse gases and toxic gases and liquids by enterprises or promote tax incentives to encourage enterprises to emit green emissions, and so on.

4.1.5 Public education and awareness-raising

Finally, the promotion of sustainable development of the oceans also requires the strengthening of public education and awareness-raising to arouse the public's enthusiasm for marine ecological protection and to promote the participation of more people in the sustainable development of the oceans.

The above measures show that the sustainable development of the oceans and seas is a comprehensive systematic project that requires the joint efforts of many parties.

4.2. Expectations for future Development

In the future, coastal communities will thrive through a balanced "blue economy". Sustainable fisheries and ecotourism are combined. This economic model prioritizes the protection of marine resources and ecosystems while ensuring economic growth.

At the same time, the shipping industry is undergoing a green transformation, with ships powered by renewable energy. This not only reduces emissions but also promotes a sustainable maritime sector. At the same time, offshore renewable energy platforms, such as wind farms, contribute to clean energy generation and marine habitat protection, reducing the cost of sustaining a sustainable marine economy.

A circular economy for plastics could significantly reduce marine pollution. Through innovative technologies and policies, single-use plastics are effectively collected, recycled, and reused, reducing environmental impacts and promoting healthier oceans.

Strategically located and rigorously managed, marine protected areas can serve as refuges for marine life and enable ecosystem restoration. Meanwhile, the widespread adoption of marine sustainable agricultural systems promotes biodiversity by providing habitat and sequestering carbon dioxide, thereby contributing to overall ocean health.

5. Conclusion

In recent years, the marine environment has changed dramatically due to global warming, sewage discharges, and other pollution of the marine environment. Because of the greenhouse effect and other impacts, the average seawater temperature has risen by at least 1.8 degrees Celsius, and the pH value has dropped in the last 10 years or so, and the natural disasters caused by this have inevitably affected aquaculture, which is dependent on the sea.

To protect the marine environment and promote sustainable development of the oceans, the establishment of marine protected areas to restrict fishing activities, the development of

renewable energy to reduce pollution emissions, the formulation and implementation of international policies, and the promotion of civic awareness are all effective measures.

Understanding the pollution of the marine environment can help us to know the changes in the marine environment today and make better solutions. The sooner we can identify and change the situation, the better we can contribute to the sustainable development of mankind in the future. In the future, we hope that the marine environment can become better and better and insist on the sustainable development of the oceans.

Authors Contribution

All the authors contributed equally, and their names were listed in alphabetical order.

References

- [1] Yang, R. Mariculture becomes an important source of offshore pollution. *Ecological Economy*, 2023, (06): 9-12.
- [2] Wen, Z. Wen, Y. The impact of mariculture on the environment. *Environmental science dynamic*, 2000, (01): 29-32
- [3] Cui, Z. Strategies for countries to cope with sea level rise. *Ecological Economy*, 2022, (11): 1-4.
- [4] Zhao, X. Gao, L. Study on fishery loss caused by storm surge disaster. *China Fishery Economy*, 2015, (04), 89-94.
- [5] Wang, Z. Li, T. Liu, M. Sun, W. Study on the Oil Spill Environmental Damage Assessment. *Environmental Science and Management*, 2008, (08): 62-65.
- [6] Liu, T. Li, B. Chen, W. Zhou, Z. Song, X. et al. Discussion on the evaluation method of the impact of oil overflow on the function of mariculture area. *China Fisheries*, 2014, (12): 31-34.
- [7] Jiang, Z. Cai, Q. Analysis on the Evolution Trend of Marine Disasters (1949-2020). *Journal of Institute of Disaster Prevention and Technology*, 2022, (02): 90-99.