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ANALYZING SEA WATER FOR SUSTAINABLE DEVELOPMENT: PHYSICAL AND CHEMICAL ASPECTS

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Abstract

This scientific research projects is devoted to the topic of sustainable development of the ecological state of sea water on the example of the Black Sea. Large-scale physical and chemical studies of the territorial waters of the settlement of Gelendzhik were carried out in order to study the composition of water and check its chemical properties, their compliance with established standards. In addition, additional sea water samples were taken from nearby settlements to obtain the most reliable and up-to-date data. In our opinion, it is very important to monitor the composition and condition of such a valuable recreational resource. Nowadays, more and more attention is paid to ecology, as it is inextricably linked with the well-being and prosperity of certain territories. And given that the Black Sea is the center of attraction for a large number of vacationers and tourists, it is important to control that nothing threatens their health.

Keywords: Ecological state, ecology, sustainable development

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1. Introduction

The strategy of sustainable development in the context of ecology and modern ecosystems has long been an important and discussed topic. Today, many states allocate large amounts, conduct grant programs for the study of the state of the environment, as the risks of pollution and harm to humans are growing. In connection with overcoming these problems, many have developed strategies for the sustainable development of regions, the main tasks of which are monitoring the current state, collecting up-to-date data and prototypes, conducting laboratory tests, building predictive models and creating analytical reports (Dzhabrailova et al., 2021; Barzaeva & Ilyasov, 2022). If there are certain problems, experts also offer ways to solve them. Such a trend can have an extremely positive impact on our environment and prevent the occurrence of any man-made or environmental disasters. After all, the quality of ecology and functioning ecosystems directly affects the livelihoods and well-being of millions of people.

By itself, sustainable development does not have any well-defined term. Depending on the territorial features, there are quite a few interpretations (Taranova et al., 2021; Khudyakova & Lyaskovskaya, 2021). However, common features can also be distinguished, such as the division into macro, meso and micro levels. Accordingly, the macro level represents research at the international level, meso - national and micro - regional / sectoral (Apostolov, 1927).

It should be noted that the category of "sustainable development" has the peculiarities of its interpretation depending on the level of economic activity (macro-, meso-, micro-level). Accordingly, it seems appropriate to us to single out the following levels of research: – international (global); - National; – regional; - industry; - the level of an individual business entity. At the international level, sustainable development should be understood as the managed development of the entire world community in order to preserve the biosphere, meet basic human needs without harming the environment, achieve equality and social justice, ensure social self-determination and cultural diversity, and maintain the integrity of ecosystems. Sustainable development at the national level implies a balanced socially oriented, cost-effective and environmentally protective development of the country (Shakhgiraev, 2019; Magomedov et al., 2020). At the regional level, sustainable development is associated with the effective competitive functioning of socio-economic systems, the comprehensive improvement of territories and their respective settlements with social and engineering infrastructure facilities, as well as an increase in the level and quality of life of the population, the preservation of culture and traditions, and the environment (Belikov, 2002).

2. Problem Statement

The ecological state of sea water is crucial for sustainable development, especially in the context of tourism. However, there is a lack of comprehensive and up-to-date data on the chemical properties and composition of sea water in many regions. The Black Sea is one such region, which attracts a significant number of vacationers and tourists. Therefore, there is a need to investigate the ecological state of sea water in the Black Sea, particularly in the territorial waters of Gelendzhik.

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3. Research Questions

The research questions focus on the ecological condition of sea water in Gelendzhik. The first research question seeks to determine the current state of the ecological condition of the sea water in Gelendzhik. This would entail an evaluation of various factors that affect the state of the sea water, such as pollution from various sources, including human activities.

The second research question seeks to determine the chemical properties and composition of the sea water in Gelendzhik and whether they comply with established standards. This would involve testing the sea water for various chemical parameters, such as pH, dissolved oxygen levels, and presence of harmful substances like heavy metals and organic pollutants.

The third research question seeks to compare the ecological state of sea water in Gelendzhik to nearby settlements. This will provide a basis for determining whether the ecological condition of the sea water in Gelendzhik is better or worse than that of neighboring areas.

Finally, the fourth research question seeks to determine the potential threats to the health of vacationers and tourists due to the ecological state of the sea water. This would involve assessing the risks associated with swimming, fishing, and other recreational activities in the sea water in Gelendzhik.

4. Purpose of the Study

The purpose of this work is to conduct a study of the regional level to study the dynamic balance of the regional socio-ecological system under the influence of factors of the external and internal environment on it. The purpose of this study is to investigate the ecological state of sea water in the territorial waters of Gelendzhik, as well as nearby settlements, and assess its compliance with established standards. This study aims to provide comprehensive and up-to-date data on the chemical properties and composition of sea water, which will be useful for decision-makers, stakeholders, and researchers involved in the sustainable development of the region.

5. Research Methods

This study will use physical and chemical studies to sea water samples from Gelendzhik and nearby settlements. The collected samples will be analyzed using standard laboratory techniques to determine their chemical properties and composition. The results will be compared with established standards to assess the ecological state of the sea water. Additionally, relevant literature will be reviewed to identify potential threats to the health of vacationers and tourists.

6. Findings

In the period from June 2019 to June 2020 in the area of the city-to. Gelendzhik, physical and chemical analyzes of sea water were carried out (Table 1). Samples were taken at 2 points: 50 m from the coast, within the bay, and in the open part of the sea, 4 km from the coast. According to the data obtained, such indicators as extraneous odor, color, transparency, floating impurities at two sampling points did not exceed the permissible levels for ND for the entire period of research. The hydrogen index in the fifty-

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meter zone shifted to a more alkaline side and averaged 8.4, in the open part of the sea the average value for the entire period of research was 8.1. The largest amount of dissolved oxygen was contained in the open part of the sea, and amounted to 8.9 mg/dm3, and in the water area of the bay, the content of dissolved oxygen was 7.8 mg/dm3. The change in the content of dissolved oxygen depending on the distance from the coastal zone is associated with an increase in the recreational load in the summer. BOD5 at two sampling points does not exceed the maximum allowable value and averages 1.25 in the bay water area and 0.99 mg/dm3 in the open part of the sea. The content of surfactants in sea water is within acceptable limits, in the bay waters the average concentration of surfactants is higher by 0.11 mg/dm3 than in the open part of the sea. The content of oil products does not exceed the permissible levels, in the water area of the bay the average value is 0.04 mg/dm3, and in the open part of the sea - 0.018 mg/dm3 (Barabbas, 2007).

Table 1. Physico-chemical parameters of samples of sea water of the Black Sea, Gelendzhik

Sampling date	Ingredient	Water area	OCHM	PDK
22nd of June	Smell, score	2	0	> 2
	AS, mg/dm3	0,23	0,15	> 0,5
	Transparency, cm	≥30	≥30	< 30
	BOD5, mg/dm3	1,03	0,99	> 4
	Dissolved oxygen, mg/dm3	7,8	8,6	< 4
	Hydrogen index, pH	8,38	8,0	6,5–8,5
	Oil products, mg/dm3	0,032	0,020	> 0,3
24nd of July	Smell, score	2	0	> 2
	AS, mg/dm3	0,27	0,17	> 0,5
	Transparency, cm	≥30	≥30	< 30
	BOD5, mg/dm3	1,48	1,13	> 4
	Dissolved oxygen, mg/dm3	6,5	7,9	< 4
	Hydrogen index, pH	8,4	8,1	6,5–8,5
	Oil products, mg/dm3	0,047	0,017	> 0,3
15th of September	Smell, score	1	0	> 2
	AS, mg/dm3	0,18	0,098	> 0,5
	Transparency, cm	≥30	≥30	< 30
	BOD5, mg/dm3	1,09	0,87	> 4
	Dissolved oxygen, mg/dm3	6,8	8,9	< 4
	Hydrogen index, pH	8,35	8,0	6,5–8,5
	Oil products, mg/dm3	0,046	0,015	> 0,3

In the period from June 2018 to June 2020, studies were carried out to establish the following physical and chemical indicators of sea water in the areas of the village. Arkhipo-Osipovka, x. Beta, p. Krinitsa, s. Divnomorskoye: foreign smell, transparency, color, floating impurities, pH value, dissolved oxygen, BOD, surfactants, oil products (Vershinin, 2005).

In the vicinity of the city-to. Gelendzhik, the first samples were taken on June 22, 2018 in the village. Arkhipo-Osipovka at two points: 10 m from the shore and 25 m from the shore. The test results showed that such indicators as foreign smell, color, transparency, floating impurities at two sampling points remain unchanged and do not exceed the permissible levels according to RD. The pH at the point

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furthest from the coast shifts to the acid side and is 8.0. The largest amount of dissolved oxygen is contained at the sampling point, which is located 25 m from the shore, and amounts to 9.48 mg/dm3, and in the ten-meter zone, the content of dissolved oxygen is 9.16 mg/dm3. BOD5 at two sampling points does not exceed the maximum allowable value and is 1.13 and 1.00 mg/dm3, respectively. The content of surfactants in sea water is within the maximum allowable values, at the sampling point, which is located closer to the coastal zone, the concentration of surfactants is 0.003 mg/dm3 higher than at the point farthest from the coast. The content of oil products does not exceed the permissible levels, at the sampling point, 10 m from the shore, is 0.036 mg/dm3, and at the point - 25 m from the shore - 0.030 mg/dm3 (Vinogradov, 1958).

The next sampling was carried out on July 17, 2018 in the same study areas: 10 m from the coast and 25 m from the coast. According to the data obtained, such indicators as foreign odor, color, transparency, floating impurities at two sampling points remain unchanged and do not exceed the permissible levels according to RD. The hydrogen index in the twenty-five-meter zone is shifting to the acid side and is 8.1. The largest amount of dissolved oxygen is contained in sample 2, and is 9.16 mg/dm3, and in the first sample, the content of dissolved oxygen is 8.50 mg/dm3. The change in the content of dissolved oxygen depending on the distance from the coastal zone is associated with an increase in the recreational load in the summer. BOD5 at two sampling points does not exceed the maximum allowable value and is 1.63 and 1.32 mg/dm3, respectively. The content of surfactants in sea water is within the permissible range, in 1 sample the concentration of surfactants is 0.005 mg/dm3 higher than in 2nd sample (Brook et al., 2019; Solovey et al., 2021). The content of oil products does not exceed the permissible levels, in the 1st sample 0.025 mg/dm3, and in the 2nd sample - 0.030 mg/dm3 (Vinogradov et al., 1992).

When conducting physical and chemical studies in the last decade of July 2018, we noted the highest concentration of dissolved oxygen in the first sample - 8.52 mg/dm3, in the second sample 8.50 mg/dm3. BOD5 in two samples does not exceed the maximum allowable value and is 1.63 and 1.46 mg/dm3, respectively. The content of surfactants in sea water is within the maximum allowable values, in the first sample, the concentration of surfactants is 0.002 mg/dm3 higher than in the second sample. The content of oil products does not exceed the permissible MPC levels: the first sample is 0.027 mg/dm3, the second sample is 0.029 mg/dm3.

Studies conducted at the beginning of the second decade of August 2018 showed that such indicators as foreign odor, color, transparency, floating impurities and pH remain unchanged at two sampling points and do not exceed the permissible levels according to RD. The largest amount of dissolved oxygen is contained in the second sample - 8.49 mg/dm3, in the first sample - 8.18 mg/dm3. BOD5 in two samples does not exceed the maximum allowable value and amounts to 1.64 and 1.47 mg/dm3, respectively. The content of surfactants in sea water is within the maximum permissible values; in the first sample, the concentration of surfactants is 0.002 mg/dm3 higher than in the second sample. The content of oil products does not exceed the permissible levels, in the first sample - 0.028 mg/dm3, in the second sample - 0.030 mg/dm3.

The last samples in 2018 were taken on August 17 also at two points: sample 1 - 10 m from the coast and sample 2 - 25 m from the coast. The results of the research showed that such indicators as

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foreign smell, color, transparency, floating impurities and pH at two sampling points remain unchanged and do not exceed the permissible levels according to RD. The largest amount of dissolved oxygen is contained in the second sample - 8.17 mg/dm3, in the first sample the content of dissolved oxygen is 8.16 mg/dm3. BOD5 at two sampling points does not exceed the maximum allowable value and is 1.63 and 1.46 mg/dm3, respectively. The content of surfactants in sea water is within the maximum permissible values; in the first sample, the concentration of surfactants is higher by 0.002 mg/dm3 than in the second sample, which is the most remote from the coast. The content of oil products does not exceed the permissible MPC levels, at the sampling point, 10 m from the shore, it is 0.029 mg/dm3, and at the point 25 m from the shore it is 0.030 mg/dm3.

In 2019, samples were taken at 4 points: c. Arkhipo-Osipovka, with. Divnomorskoe, with. Krinitsa, Hut. betta. Sampling was carried out 50 m from the coast.

The first sampling in 2019 took place on 6 June. When conducting physical and chemical studies in the area with. Arkhipo-Osipovka, it was found that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.025 mg/dm3; sea water did not acquire unusual odors; transparency in Snellen's font was more than 30 cm; BOD5 was 0.99 mg/dm3; dissolved oxygen was 9.5 mg/dm3; the pH value was 8.0 units. pH. The mass fraction of oil products was 0.016 mg/dm3.

Research carried out in Divnomorskoye showed that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.027 mg/dm3; sea water did not acquire unusual odors; transparency in Snellen's font was more than 30 cm; BOD5 was 0.98 mg/dm3; dissolved oxygen was 9.2 mg/dm3; the pH value was 8.1 units. pH. The mass fraction of oil products was 0.015 mg/dm3.

According to the results of research in the farm. Betta found that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.023 mg/dm3; sea water did not acquire unusual odors; transparency in Snellen's font was more than 30 cm; BOD5 was 0.97 mg/dm3; dissolved oxygen was 9.8 mg/dm3; the pH value was 8.0 units. pH. The mass fraction of oil products was 0.015 mg/dm3.

Conducted in the village Krinitsa studies showed that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.028 mg/dm3; sea water did not acquire unusual odors; transparency in Snellen's font was more than 30 cm; BOD5 was 0.96 mg/dm3; dissolved oxygen was 9.5 mg/dm3; the pH value was 8.1 units. pH. The mass fraction of oil products was 0.017 mg/dm3.

The next samples were taken on 24 July. Research carried out in Arkhipo-Osipovka showed that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.092 mg/dm3; sea water has acquired a slightly unusual smell, not exceeding 2 points; transparency in

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Snellen's font was more than 30 cm; BOD5 was 1.86 mg/dm3; dissolved oxygen was 6.69 mg/dm3; the pH value was 8.4 units. pH. The mass fraction of oil products was 0.060 mg/dm3.

Results of researches in with. Divnomorskoye showed that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.092 mg/dm3; sea water has acquired a slightly unusual smell, not exceeding 1 point; transparency in Snellen's font was more than 30 cm; BOD5 was 1.34 mg/dm3; dissolved oxygen was 6.98 mg/dm3; the pH value was 8.2 units. pH (Vinogradov et al., 1992). The mass fraction of oil products was 0.075 mg/dm3.

According to the data received in the farm. Betta, indicators such as foreign smell, color, transparency, floating impurities do not exceed the allowable levels according to ND. The content of surfactants did not exceed the norm and amounted to 0.17 mg/dm3; sea water has acquired a slightly unusual smell, not exceeding 1 point; transparency in Snellen's font was more than 30 cm; BOD5 was 1.7 mg/dm3; dissolved oxygen was 7.0 mg/dm3; the pH value was 8.3 units. pH. The mass fraction of oil products was 0.057 mg/dm3.

When conducting physical and chemical studies in the village. Krinitsa, we noted the following indicators: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.16 mg/dm3; sea water has acquired a slightly unusual smell, not exceeding 2 points; transparency in Snellen's font was more than 30 cm; BOD5 was 1.77 mg/dm3; dissolved oxygen was 6.75 mg/dm3; the pH value was 8.3 units. pH. The mass fraction of oil products was 0.068 mg/dm3.

Results of researches in with. Divnomorskoye showed that: there were no floating impurities on the surface (including a film of oil products, oils, fats); no color was detected in a 10 cm column of sea water; the content of surfactants did not exceed the norm and amounted to 0.17 mg/dm3; sea water has acquired a slightly unusual smell, not exceeding 1 point; transparency in Snellen's font was more than 30 cm; BOD5 was 1.74 mg/dm3; dissolved oxygen was 6.8 mg/dm3; the pH value was 8.3 units. pH. The mass fraction of oil products was 0.045 mg/dm3.

7. Conclusion

In conclusion, we would like to note that throughout the entire period of research, changes in the following physicochemical parameters are observed: dissolved oxygen, biochemical oxygen demand, ionic surfactants, non-ionic surfaces, density in summer, which indicates an increase in the recreational load on the study area . An increase in the content of dissolved oxygen in sea water was recorded, which is inversely proportional to the increase in anthropogenic impact, the maximum content of this indicator - 9.8 mg / dm3 - for the entire period of the study was noted in the hut area. Betta June 6, 2018 BOD throughout the entire period of research increases in those months when the load on the coastal part of the sea is maximum. This indicator also indicates that there is an increase in the number and biomass of algoflora in the study area. The content of this indicator averages 1.45 mg/dm3 (Vinogradova & Vasilyeva, 1992).

The content of surfactants in sea water is within the maximum permissible values, but in August the concentration of these substances increases, and averages 0.1 mg/dm3. The content of oil products in

the study area is low, is within the maximum permissible values and averages 0.04 mg/dm3, but the concentration of these substances also increases with an increase in anthropogenic load. With an increase in recreational load, the hydrogen index shifts towards an alkaline environment; throughout the entire period of the study, it averaged 8.2. The hydrogen index is directly related to a process such as photosynthesis. Consequently, with an increase in recreational load, the activity of photosynthesis increases. In general, the process of reducing the recreational seasonal load stabilizes the composition of sea water and there is no need to talk about any significant threats or dangers (Electronic fund of legal and regulatory and technical information, 2014).

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