RESEARCH ARTICLE **(Open Access)**

Physico-chemical characteristics of seawater in the Bay of Vlora, Albania

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Abstract

This study was conducted between May and September 2013 in the Gulf of Vlora, an important area of ecological, economic and tourism in south - west Albania. The study aims at determining: (a) the quality of marine waters in the Gulf of Vlora analyzing physical - chemical parameters, (b) the status of the area in support of economic development and tourism. The employed method was the monitoring data for the specified period. The data for temperature, pH, salinity, dissolved oxygen, were obtained using multiparameter portable instrument. Also transparency measurement is performed using disk Sechin. Results of measuring the temperature of the water showed that they differ, depending on seasons and sampling areas. The lower and higher temperature measured in February were around 13.1^{o} C on Aug. 25 to 26.1^{o} C . Seawater pH is fundamental to living creatures, and they had measured values ranging from 7.86 to 8.14. Values of salinity in the Bay of Vlora consider various comparisons between monitored stations. In physico-chemical indicators of marine waters of the Bay of Vlora, as very influential factors in particular seasons or months of the year, affect the solid Izvori river, Dukati and Vjosaas well as marine currents that determine the displacement of marine sediments, which cannot be excluded Vlora Bay.

Keywords: Bay of Vlora, physico-chemical parameters, marine environment, monitoring, samples.

1. Introduction

Increased human activity near marine areas has caused a significant increase in the degree level of pollutants affecting directly the natural ecosystem, especially in parts with low rate of water, such as marine protected areas. Physical and chemical characteristics of marine waters are considered to have a great importance in their quality and are key factors for living resources in this area[1,3]. Water quality of the Bay of Vlora varies depending on the seasons and areas near the coast and on its depths. Some important parameters of the physical and chemical affecting the aquatic environment are temperature, pH, salinity, dissolved oxygen and conductivity. These parameters are mandatory factors for the survival of marine organisms. Poor water quality can be the result of industrial and urban discharges, emissions and transportation of fishing vessels as well as illegal constructions in the coastal one. Temperature plays a very important role in the content of dissolved oxygen in the water. PH is an important characteristic of the marine aquatic environment related to the survival of aquatic organisms, and increases their metabolism. Salinity is subject to broader changes in the coastal belt, where modifying actions are more intense and variable. Dissolved oxygen is one of the key parameters necessary for a good quality of water[2,4,10]. It can become a critical factor especially in summer, when due to high temperature, increased oxygen consumption and at the same time many of its solubility in water decreases, due to the presence of pollutants which may have the phenomenon of decreasing dissolved oxygen and increased carbon dioxide. High rates of dissolved carbon dioxide are harmful to the physiology and metabolic activity of aquatic animals. Elements such as industrial development, agriculture and urban activities significantly affect water quality. Even marine areas of the Bay of Vlora are affected by the phenomenon of multiple pollutants spill by encreasing the human waste in buildings inappropriate discharge areas. Therefore, accurate determination of physico-chemical parameters and nutrient in the marine aquatic environment are important to control the level of pollution and its state. The main purpose of this study is to provide information on water quality of the Bay of Vlora and the evaluation of its environmental condition. We also will give some recommendations to realize the preservation and protection of the marine protected area[2,3,9,10].

1.1 General considerations in the study area

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Vlora Bay is located in south-west Albania with coordinates 40° 25' 2 " N, 19° 25' 49" E and 40° 41' 7" N, 19° 43' 2" and it is 21 km long and 17 km wide. It extends over an area of 305 km^2 starting and ending from Triport Cape to Gjuhez Cape, where in the middle is Sazan Island, about 17 km away from the city of Vlora. In Vlora Bay a Mediterranean climate prevails throughout the year and has an average of 106 sunny days and 190 partly cloudy days. Sea water temperature in the Bay of Vlora reaches up to 27, 5 °C maximum and minimum 13.5°C and cold sea currents are less influential. The winds are not only an important factor in determining the climate factors but also affect the environmental performance of marine waters. Vlora Bay is characterized by winds that usually blow from the northeast to northwest and south. Average rainfall is 1,200 mm a year, where many more precipitation falling in the winter. Winters are mild, and January is considered to be the coldest month of the year (average temperature 12°C), while the warmest month is August (average temperature 32^{o}C).

2. Material and Methods

2.1 Sampling and collection stations

The uptake of the samples was carried out by a network of eight monitoring stations spread along the coast of the Bay of Vlora in distance from 50 to 100 m from shore. Sample stations obtained at each position are shown in Figure 1. Station 1 (N: 40° 19' 3" and E: 19° 26' 5") is located in Bay Orikumi 100 m distance from the shore to see the impact of the Orikumi sewage waters; Station 2 (N: 40° 20' 1" and E: 19° 28' 1") is located at the Izvor river to see the impact of Izvor river flows: Station 3 (N: 40° 22' 2" and E: 19° 28' 5") is located in Radhima to evaluate the impact of uncontrolled spills from land pollutants, especially in summer times; Station 4 (N: 40° 25' 1" and E: 19° 29' 09") is located in the Vlora Bay cold waters to see the impact of the spills from the land pollutants; Station 5 (N: 40° 26' 4" and E: 19° 29' 3") was respectively in the marine area of the Naval School to see the impact of pollution from sewage canals and sewage flowing into the sea from urban areas. Station 6 (N: 40° 27' 1" and E: 19° 28' 2") is 100 m from the sea port to see the impact of pollution from portual infrastructure; Station 7 (N: 40 ° 27' 3" and E: 19° 28' 2") is located in the area of Soda Forest. Station 8 (N: 40° 28' 4" and E: 19° 26' 1") is the new port area near Zvërnec. For sampling the water of the Bay of Vlora we used the model "Ruttner". Water samples were taken at a distance of 50-100 m from shore in 1.5 liter bottles and transported to the laboratory in coolant temperature 4°C overnight. Sample stations were chosen in such a way so as to obtain a more complete assessment of the overall environmental situation throughout the bay area and the impact of possible sources of pollution in the monitored areas.

Measurement of physico-chemical parameters of the Bay of Vlora water is done on site in two seasons, at the beginning of the touristic season in May and late September tourist season, using portable instruments. The measured parameters were: temperature, salinity, pH, DO and transparency[1,5,10]. In Figure 1, histograms are shown through the measured levels of physico-chemical parameters in the Bay, while eight stations in Table 1 present some statistics on the results of physico-chemical parameters measured in May - September 2013. Their values are compared with data values certified under EU Directive EEC 78/659 and classification of the Norwegian research institute of water (NIVA 1997)[4].

Figure 1. Locations of Water Samples in Vlora Bay

2.2 Methods of chemical analysis

Taking water samples, transportation, conservation and chemical analyzes were based on standard methods recommended by APHA[7,10]. Shortly after the arrival in the laboratory samples were analysed to determine physico-chemical parameters using a conductometer (DDSJ Model 308A) for determining electrical conductivity, salinity and a pH meter (Model PHS-3BE) for determination of pH and temperature. Afterwards, samples were taken to the laboratory (0:42 μm glass filter) in order to be separated from inert materials that can affect the acquired outcome and part of it qere preserved in a temperature -20°C to determine the nutrient. In addition, the experiment involved filtering solid materials at a temperature 105 °C in order to determined the weight of TSS. Determination of nutrient was conducted by UV-VIS spektrofotometry according by Standard Methods for the Examination of Water and Wastewater. We utilized the device Turbidimeter field Type "TURBIDITY METER" and drive "Secchi disc" to measure water transparency. Samples were analyzed in the laboratory environment at the University “Ismail Qemali” of Vlora with the laboratory methods of extraction values.

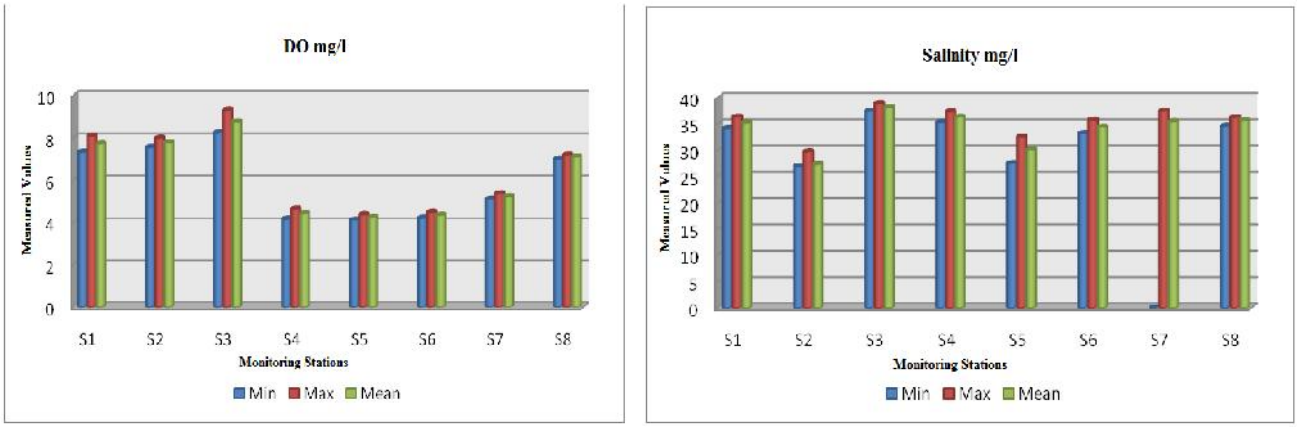
3. Results and Discussion

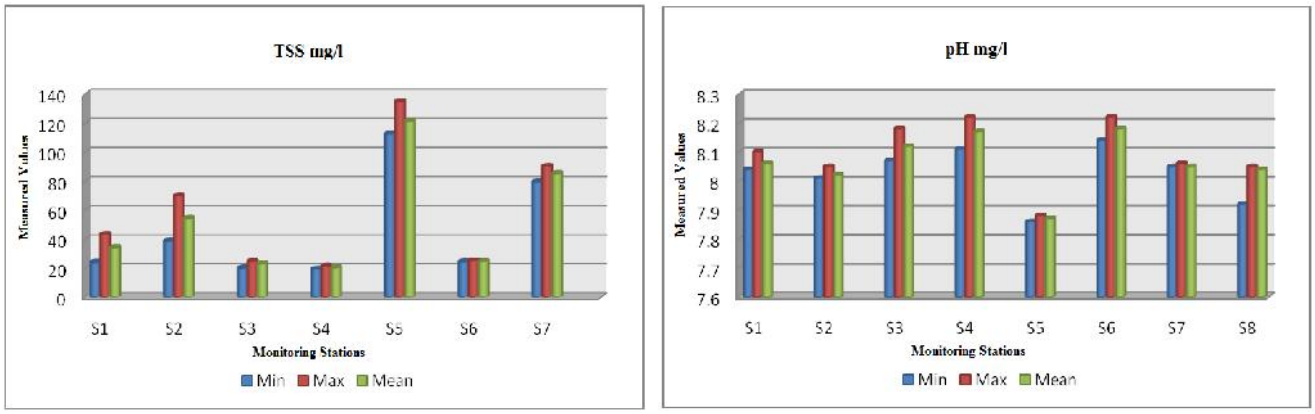
3.1 Assessment of physic-chemical parameters

The outcomes have indicated that the seawater of Vlora Bay the pH values were in normal range [5,10]. Moreover, there are indications that reveal lower values of pH in stations 3 and 6 of the Bay of Vlora, and mainly in the area of station 6 at Navy School. This is due to wastewater and sewages which are discharged through two channels of urban water systems.

The values of salinity parameters at the stations 2 and 4 were found in lower levels, a phenomenon caused by the flow of fresh water from the river station Izvor 2 and urban sewage spills 4, 5 and 6 stations, in which the largest number of urban water channels which flow into the sea are located. These values varying from 27.3 mg / l at station 2 at 38.1mg / l at station 3. Values of water transparency measured by Sechi disc show the lowest values of water transparency. These values are below the standard for coastal waters which are more prominant at stations 2, 5, 6 and 7 due to the inflow of urban waste water and solid waste coming from multiple channels. In the Bay there are about 53 channels mainly urban water shed area of the city of Vlora. We also have in this area the river flows Izvori and Duchy. These values varying from 6.3 m to 12.7 m. Dissolved oxygen is one of the key parameters necessary for a good quality of water. The major changes in its content in water are caused by aquatic vegetation. During the development process of photosynthesis, the amount of DO in the water will rise and during the breathing plant process (wasted oxygen and CO_2 released) quantity DO will decrease. DO can be a critical factor, especially in summer when temperatures due to high consumption of O_2 and simultaneously grow more O_2 solubility in water decreases[1,5,10]. Therefore, DO values measured at stations resulted in normal levels if we refer to the standard level; (≥ 8 mg/L according to EU Directive EEC 78/659. In addition, lowest value of DO was measured at stations 4, 5 and 6 due to urban sewage discharges near them[4,7,9].

Figure 2. Histograms of measured physico-chemical parameters mg/L





3.2 Nutrient levels in the Bay of Vlora

Nitrate concentrations in all analyzed samples range at levels from 0.08-0.81 mg/L. Vlora Bay seawater resulted in higher content of nitrates, especially in station 3, 4, 5, 8. This may be caused by discharges of sewage, agricultural waste and livestock in the area where these activities are enhanced.

The table shows that the content of nitrites ranges from 0.02 to 0.08 mg/L . Vlora Bay resulted in higher content of nitrites in almost all stations in the study. Maximum values were recorded at station 8 (Zvernec), station 6 (the Old Beach) and station 5 (the Naval School). These high values of nitrites are caused by the discharges from wastewater system.

High levels of ammonium are considered a very good indicator of sewage discharges and liquid livestock waste. In the samples taken for analysis, the ammonium concentration ranges from 0.02-4.49 mg/L, where the highest content resulted on Zvernec beach (station 8) and lower contents on stations 1 and 4. According to EEC Directive 78/659 maximum allowed concentration of ammonium in ciprinide waters is 0.025 mg/L and compared with this limit the ammonium is at a very high level for most of the stations considered in the study.

Phosphate parameters resulted in very low levels in all stations under 0.05 mg/L. These values are lower than the maximum allowed concentration < 0.4 mg / l according to EEC Directive 78/659. Based on the generally low levels of phosphates, we can conclude that phosphates constitute the limiting element of water eutrophication, because the concentrations of soluble phosphates determine the general speed of the photosynthesis process and algae development.

Figure 3. Histograms of measured values of nutrients and BOD, COD mg/L

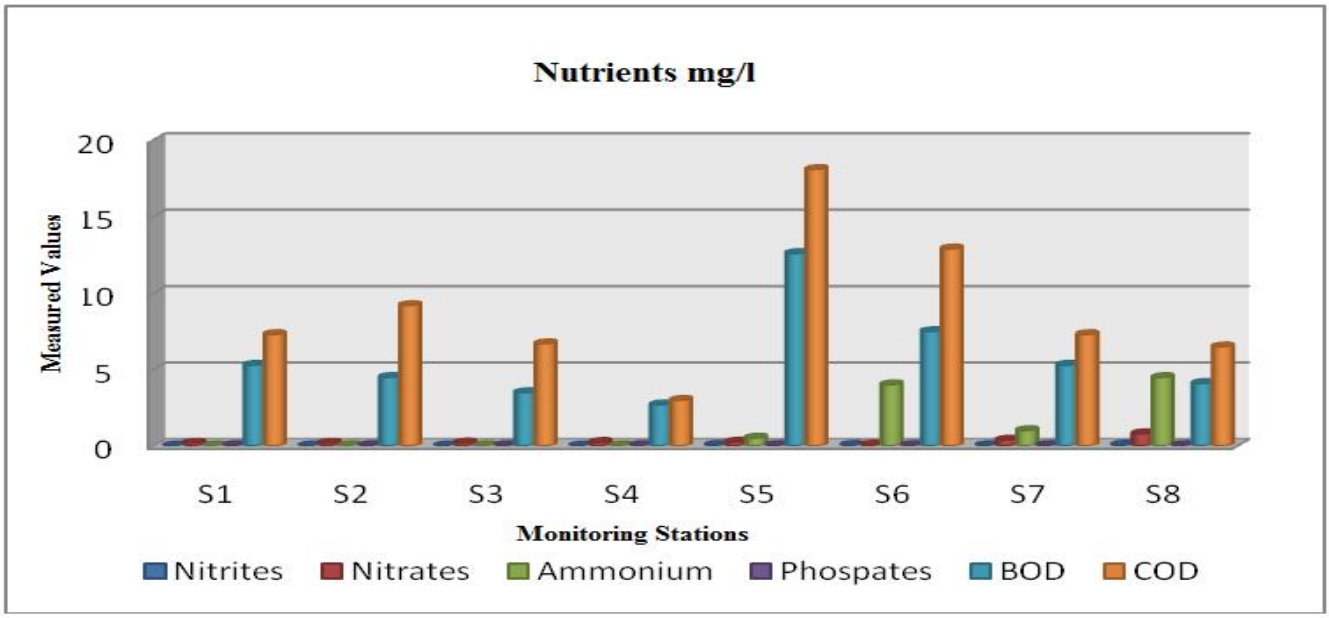


Table 1. Statistics of the results of physico-chemical parameters

Monitoring area	Parameters					
	pH	Do mg/L	Temp ^{0} C	Salinity mg/L	TSS mg/L	Transparency m
S1	8.06	7.72	20.4	35.2	34.3	11
S2	8.03	7.77	20.1	27.3	54.5	6.8
S3	8.12	8.76	19.4	38.1	23.0	12.7
S4	8.17	4.41	19.9	36.3	20.5	9.7
S5	7.87	4.24	20.5	30.0	121.4	6.3
S6	8.18	4.35	20.6	34.4	24.8	7.5
S7	8.05	5.24	19.7	35.4	85.2	7.3
S8	8.04	7.1	20.7	35.6	120.3	8.7
Average values	8.065	6.19875	20.1625	34.0375	60.5	8.75
Standart deviation	0.105965	1.865649	0.492322	3.819998	44.93257	2.208102

Table 2. Statistics of the results of nutrients

Monitoring area	Parameters					
	NO_2 (mg/L)	NO_3 (mg/L)	NH_4 (mg/L)	PO_4 (mg/L)	BOD (mg/L)	COD(mg/L)
S 1	0.02	0.2	0.02	0.02	5.3	7.3
S 2	0.02	0.2	0.04	0.02	4.5	9.2
S 3	0.02	0.21	0.04	0.03	3.5	6.7
S 4	0.02	0.25	0.02	0.04	2.7	3.0
S 5	0.07	0.27	0.53	0.07	12.6	18.1
S 6	0.06	0.08	4.02	0.05	7.5	12.9
S 7	0.04	0.4	1.02	0.05	5.3	7.3
S 8	0.08	0.81	4.49	0.06	4.1	6.5
Average values	0.04125	0.27775	1.2725	0.0375	5.6875	8.875
Standart deviation	0.025319	0.223591	1.878135	0.018323	3.139808	4.648425

It is important to note that the average BOD values was discovered to ranging from 2.74 mg/L to 12.62 mg/L. It is generally observed that there is great need for oxygen in the two stations 5 and 6 and we can conclude that this area has very polluted waters. Moreover, it could also be noted the merged trend of performance values measured at all stations. According with the EU norms, station waters 2,5,6,7,8, are under the norms which allow the survival of marine living resources. Our opinion is that the main cause of these conclusions are derived from the high discharges waste in their seawaters which have caused deoxygenated water, increasing as a result the biological need for oxygen.

The COD average values is ranged from 3 mg/L to 18.1 mg/L. We notice an increase in average values at stations S5, S6, S7, S8, which explains the fact that in this area seawater collects most urban emission channels from the city of Vlora.

The BOD and COD values determined according to the European norm of stations, are classified as follows: S1 reflects Class II norms; S2 belongs to

Class III, and; S5 belongs to Class IV (polluted)., On the other hand, S6, S7, S8 belong to Class III (contaminated).

According to the classification of water quality of NIVA, and EU Directive EEC 78/659, based on the content of pH and dissolved oxygen, waters in Orikumi area are classified in Class II. Radhima area and cold seawater are classified in Class I. While Naval School and Old Beach area is classified in Class III. Naval school area results polluted due to some sewage channel spills which come from the land based sources. Based on the nutrients analysed we can conclude that the Naval School area is contaminated and classified in Class IV. Other areas have a water quality that is classified under the Class II.

The results of our study are compared with previous studies [11] regarding Bay of Vlora water pollution. In this respect, it is noted that our data have similar values with this study, with few differences. These diversifications are resulted from different time period in which the relevant studies are carried out.

4. Conclusions

The shores in Vlora Bay are exposed to pollution problems related to the land based sewage discharges into the seawater. From the measurements of turbidity we can see clean water, physically present at some stations. However, in stations 2, 5 and 6, as indicated from the measurements, there is a small scale transparency, which does not exceed the accepted norm. Also, we believe that greater attention should be given to the monitoring of waters, since they belong to the shores marine areas, regularly used by the population during the holiday period with higher temperatures.

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