

Chapter 15

Fisheries and Aquaculture: Implementing Sustainable Development Goals



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Abstract The blue bioeconomy is considered as a factor of sustainable development of society through sustainable development of fisheries and aquaculture. The purpose of the study is scientific and practical re-search on the problem of sustainable development in the context of blue bioeconomy, the development of its theoretical and applied provisions and scientific tools. Based on the application of methods of analysis, synthesis and decomposition, the structure and patterns of the functioning and development of the world fisheries have been investigated. Furthermore, the Sustainable Development Goals (SDGs) in the context of a blue bioeconomy have been specified. The use of methods of statistical and comparative analysis made it possible to identify the conditions and trends in the functioning and development of the global fisheries and aquaculture sector, to compare data on the dynamics of the global catch and population of the Earth, to assess the volume and structure of production, as well as the level of employment in the global fishing and fish farming sector. Based on the world statistics and analytics, the role of the fisheries and aquaculture sector in the implementation of sustainable development goals is shown. The SDG 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) and the Blue Growth initiative are emphasized. The basic characteristics of the Blue Growth initiative that are relevant in the context of the blue bioeconomy are highlighted. It is proved that for the development of the fisheries and aquaculture sector, it is necessary to competently regulate fisheries and apply methods in aquaculture that contribute to the sustainable use of resources and the conservation of aquatic biodiversity, that is, to act on the basis of the sound principles of the blue bio-economy.

Keywords Sustainable development · Goals · Blue Growth initiative · Blue bioeconomy · Fisheries · Aquaculture

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15.1 Introduction

The world we live in now (fields and forests, seas and oceans, atmosphere and biosphere), suddenly from a reliable, constant basis of our life turned into a fragile creation. It is our turn now to protect it, thus ensuring the ability to eat, maintain physical health and spiritual development, that is, just to live.

Humanity has entered the time of active exploitation of natural resources, associated with the undermining of the reproductive capacity of some of them and the degradation or complete disappearance of others. We are the only ones who can stop this destructive process, creating guarantees for current life and providing future generations the right to life.

Bioeconomics is one of the means of ensuring the sustainable development of modern society. It is also recognized as a means of ensuring the viability and prosperity of subsequent generations (Bruckner et al. 2019; Lopes et al. 2021; Hasselstrom and Grondahl 2021).

One of the prerequisites for the development of the bioeconomy concept (“green” and “blue”) is the need to solve and (or) mitigate the problems of imbalance in the economic, social and environmental goals of society. Neither economic growth nor social progress is possible without maintaining environmental sustainability. Thus, the inevitability of joint action to ensure economic growth, social progress and environmental sustainability also prompted the development of the bioeconomy concept.

15.2 Materials and Methods

The objective of the research is to continue scientific and practical research on the problem of sustainable development in the context of blue bioeconomy (Austen et al. 2019) and the development of its theoretical and applied status and scientific tools.

Objectives of the study: consideration of the fisheries and aquaculture sector as a subject of the implementation of sustainable development goals; analysis of the dynamics and structure of the global fisheries and aquaculture sector; highlighting the fundamental characteristics of the Blue Growth initiative, relevant in the context of the blue bioeconomy. To carry out the study, a wide methodological toolkit was used. Thus, the application of methods of analysis, synthesis and decomposition allowed solving problems related to the study of the structure and patterns of functioning and development of the world fisheries, as well as specifying the goals of sustainable development in the context of blue bioeconomy. The use of methods of statistical and comparative analysis made it possible to identify the conditions and trends in the functioning and development of the global fisheries and aquaculture sector, to compare data on the dynamics of the global catch and population of the Earth, to assess the volume and structure of production by the global fishing and fish farming sector, as well as the level of employment in this sector. On the basis

of deduction and synthesis methods, conclusions were made about the prospects for sustainable development of the fisheries and aquaculture sector. Moreover, the fundamental characteristics of the Blue Growth initiative in the context of blue bioeconomy were highlighted.

15.3 Results

Please note that the first paragraph of a section or subsection is not indented. The first Sustainable development is a global goal. Thereby, ensuring this development is the challenge that requires joint, consistent efforts of countries, international organizations and their institutions aimed at creating conditions and developing specific measures for the evolution of society and maintaining harmony between the world of the people and world of animals and plants. Only coherent, rational and effective actions of the world community will make it possible to end poverty (SDG 1), end hunger, achieve food security (SDG 2), ensure health and well-being for all (SDG 3), ensure quality education (SDG 4), ensure gender equality (SDG 5), ensure availability and sustainable management of water and sanitation (SDG 6), ensure universal access to affordable energy services (SDG 7), ensure decent work and economic growth (SDG 8), develop quality, reliable infrastructure, promote sustainable industrialization and foster innovation (SDG 9), reduce inequality (SDG 10), ensure sustainable cities and human settlements (SDG 11), ensure sustainable consumption and production (SDG 12), combat climate change (SDG 13), conserve marine ecosystems (SDG 14), conserve terrestrial ecosystems (SDG 15), promote peace, justice and efficient institutions (SDG 16), build partnerships for sustainable development (SDG 17). The presented system of seventeen large-scale sustainable development goals (SDGs), originally formulated in the Millennium Declaration, formed the basis of the 2030 Agenda for Sustainable Development—a program document adopted by the UN in 2015 (FAO 2015). To implement these goals, 169 target tasks have been established. These include the tasks of transformation in technical, institutional and political spheres. The complex solution of these tasks is considered as a guarantee of achieving sustainable development of modern society.

Fishing activities within the sectoral framework of fisheries and aquaculture are integrated into the overall process of achieving the specified goals. In the preface to the report “The State of World Fisheries and Aquaculture 2020” devoted to the theme of “Measures to Improve Resilience”, the FAO Director-General Qu Dongyu emphasized that “The fisheries and aquaculture sector has much to contribute to securing all the SDGs” (The State of World Fisheries and Aquaculture 2020).

The direct participation of fisheries and aquaculture economic entities in ensuring people’s livelihoods and analyzing their potential in the sustainable development system made it possible to systematize and rank the SDG groups according to the degree of influence on their implementation in the global fishery sector.

The group of the most significant, real and potential contribution of fisheries to their implementation includes such sustainable development goals as:

- SDG 2: End hunger, ensure food security and improve nutrition, and promote sustainable agricultural development;
- SDG 3: Ensure healthy lifestyles and promote well-being for all at all ages;
- SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
- SGG 12: Ensure the transition to sustainable consumption and production patterns;
- SDG 14: Conservation and sustainable use of the oceans, seas and marine resources is a key to sustainable development.

It is recognized that “fish and fish products are not only the healthiest products on the planet, but also have the least significant impact on the environment. Therefore, they need to become much more prominent in national, regional and global food security and nutrition strategies and should play an important role in transforming food systems. Thus, it will help to erase hunger and malnutrition” (FAO).

Hunger and malnutrition is a very complex issue that requires urgent solutions. Today, one in nine people on the planet is undernourished. According to official UN statistics, 821 million people faced malnutrition in 2018. It should be noted that the number of hungry people has been decreased over the years, but this figure has been increasing since 2014.

The fisheries and aquaculture sector makes a unique contribution to improving all four dimensions of food security: availability, access, use and stability.

According to Table 15.1, the growth in dynamics of the world catch of fish and seafood in terms of live weight and the number of inhabitants of our planet during 1900–2018 is evident. It is seen in favour of fishing activities results. For more than a century, there has been the sharp growth in the production of world fisheries products in live weight equivalent compared to the growth in the world’s population.

Of the total world catch in 2018 of 178.5 million tons of fish in live weight equivalent (the term “fish” includes fish, crustaceans and molluscs), 156 million tons were used for human consumption, which is equivalent to 20.5 kg per capita per year. Comparatively, in 1961 the consumption of food fish in live weight equivalent was 9.0 kg. Since 1961, per capita consumption of food fish has grown by about 1.5% per year. The rate of growth in the production of fish products in live weight equivalent significantly exceeded the rate of increase in the volume of production of all other products containing animal proteins (meat, dairy products, milk, etc.). In 2017, fish represented about 17% of animal protein and 7% of all protein consumed by people in the world (FAO).

Despite the stable differences in fish consumption in different regions and states, the following positive trends are seen (FAO):

- in developed countries, fish consumption per capita increased from 17.4 kg in 1961 to the maximum level of 26.4 kg in 2007, and then began to decrease and in 2017 amounted to 24.4 kg;
- in developing countries, fish consumption per capita in 1961 was 5.2 kg, and in 2017 amounted to 19.4 kg, which corresponds to an average annual growth rate of 2.4%;

Table 15.1 Dynamics of world catch and population of the Earth for 1900–2018

Index	Years																
	1990	1950	1960	1970	1980	1990	2000	2021	2015	2016	2017	2018					
World catch, million tons	4.0	21.1	40.0	70.8	71.9	97.7	126.0	148.1	168.7	166.1	172.7	178.5					
Population of the Earth, billion people	1.6	2.5	3.0	3.6	4.4	5.3	6.1	6.9	7.3	7.4	7.5	7.6					
Average annual growth rate for the previous chain period, %																	
World catch		3.4	6.6	5.9	0.2	3.1	2.6	1.6	2.6	-1.5	4.0	3.4					
Population size		0.9	1.8	2.2	2.0	1.9	1.4	1.2	1.1	1.4	1.3	1.3					

Source: FAO

- in the least developed countries, the annual per capita fish consumption increased from 6.1 kg in 1961 to 12.6 kg in 2017, i.e., grew on average by 1.3% per year. In the past 20 years, the growth rate of this indicator has increased to 2.9% per year, which is associated with an increase in the production and import of fish;
- in low-income and food-deficit countries, fish consumption has grown steadily by about 1.5% per year; in 1961 it was 4.0 kg, and in 2017 it was already 9.3 kg.

The contribution of the world fishery sector to solving food problems is unquestionable, and its potential is demonstrated by the dynamics of production volumes in live weight equivalent for 2000–2018 (see Table 15.2).

In 2018, the world produced a record number of industrial fishery products—96.4 million tons. However, the possibilities for a sustainable increase in the production of fish products are not just limited, but also constrained by the factor of the natural reproductive capacity of the raw material base of oceanic fisheries, significantly

Table 15.2 The volume and structure of production by the global fishing and fish farming sector in 2000–2018

Year	World catch, in total		Including							
			Fishing, in total		Sea waters		Inland waters		Aquaculture, in total	
	Million tons	%	Million tons	%	Million tons	%	Million tons	%	Million tons	%
2000	126.0	100.0	93.6	74.3	85.0	67.5	8.6	6.8	32.4	25.7
2001	129.8	100.0	93.4	72.0	84.8	65.3	8.6	6.7	36.4	28.0
2002	133.6	100.0	93.2	69.8	84.5	63.2	8.7	6.6	40.4	30.2
2003	133.2	100.0	90.5	67.9	81.5	61.2	9.0	6.7	42.7	32.1
2004	134.3	100.0	92.4	68.8	83.8	62.4	8.6	6.4	41.9	31.2
2005	136.4	100.0	92.1	67.5	82.7	60.6	9.4	6.9	44.3	32.5
2006	137.3	100.0	90.0	65.5	80.2	58.4	9.8	7.1	47.3	34.5
2007	140.7	100.0	90.8	64.5	80.7	57.3	10.1	7.2	49.9	35.5
2008	143.1	100.0	90.2	63.0	79.9	55.7	10.3	7.3	52.9	37.0
2009	145.9	100.0	90.2	61.8	79.7	54.6	10.5	7.2	55.7	38.2
2010	148.1	100.0	89.1	60.2	77.8	52.5	11.3	7.7	59.0	39.8
2011	154.0	100.0	92.2	59.9	81.5	52.9	10.7	7.0	61.8	40.1
2012	156.0	100.0	89.5	57.4	78.4	50.3	11.1	7.1	66.4	42.6
2013	160.7	100.0	90.6	56.4	79.4	49.4	11.2	7.0	70.1	43.6
2014	164.9	100.0	91.2	55.3	79.9	48.4	11.3	6.9	73.7	44.7
2015	168.7	100.0	92.6	54.9	81.2	48.1	11.4	6.8	76.1	45.1
2016	166.1	100.0	89.6	53.9	78.2	47.1	11.4	6.8	76.5	46.1
2017	172.7	100.0	93.1	53.9	81.2	47.0	11.9	6.9	79.6	46.1
2018	178.5	100.0	96.4	54.0	84.4	47.3	12.0	6.7	82.1	46.0

Source FAO

undermined by ecosystem problems caused by the intensification of fishing because of climate change and negative anthropogenic impact.

During the period under study, the volume of catches of world fisheries fluctuated within the range of 89.1–96.4 million tons. Thus, there was no strong tendency of development either to increase or to decrease, which allows us to conclude that the global oceanic catch has reached its critical point. In turn, the world aquaculture during 2000–2018 developed according to an arithmetic progression, and the average annual absolute increase in the volume of production of its products in live weight equivalent was 2.79 million tons. According to Table 15.2, the volume of withdrawals of world fish farming products in 2000 was 32, 4 million tons or 25.7% of the total world catch, and in 2018—82.1 million tons or 46.0%, respectively. It was despite the fact that 52% of the fish consumed by people was produced in 2018.

The results of the study clearly indicate that the future in the development of the global fishery sector belongs to aquaculture. Aquaculture has significant potential in solving not only food problems of society (and recognized as the most important factor in global food security), but economic ones, contributing to sustained and sustainable economic growth. In particular, the ratio in 2018 of the physical volumes of the world catch of fisheries and aquaculture (in tons) was 1.17: 1 (54.0% and 46.0%, respectively), and the ratio of the market value of fishery and aquaculture products (in prices of initial sale) amounted to 0.6: 1 (37.7% and 62.3%, respectively). In absolute terms, according to 2018 data, the following is observed: total sectoral catch of fish amounted to 178.5 million tons, of which 82.15 million tons are aquaculture products; US\$401 billion is the total initial sales of world fisheries products, of which US\$250 billion is from aquaculture (FAO).

Sustainable development of aquaculture requires forging new strategies that will help to realize the full potential of the sector as one of the actors of global development and solve the large-scale environmental problems that will inevitably arise in the process production intensification. These strategies must take into account the technological advances in feed production, selective breeding, biosafety and disease management, as well as innovative digital solutions and new approaches to entrepreneurship in investment and trade.

The global fisheries and aquaculture sector in 2018 employed 0.8% of the world's population, i.e. almost every 125. During the period under study, there was mainly a positive trend in the number of people employed in the industry (see Table 15.3). Thus, aquaculture showed a sharp growth.

The majority of those employed in fisheries and aquaculture are from developing countries. Persons employed in artisanal, small-scale fisheries and aquaculture workers predominate. Thus, the sector addresses social and economic issues where poverty, hunger and malnutrition are most acute. Hence, the sector provides productive employment and is a source of income and food.

In the context of food deficit and limited possibilities of the raw material base of the fish industry, the problem of rational production and consumption of fish products is acute. Food loss and spoilage is a worldwide challenge.

Fish raw materials are unique as they can be fully used by processing for food and technical purposes. Modern technologies make it possible to increase the yield

Table 15.3 Level, structure and dynamics of employment in the global fisheries and aquaculture sector in 2020–2018

Fisheries and aquaculture sector	Employed, thousand people						Share, %					
	2000 year	2005 year	2010 year	2015 year	2018 year	2000 year	2005 year	2010 year	2015 year	2018 year	2018 year	
Fishery	34,439	36,655	39,305	38,771	38,976	72.9	70.5	67.8	65.5	65.5	65.5	
Aquaculture	12,825	15,364	18,625	20,390	20,533	27.1	29.5	32.2	34.5	34.5	34.5	
In total	47,264	52,019	57,930	59,161	59,509	100.0	100.0	100.0	100.0	100.0	100.0	
	Average annual growth rate of the employed, %											
	Deviation from the previous period (±), %											
Fishery	–	101.3	101.4	99.7	100.2	–	–2.4	–2.7	–2.3	0.0	0.0	
Aquaculture	–	103.7	103.9	101.8	100.2	–	+2.4	+2.7	+2.3	0.0	0.0	
In total	–	101.9	102.2	100.4	100.2	–	0.0	0.0	0.0	0.0	0.0	

Source: FAO

of finished food products through the use of fish processing by-products, which are widely used. As we know, heads, backs, fillet trimmings and skin can be used directly in food or for preparing fish sausages, pies, pate, snacks, gelatin, soups, sauces and other foods.

Moreover, by-products are used for the production of feed and fertilizers, biofuels and biogas, dietary products (chitosan), pharmaceuticals (oils—sources of omega-3), natural dyes, cosmetics and plastic alternatives, and are also used for other industrial purposes.

By-products can make up 70% of processed fish. Consequently, it leads to serious environmental technical problems, since they have a high microbial and enzymatic load and rapidly decompose if not processed or stored them properly. Thereby, the studied issue is relevant and significant.

Sustainable use of natural resources is not only a key principle for the implementation of SDG 12, but is also a cross-cutting issue of all sustainable development goals.

The existing global sustainable development goals can be achieved only on the condition of conservation and sustainable use of the oceans, seas and marine resources (SDG 14).

15.4 Discussion

Sustainable fisheries and aquaculture is the key to achieving goals of sustainable development of modern society. As a party to the global fishery processes in the triad of the World Ocean, Subjects of fisheries and Humanity, fisheries and aquaculture are subjects of reciprocal relations with other two of its components.

Environmental degradation is caused by the actions of the main users of oceans and in-land water bodies, such as fishing and aquaculture, irrigation, tourism, maritime transport, renewable energy production, desalination of water, mining on the seabed, marine biotechnology. Thus, the desire to separate socio-economic development from this environmental degradation formed the basis of the concept Blue growth, launched by FAO in 2013.

The concept, defined as the Blue Growth initiative, is formulated as follows: “the use of natural renewable resources of the oceans, inland waters and wetlands for economic returns in a way that minimizes environmental degradation, loss of biodiversity and unsustainable use of water resources, and maximizes economic and social benefits” (FAO 2015).

This definition links the concepts of “sustainable development” and “blue bioeconomy” and acts in the framework of the implementation of sustainable development goals.

The Blue Growth initiative aligns with the need of conservation and sustainable use of the oceans, seas and marine resources for sustainable development (SDG 14) and contributes to its key objectives:

- reduce and control marine pollution (14.1);
- protect and restore ecosystems (14.2);
- reduce ocean acidification (14.3);
- regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices (14.4);
- eliminate fisheries subsidies which contribute to overcapacity and overfishing (14.6);
- increase the economic benefits from sustainable use of marine resources (14.7);
- increase scientific knowledge, research and technology for ocean health (14.a);
- provide access for small-scale artisanal fishers to marine resources and markets (14.b);
- enforce international sea law concerning the sustainable use of the oceans (14.c).

The Blue Growth Initiative is an innovative, integrated and multisectoral approach to the management of aquatic resources aimed at maximizing the ecosystem goods and services obtained from the use of oceans, inland waters and wetlands, while also providing social and economic benefits (Yarkina 2019).

Consideration of FAO programs on the issue of sustainable development of fisheries and aquaculture made it possible to highlight a number of fundamental characteristics of the Blue Growth initiative that are relevant in the context of blue bioeconomy:

- the object to which it is directed is a responsible management of water resources aimed at inclusive growth, which should contribute to ensuring sustainable development in all three components (economic, social, environmental);
- focus areas of the initiative are fisheries, aquaculture, fish processing, as well as eco-system (ecological) services, trade and social protection;
- methodological approach to the implementation of the initiative is integrated and is based on the idea of integrating fisheries with other users and services of aquatic ecosystems and applying an integrated methodological approach;
- the mission of the initiative is to restore the productive potential of the oceans, seas, inland water bodies;
- the idea of the initiative is to create favorable conditions for transforming the population employed in fishery and aquaculture from a user of resources into their sustainable owner;
- the principle on which the initiative is based is the recognition of the absolute necessity of the ecological services provided by aquatic ecosystems (the air we breathe; the food we eat; the water we drink) from the point of view of human well-being.

Considering the blue bioeconomy as a factor of sustainable development of modern society through the sustainable development of the fisheries and aquaculture sector, it is necessary to emphasize the key principles, without the implementation of which the fishery sector will not be able to fulfill its own mission—these are responsibility, rationality and balance (Yarkina and Logunova 2021).

15.5 Conclusion

The blue bioeconomy as a branch of economic activity is designed to address the key economic and social problems of modern society without damage to the ecosystems of the oceans. Thus, it ensures sustainable development, the idea of which is to meet the needs of living generations, without depriving future generations of the opportunity to meet their needs as well.

The fisheries sector is directly involved in achieving sustainable development goals such as ending hunger, ensuring food security and improving nutrition; ensuring healthy lifestyles; promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; ensuring the transition to sustainable consumption and production; conservation and sustainable use of the oceans, seas and marine resources for sustainable development.

The growing needs, caused primarily by the growth in the world's population due to the degradation of natural biological resources, predetermine the shift in emphasis in the development of the fishery sector in favor of aquaculture. In turn, aquaculture has the potential to fight against hunger and poverty, to ensure food security and productive employment, as well as to implement other sustainable development goals.

The existing environmental problems associated with the management of fisheries and aquaculture, climate change and the growing anthropogenic and technological pressures represent the most important group of threats to the sustainable development of the fishery sector. It predetermined the Blue Growth initiative, focused on maximizing environmental benefits and services provided by the aquatic environment while providing benefits of a social and economic nature.

For the further development of fisheries and aquaculture sector, it is necessary to expertly manage fisheries. As for aquaculture, it is essential to use methods that contribute to the sustainable use of resources and the conservation of aquatic biodiversity, i.e. act on sustainable blue bioeconomy principles.

References

- Austen MC, Andersen P, Armstrong C, Döring R, Hynes S, Levrel H, Oinonen S, Ressurreição A et al (2019) Valuing marine ecosystems—taking into account the value of ecosystem benefits in the blue economy. In: Future science brief 5 of the European Marine Board. Ostend, Belgium
- Bruckner M, Häyhä T, Giljum S, Maus V, Fischer G, Tramberend S, Börner J (2019) Quantifying the global cropland footprint of the European Union's non-food bioeconomy. *Environ Res Lett* 14 (4), art no 045011
- Hasselström L, Gröndahl F (2021) Payments for nutrient uptake in the blue bioeconomy—when to be careful and when to go for it Marine. *Pollut Bull* 167:112321
- Hasselström L, Thomas J-B, Nordström J, Cervin G, Nylund GM, Pavia H, Gröndahl F (2020) Socioeconomic prospects of a seaweed bioeconomy in Sweden. *Sci Rep* 10(1):1610

- Lopes D, Melo T, Rey F, Calado R, Rosário Domingues M et al (2021) Insights of species-specific polar lipidome signatures of seaweeds fostering their valorization in the blue bioeconomy. *Mar Pollut Bull* 167:112321
- Silver JJ, Gray NJ, Campbell LM, Fairbanks LW, Gruby RL (2015) Blue economy and competing discourses in international oceans governance. *J Environ Dev* 24(2):135–160
- Sustainable development goals. <https://www.un.org/sustainabledevelopment/ru/sustainable-development-goals/>
- The FAO Blue Growth Initiative and aquaculture (2015). <https://www.fao.org/cofi/43732-0d96f652208820299a272b5bd477b0406.pdf>
- The State of World Fisheries and Aquaculture (2020). FAO, Rome, Italy. <https://doi.org/10.4060/ca9229ru>
- The State of World Fisheries and Aquaculture 2018—meeting the sustainable development goals. Rome (2018). Licence: CC BY-NC-SA 3.0 IGO. FAO, Rome. <https://www.fao.org/3/i9540EN/i9540en.pdf>
- Yarkina N (2019) Sustainable development and the Blue Growth initiative. *Kerch State Maritime Technol Univ Electron J* 3:117–131 (in Russian)
- Yarkina N, Logunova N (2021) The concept blue growth as a way for sustainable development of the fisheries. *E3S Web Conf* 244:03021