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RESEARCH ARTICLE

THE PHYSICO-CHEMICAL AND BIOLOGICAL CHARACTERISTICS OF DIPOLOG BAY

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ABSTRACT

The present status of Dipolog Bay was assessed at three selected sites and two substations (nearshore and offshore). The physico – chemical and biological characteristics of seawater were determined from the water samples of the three stations from March to May 2016. Data on total coliforms, fecal coliforms, heterotrophic plate count, total suspended solids, nitrates, phosphates, as well as the physico-chemical parameters such as dissolved oxygen, salinity, pH and temperature were collected and analyzed. The results showed that some of the physico-chemical and biological parameters were significantly correlated with each other with higher values and may attribute to the wastes or effluents that come from household sewage, industrial and agricultural activities. The presence of pollution-tolerant coliforms indicate that Dipolog Bay is deteriorating and does not fit for human utilization thus requires proper treatment and soothing measures. Moreover, Dipolog Bay does not qualify for Class coastal water criteria suitable for fishing, commercial purposes and tourist zones, and for Class recreational water class 1 (areas for bathing, swimming, skin diving, boating, etc.) based from the DENR standards.

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INTRODUCTION

Water is the most important natural resource in the world. The composition of seawater is important for the suitability of aquatic life. The urban and industrial development causes severe threats to seawater integrity and sustainability. The physical, chemical and biological processes occurring in coastal zones can modify the marine ecosystem conditions. Physico-chemical properties of the ambient marine environment will play a pivotal role in determining the type of ecosystem besides several other parameters. The natural composition of water could be affected by human pollution through water discharges from the surrounding areas. Coastal areas today have become collectors of all urban and industrial discharges; in this context Dipolog's seacost is included. Dipolog is a third class city and the capital of the province of Zamboanga del norte on the southern Philippine island of Mindanao. It is known for its wild orchids and its sardine industry which stems from the rich fishing area off its shores. It becomes an ideal place to live in, visit for relaxations, adventures, gatherings and travels. Dipolog Bay is major resources base for the twenty six (26) coastal communities of Dipolog City as well the nearby municipalities. It is one of the most attractive and inviting coastal zones of Zamboanga del Norte. Unfortunately, the area has suffered from significant population growth and increase in human activities in recent years. Many residents in the city live near the area which is surrounded by poultry, piggery and the river passes through some densely populated areas in the city. The wastes from these commercial establishments will flow into the river during heavy rains. Likewise, the agricultural activities going on in these places contribute to discharge of effluents into water. City's tourism industry is booming and it is imperative that the health and safety of the general public immersing in the coastal water should be secured.

Moreover, this study is important to minimize the factors that affect negatively the seawater quality of Dipolog Bay. This would also prompt certain agencies in the city to intensify their measures to secure the public safety in relation to seawater. The researchers aimed to find out information on the physico-chemical and biological characteristics of Dipolog Bay. Results obtained from this study might serve as a baseline data for future researchers on monitoring the coastal water in Dipolog City.

Methodology

Three stations were established as sampling sites along Dipolog bay and were sampled from March 2016 to may 2016. Physico-chemical parameters such as pH, temperature, dissolved oxygen (DO), salinity, total suspended solids, phosphates and nitrates were measured, as well as the

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biological parameters such as total coliform, fecal coliform and heterotrophic plate count.

Sampling stations

Station 1–Boulevard. The boulevard is filled with basic amenities such as benches, restrooms, functional stage for events, kiddie playground, physical fitness activities, center for all kinds of street foods, with commercial buildings augmenting the presently existing restaurants, bars and several food and beverages peddlers, and recreational activities like beach volleyball, dragon boat races, and swimming along the beach.

Station 2 – Galas. A docking port for travelers from Cebu. Many settlers inhabits in this place. Most have beaches that surround the area for recreational activities and bathing. Wastes from their backyard piggery and other domestic animals washed down to this site.

Station 3 – Sicayab. A beach known for its fine gray sand and relaxing view of the sea all perfect for skimming. The barangay is known for its clean beaches. Mostly, the settlers that surround the site were fishermen.

Physico – chemical framework of analysis

Determination of pH. pH of the samples were determined against pH 4 and pH 7 in an Oakton pH700 pH meter equipped with an automatic temperature compensation probe respectively in three replications.

Turbidity. Water turbidity was determined nephelometrically with a Merck Turbiquant 1500T in three replications.

Salinity and Temperature. In three replications, a hand-held refractometer was used to measure salinity where salinity is expressed as PDU (Practical Salinity Units) and temperature were conducted by a thermometer.

Total Suspended Solids (TSS). One-liter samples in three replications were collected in each of the sampling station. In the laboratory, water samples were filtered through preweighed GF/C and dried. The filters were pre-stabilized, weighed before filtration. After filtration, the residue was air-dried at 110°C a GF/C filter for one hour to constant dry weight and weighed again.

$$\text{TSS, mg/L} = \frac{weightofsolidsinmg}{volumeofsampleinL}$$

Phosphates (PO_4 –P mg/L) Analysis. Water samples in three replicates were taken from the three sampling sites and were placed in a glass bottle. Samples were then placed in a styropore box with ice and brought to the laboratory for analysis.

Stock solutions of Sulfuric acid, Ascorbic acid and Mixed reagent were first prepared. Sulfuric acid was prepared through adding 125 ml concentrated H_2SO_4 to water and was diluted to 500 ml, stored in a plastic bottle. Ascorbic acid on the other hand, was prepared through dissolving 5 grams ascorbic acid in a glass bottle with 25 ml water, and added with 25 ml sulfuric acid solution, stored in a refrigerator. Mixed reagent was prepared through dissolving 6.25 g $(NH_4)_6Mo_7O_{24}•4H_2O$ in 62.5 ml of water. Dissolve 0.25 g potassium antimony tartrate (with or without ½ H_2O) in 10.0 ml water. Add the molybdate solution to 175 ml of dilute sulfuric acid with the tartrate and was stored in a glass bottle. Then the following were added to a test tube or scintillation vial: 10 ml filtered sample, 0.2 ml ascorbic acid mixed reagent. Absorbance at 880 nm was measured between 5 and 30 minutes.

Determination of Nitrate (NO_3-N). Surface water samples were collected in clean bottles and kept in an icebox and transported immediately to the laboratory. In the lab, six (6) 10-mL from pipet was transferred into separate canisters and to 3 of the canisters it will be added with 0.2 mL of 1.0535 ppm NO_3-N (spiked samples). It is added with 10 mL of ammonium chloride buffer to both unspiked and spiked samples.The mixture is poured into the reductor and collect about 8 to 10 mL to rinse and collect the last 10mL before adding 0.4 mL sulfanilamide and 0.4 mL N-1-naphthylenediamine hydrochloride to the reduced sample. Allow the color of the azo dye to develop for about 15 minutes and measure the absorbance within 1 hour at a wavelength of 540nm.

conc, mg NO_3-N/L =

$$\frac{(Aofunspikedxvolofstd NO3 - NxconcofNO3 - Nstd)}{((Aofspikedsamplextotalvol) - (Aofunspikedxvolofsample))}$$

Where

Vol of std NO3-N = 0.2 mL
Conc of std NO3-N = 1.0535 ppm
totalvol = 10.2 mL
vol of sample = 10 mL

Bacteriological Determination

Total Coliforms/Fecal Coliforms Analysis. *Multiple Tube Fermentation Technique*is used to determine the presence of a member of the coliform group in ground water and surface water. Water samples (100 mL each) were collected using a sterile sampling bottle and processed using membrane filtration method for coliform analysis. Coliform was cultured in endobroth medium at 35˚ C for 48 hours. The colonies were counted and recorded. The most probable number (MPN) of colonies per 100 mL of seawater was determined using the formula:

$$\text{MPN/100 mL} = \frac{\text{No. of Colonies}}{\text{Volume of water sample in mL}} \times 100$$

Heterotrophic Plate Count Analysis. The *pour plate technique* is used to determine the number of microbes/mL in a specimen. Water samples that were collected using a sterile sampling bottle are prepared and diluted. It is added with an aliquot of the prepared sample in a labeled empty sterile plate and 15 mL of melted agar was poured and cooled to 45°C. Into the plate, swirl and mix well, let cool to solidify (without disturbing) and invert and incubate to develop colonies for 24-48 hours. The resulting colony represents a "colony forming unit" (CFU). The accurate and optimum count should be within the range of 30 to 300 colonies/plate.

RESULTS AND DISCUSSION

Table 1. The values of physico-chemical parameters recorded of stations 1, 2, and 3 as compared with the DENR Standards

Parameters (DENR Standards)	Unit	Station 1 (Boulevard)	Station 2 (Galas)	Station 3 (Sicayab)
Temperature (max.rise in 3˚C)	(˚C)	**28.00^{A}**	**30.35^{A}**	**29.50^{A}**
Salinity (35g/L)	(g/L)	28.83^{A}	35.00^{A}	35.00^{A}
Total Suspended Solids (g)	mg/L	19.73^{A}	15.27^{A}	42.32^{A}
Turbidity	(NTU)	2.12^{B}	0.50^{A}	0.87^{A}
pH (range) (6.5-8.5)		8.05^{A}	8.12^{A}	8.00^{A}
Dissolved Oxygen ≤5 satn mg/L	%	6.70^{A}	6.93^{A}	7.27^{A}

Temperature

Water temperature is the best index of seasonal fluctuations. It is affected by several factors including weather conditions, removal of shading stream bank vegetation and storm weather. As would be expected, the temperature of surface water of the three stations as the studied areas of Dipolog Bay fluctuated between 28.00 to 30.35 ˚C with a mean value of 29.18 ˚C that is normal for the period of sampling process based from the water DENR standard. The mean values did not differ significantly. The higher temperature of Stations 2 and 3 compared to Station 1 could possibly attribute to the variation in the intensity of light during sampling.

Salinity and Total Suspended Solids (TSS)

Salinity is the measurement of ionic composition of water and it varies depending on mixing of relatively fresher inland waters with saltier marine waters. The measurement for Salinity among three stations ranges between 28.83 – 35.00 g/mL with a mean value of 32.94 g/mL. The mean of the three stations did not vary significantly as to the DENR standards of 35 g/mL. Salinity of station 1 (Boulevard) found to be lower due to the mixing of fresh water with saline water since the station is near in the open mouth of a river.

Total Suspended Solids(TSS) refers to any matter either suspended or dissolved in water. TSS content among three studied areas ranges between 15.27 to 42.32 mg/L. TSS content in Stations 1 and 2 recorded lower compared to Station 3. The mean of TSS do not differ significantly as compared to DENR water standards. Station 3 (Sicayab) has the highest value for TSS, which could be attributed to erosion and domestic wastes that were discharged from the nearby settlers..

Turbidity

Turbidity is a measure of the amount of cloudiness or haziness in seawater caused by individual particles that are too small to be seen without magnification. Highly turbid ocean waters are those with a large number of scattering particulates in them. Turbidity mean differs significantly among the three (3) stations based on the DENR water standards. It ranges between 2.12 to 0.50 NTU. Station 1 (Boulevard) has the highest mean value obtained among the three stations (2.12 NTU). There is a significant difference between the mean of Station 1 (Boulevard) and the mean of Station 2 (Galas) of 0.009 p-value, and between Station 2 mean and Station 3(Sicayab) mean difference of 0.041 p-value.

pH

The *pH* stands for power of hydrogen, which is a measurement of the hydrogen ion concentration in the body. A pH less than 7 is said to be acidic and solutions with a pH greater than 7 are basic or alkaline. The pH range in Dipolog Bay was 8.00–8.12. The pH values among the three stations did not vary significantly as to DENR water standards. The values obtained fall within the DENR standards. Station 2 (Galas) has a higher pH value (8.12) compared to the others. The pH value is used as a convenient method of expressing the hydroxyl ion concentrations in solution. Majority of the aquatic species prefer a pH between 6-8.5 Novotny, et al (2001).

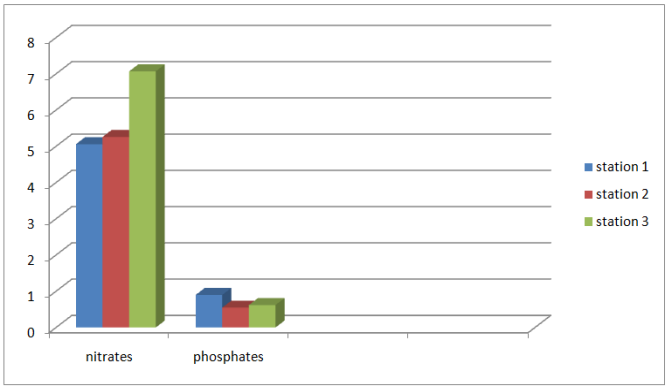
Dissolved Oxygen

Dissolved oxygen (DO) is an environmental parameter needed for a good quality of surface water. In general, it is available as s dissolved state at water bodies. In the three stations, the quantity of dissolved oxygen (DO) in water ranges from 6.40 – 7.27 mg/L, with a mean value of 6.97 mg/L and is within the normal range of 6.50-8.50 mg/L of the DENR standard of parameters. DO values across stations did not differ significantly. The DO content in water samples collected with the two stations 1 and 2 resulted lower compared to the DO content in the samples collected in Station 3.

Nutrient Content

The (Figure 1) depicts the nutrient content (nitrates and phosphates) in Dipolog Bay and based as to the DENR parameters. *Nitrate s(N-NO_3)* content in all samples collected from three stations varied from 5.06 to 7.08 mg/L. Due to the untreated urban wastes discharged into the sea, the content nitrates of the three stations were high, but the mean on nitrate concentration do not differ significantly, hence the values of the stations is below the normal range of 10 mg/L for Class SB DENR standard No. 34 s. 1990.

On *phosphates (P-PO_4^{3-})* that is essential as plant nutrient stimulating for plant growth. The phosphate content in the three stations was higher, that ranges between 0.55 to 0.90 mg/L. The mean value of 0.02 mg/L differs significantly from the DENR standard of 0.10 mg/L for coastal water.



Note: DENR parameter for nitrate is 10 mg/L and 0.10 mg/L for phosphates.

Figure 1. Nutrient content (nitrates and phosphates) in the three sampling stations

Table 2. Bacteriological analysis of Dipolog Bay

Stations	Raw water samples Count	Total Heterotrophic (CFU/mL)	Total Coliforms (MPN/100mL)	Fecal Coliforms (MPN/100mL)
1	seawater	477.17	3.53	3.23
2	seawater	1.14	1.62	0.55
3	seawater	402.67	2.63	3.02
	DENR Standard	NS	$1.0x10^3$	$2.0x10^2$

High values of these stations is caused by fertilizers and fishmeal in fishponds and the different creeks of Dipolog Bay and settlers that uses soaps for washing, bathing and any other household activities.

Biological Parameters

Coliform Contamination. Results of the bacteriological analysis of thewater samples in all three stations in three sampling periods were positive for total coliform as presented in Table 2. The total viable counts for all water samples were quite high ranging from 1.14 cfu/ml to 477.17 cfu/ml. The station 1 sample has the highest microbial load of 477.17 cfu/mL while station 2 water sample had the least value of 1.14 cfu/mL. The most probable number (MPN) for presumptive total coliform count of the water samples ranged from 1.62 to 3.53 MPN per 100ml. Water samples from stations 1 and 2 have a total coliform count greater than 1.0 x 10^3 MPN per 100ml of the DENR standard, while water sample from station 2 had the lowest total coliform count of 1.62 MPN per 100ml. In fecal coliforms on the other hand, water samples is ranging from 0.55 MPN/100mL to 3.23 MPN/100mL. Samples from stations 1 and 3 have greater count than the DENR standard of $2.0x10^2$MPN per 100mL and station 2 water sample had the lowest count of fecal coliforms of 0.55 MPN/100 mL. These results are possible because of the wastes that leach from industrial wastes and eroded pollutants from water for station 1; animal wastes and domestic sewage for station 2 and wastes from piggery and poultry farms for station 3. The presence of these coliforms would indicate that water in Dipolog Bay is polluted and indicating that the water quality is deteriorating.

Conclusion

The physico –chemical parameters of seawater (except for turbidity and total suspended solids (TSS) in station 3) were found within the permitted levels of DENR standards. Higher values of some of the physico- chemical parameters were attributed due to the wastes or effluents that come from household sewage, industrial, commercial and agricultural activities in Dipolog bay. The nutrients content such as nitrates were within the limits under the DENR standard. However, high nutrient content of phosphates were found in the three stations especially at station 1. The sources can be urban wastes discharged from the surrounding area, commercial buildings, untreated sewage discharged from vessels and others. Relatively high nutrient content in bay is an indicator of pollution factors that need a constant monitoring of the physico -chemical parameters to remain in control the water quality of Dipolog Bay. The results showed that the water in Dipolog Bay is deteriorating. The presence of fecal coliforms and heterotrophic plate count will indicate that the water in Dipolog bay is not suitable for human utilization, thus require proper treatment and soothing measures. Based on the three station sampling results, and as compared to the DENR standards, Dipolog Bay does not qualify for coastal water suitable for fishing, commercial purposes and tourist zones (Class SA) and for Class SB coastal water for recreational water class 1 (areas for bathing, swimming, skin diving, boating, etc).

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