



Assessment of water quality parameters in and off Vadinar and Sikka, Gulf of Kachchh, India

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Abstract

Water quality parameters in and off Vadinar and Sikka have been assessed thoroughly in the intertidal and subtidal areas of Vadinar coast during the year 2016. Since the southern coast of Gulf of Kachchh is a hub of industries like petroleum refineries, fertilizer industries, cement industries and the effluents from these industries are being mixed with the offshore waters of GoK, four different locations were selected including 2 intertidal and 2 subtidal. The study was conducted for a period of one year during January 2016 to December 2016. The average pH was 7.8, temperature 29.36, salinity 39.27, total dissolved solids 39.86, total suspended solids 106.68, dissolved oxygen 5.93, biological oxygen demand 2.46, chemical oxygen demand 33.09, petroleum hydrocarbons 2.3 and phenolic compounds 0.4 were recorded in the present study. Also the current scenario is compared with the prevailing conditions of Gulf of Kachchh.

Keywords: Marine water, offshore, gulf of Kachchh, physico-chemical, petroleum hydrocarbon.

Introduction

Gulf of Kachchh is a water body lies in west to east direction, situated between Kachchh and Saurashtra with 163km long right from Okha to Navlakhi and 73.2km wide at the mouth. The total area of GoK covers around 7363square kilometers. The tidal amplitude is 4.5m in the mouth of Gulf of Kachchh and increases to 7.2m in the inner Gulf near Kandla¹. The waters of northern coast of GoK is always turbid with high suspended solid loads (up to 1500mg/L) as inflow from the Indus river travels towards the inner Gulf². The waters of Southern coast of GoK is comparatively clear with less turbidity or suspended solids (around 100mg/L).

The water quality study deals with the physico-chemical and biological characteristics of water and its relationship to all other hydrological properties³. Vadinar and Sikka are the coastal villages of Jamnagar district located at the southern coast of Gulf of Kachchh, which holds oil terminals of various industries. The single point mooring systems (SPM) of different industries are situated in the different areas off Vadinar and Sikka. The petroleum refineries and crude oil terminals present in this region, made a long pipeline from these SPMs to pump the crude oil from cargo tankers to their crude oil terminals. Hence in order to understand the influence of various activities in this region, the study was designed to envisage the water quality parameters in offshore and intertidal locations for various physico-chemical parameters. In this present study, the water quality parameters of subtidal and intertidal areas of Vadinar and Sikka were analyzed and discussed with the previous studies.

Materials and methods

A total of 4 stations (viz. Subtidal Stations ST-1 and ST-2; Intertidal Stations IT-1 and IT-2) were selected for the monitoring of marine environment off Vadinar. These stations were selected with reference to the presence of various petroleum oil based industries and its' SPMs. The samples were collected during January 2016 to December 2016.

Sampling procedure: Surface water samples for the study were collected using a clean polyethylene bucket and Niskin sampler was used to collect bottom water samples. For shallow intertidal regions, only surface water samples were collected. A glass bottle of One liter capacity was used for collecting water samples at one metre below the surface, for the estimation of Petroleum hydrocarbon (PHc). Temperature was recorded using a standard mercury thermometer (°C).

Methods of analyses: Majority of the water quality parameters were analysed within 24h of collection. Colorimetric measurements were made on a Shimadzu Spectrophotometer. Shimadzu (Model RF-5301 PC) fluorescence Spectrofluorometer was used for estimating PHc. The analytical methods of estimation were as follows:

pH and Temperature: A Thermo fisher pH/EC/Temperature meter was used for pH and Temperature measurements. The instrument was calibrated with standard buffers just before use.

Salinity: A suitable volume of the sample was titrated against silver nitrate (20g/L) with potassium chromate as an indicator. The chlorinity is estimated and from that salinity values were derived using formula.

Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD): DO was determined by Winkler's method. For the determination of BOD, direct unseeded method was employed. The sample was filled in a BOD bottle in the field and incubated in the laboratory for 3 days after which DO was again determined and the difference was calculated.

Chemical Oxygen Demand (COD): Chemical Oxygen Demand (COD) of the water samples were estimated by acidifying a known quantity of sample with sulphuric acid to reduce the pH. The organic matter in the sample was oxidized completely by potassium dichromate ($K_2Cr_2O_7$) in the presence of H_2SO_4 to produce CO_2 and H_2O . The excess $K_2Cr_2O_7$ remaining after the reaction was titrated with sodium thiosulphate, using starch as indicator. The volume of dichromate consumed gives the oxygen required for oxidation of the organic matter.

Total Dissolved Solids (TDS): The samples were subjected for gravimetric procedure for confirmation of the readings obtained from the hand held meter. About 100mL of the water sample was taken in a beaker and filtered which was then dried totally in a Hot Air Oven ($105^\circ C$). TDS values were calculated using the difference in the initial and final weight.

Total Suspended Solids (TSS): The samples (100mL) were filtered through a dry pre-weighed filter paper and the filtered contents were weight to bring out the final weight. TSS values were calculated using the difference in the initial and final weight.

Petroleum Hydrocarbons (PHc): Water sample (1L) was extracted with hexane and the organic layer was separated, dried over anhydrous sulphate and reduced to 10mL at $30^\circ C$ under

low pressure. Fluorescence of the extract was measured at 360nm (excitation at 310nm) with Saudi Arabian crude residue as a standard. The residue was obtained by evaporating lighter fractions of the crude oil at $120^\circ C$.

Phenols: Phenols in water (500mL) were converted to an orange coloured antipyrine complex by adding 4-aminoantipyrine. The complex was extracted in chloroform (25 ml) and the absorbance was measured at 460nm using phenol as a standard.

Results and discussion

Throughout the study period, pH remained alkaline in all the stations with post monsoon registering maximum whereas minimum values were recorded during monsoon. The average pH was recorded in all the stations are 7.8, with a range of 7.5 to 8.1 (Figure-1). During the study period water temperature was around 25.4 to 32ppt with an average of 29.36ppt (Figure-2). Salinity was recorded in the range between $36.7^\circ C$ and $44.3^\circ C$ with a mean of $39.27^\circ C$ (Figure-3). There was a significant fluctuation in the dissolved oxygen in all the four sites and it was studied in the range of 5 to 6.8mg/L (Figure-4). Biological oxygen demand was recorded in a range of 1.4–3.2mg/L, and average BOD was found to be 2.46mg/L (Figure-5). Chemical oxygen demand was found in a range of 18–52mg/L with an average of 33.09mg/L (Figure-6). Petroleum hydrocarbon analysis was carried out and the values were in the range of 0.36–12.6 $\mu g/L$ with an average of 2.3 $\mu g/L$ (Figure-7). Phenolic compounds were in the range between 0.5 $\mu g/L$ and 1.0 $\mu g/L$ (Figure-8). Total suspended solids were recorded at the average of 106.68mg/L (Figure-9) and average total dissolved solids were found to be 39.86g/L (Figure-10).

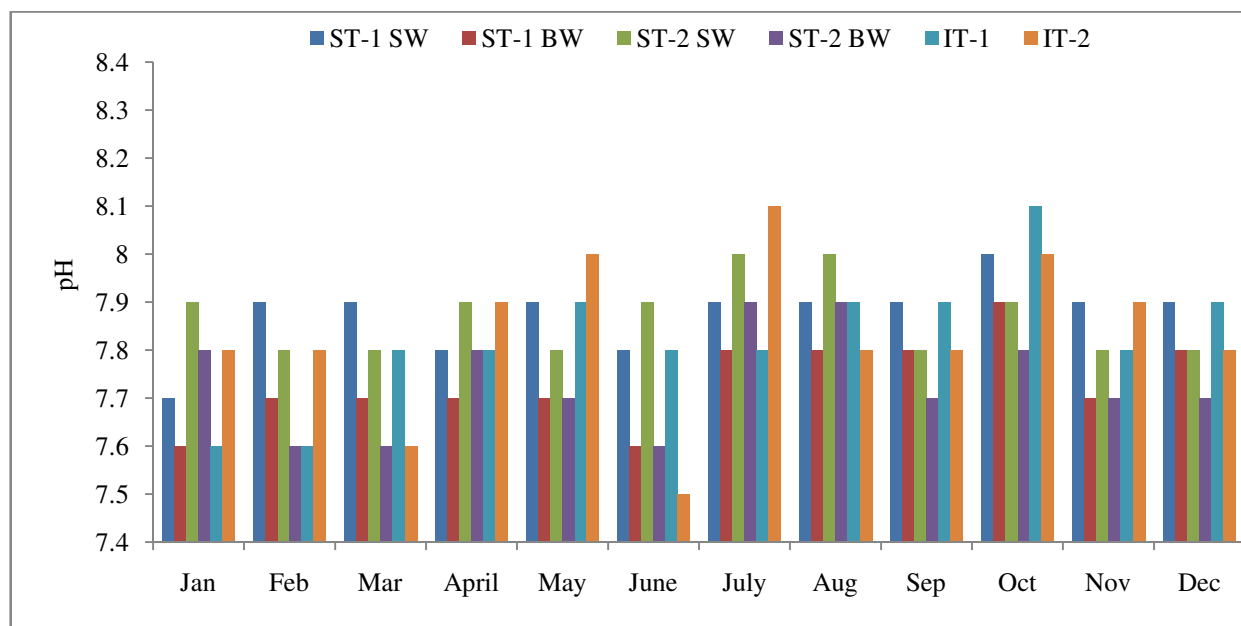


Figure-1: pH values at the study stations for the period of January'16 – December'16.

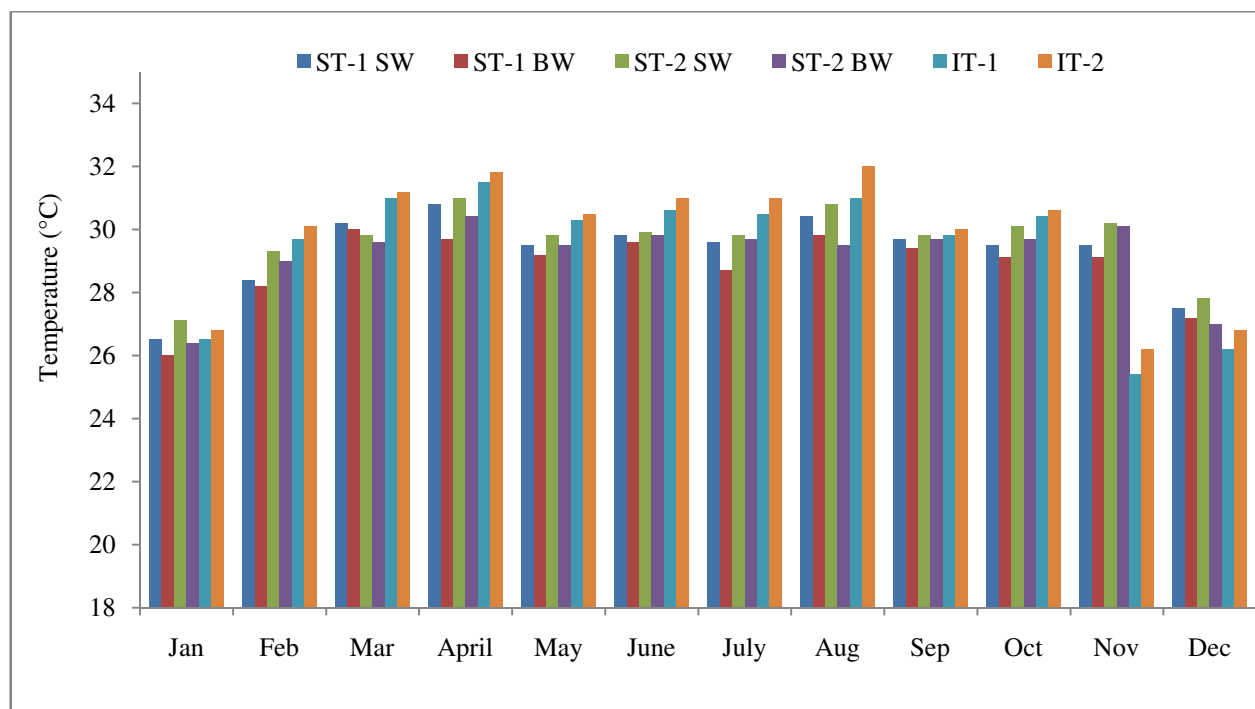


Figure-2: Temperature at the study stations for the period of January'16 – December'16.

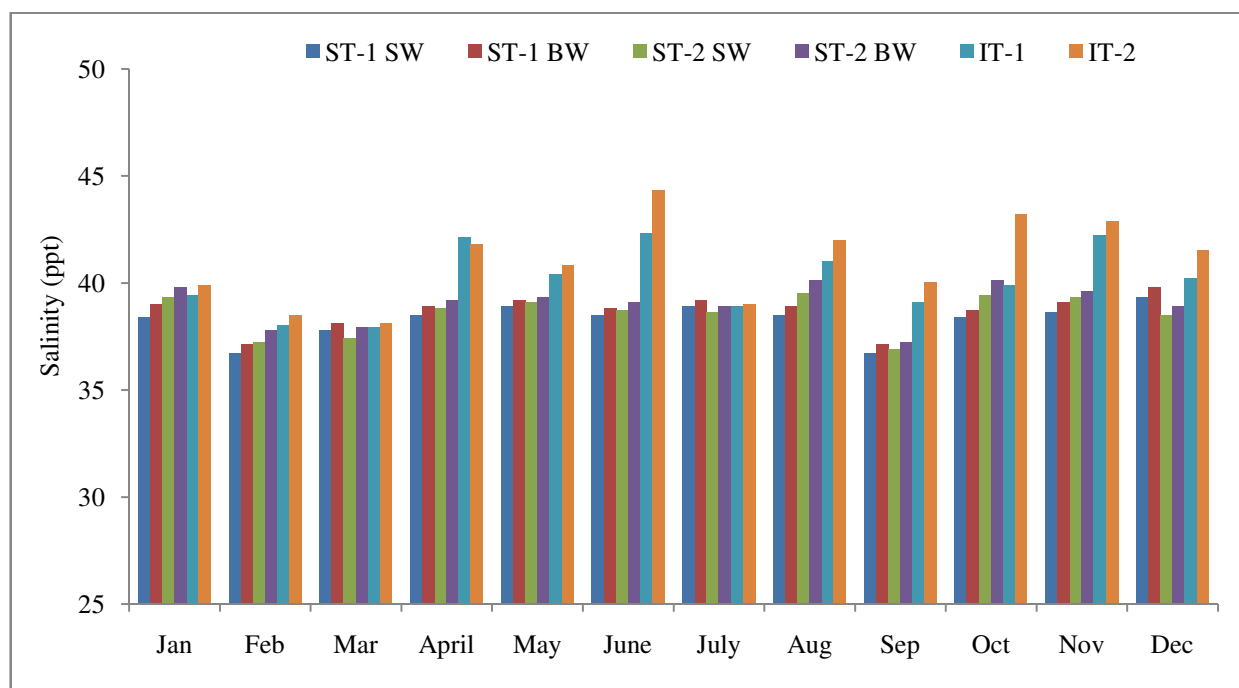


Figure-3: Salinity at the study stations for the period of January'16 – December'16.

During the recent days water resources especially of marine origin are under major threats due to the exploitation or pollution by the various activities including anthropogenic sources as major. To conserve the human health and an array of marine life forms, this should be taken as a serious concern to protect the aquatic ecosystems⁴. Coastal area is the most dynamic and productive ecosystems and are also foci of human

settlements, industry and Tourism⁵. Thus the water quality plays a vital role in well being of humans, animals and plants inhabiting the area⁶. The quality of the surface water within a region is influenced by natural processes and anthropogenic activities⁷ as well and reliable information on water quality can be gathered by conducting regular monitoring programs by assessing the Physico-chemical characteristics⁸.

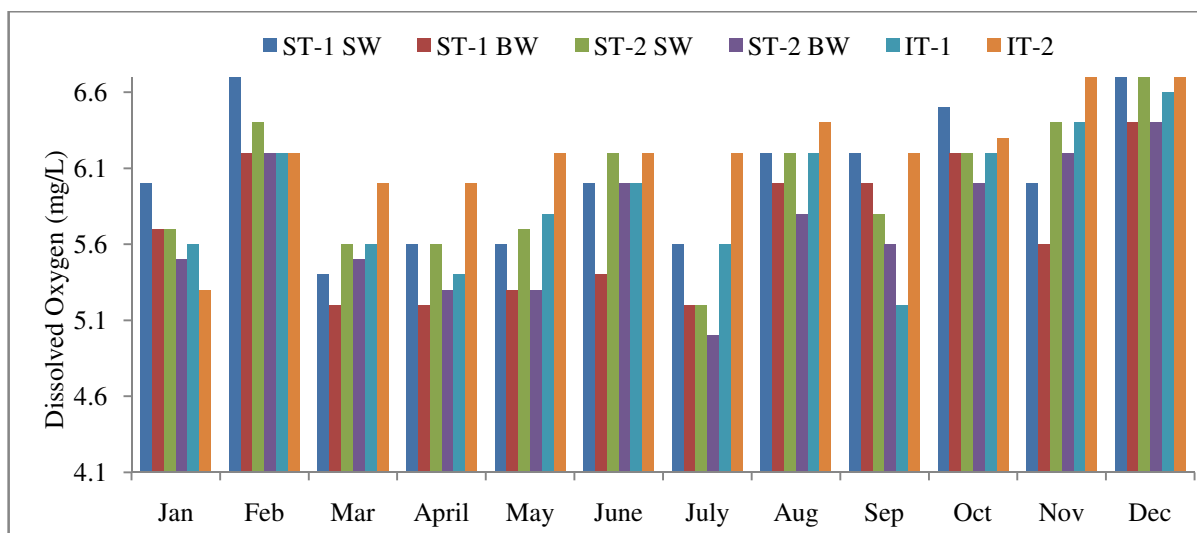


Figure-4: Dissolved Oxygen at the study stations for the period of Jan'16 – December'16.

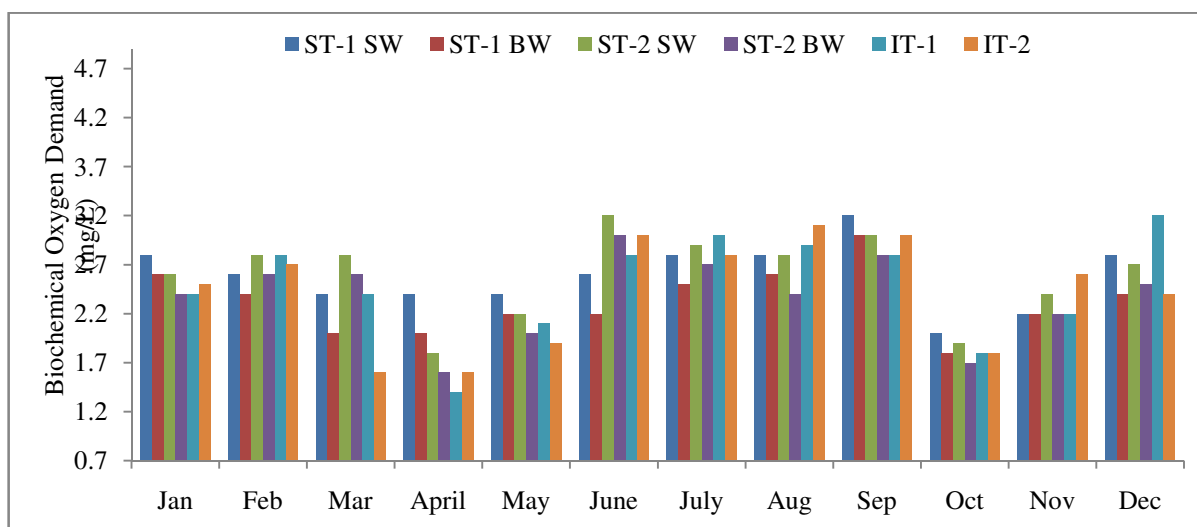


Figure-5: BOD at the study stations for the period of January'16 – December'16.

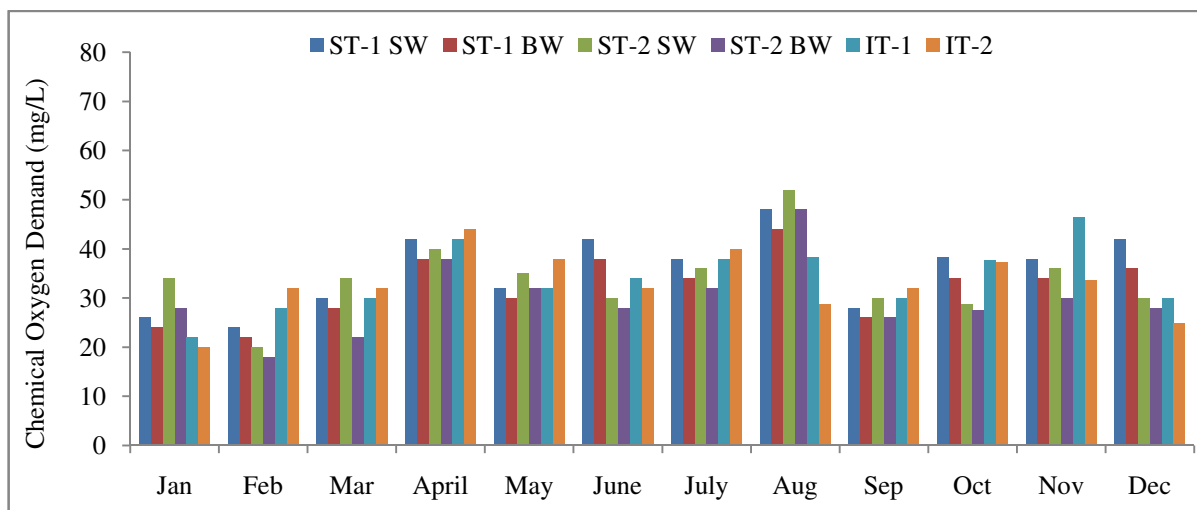


Figure-6: COD at the study stations for the period of January'16 – December'16.

Results of the physico-chemical study carried out in the coastal waters in and around Vadinar and Sikka of Gulf of Kachchh is discussed in detail. Major objective of our study is to monitor the coastal water quality in southern GoK coastal stretch and its health. For this purpose, 10 physico-chemical parameters of the surface and bottom water was analyzed in 4 stations on monthly basis for one year from January 2016 to December 2016. A similar study⁹ was conducted where 9 water quality parameters for the period of November 2010 to October 2011.

In their study, pH was recorded around 7.5 to 8.5, but in our present study the maximum value was recorded as 8.1 at IT-2,

indicating that pH is well within the range as compared¹⁰. Dissolved oxygen and biological oxygen demand ranges between 5–6.8mg/L and 1.4–3.2mg/L respectively in the present study indicates that there is no significant microbial contamination by the freshwater input in the Vadinar waters¹¹. Since the dissolved oxygen did not go below 3.5mg/L, there is no threat for marine live forms¹². Chemical oxygen demand was within the range of 18–52mg/L, indicates the water is healthy without any contamination with the any chemical substances, but the similar study⁹ conducted in the same area during 2011 showed the maximum COD of 40mg/L.

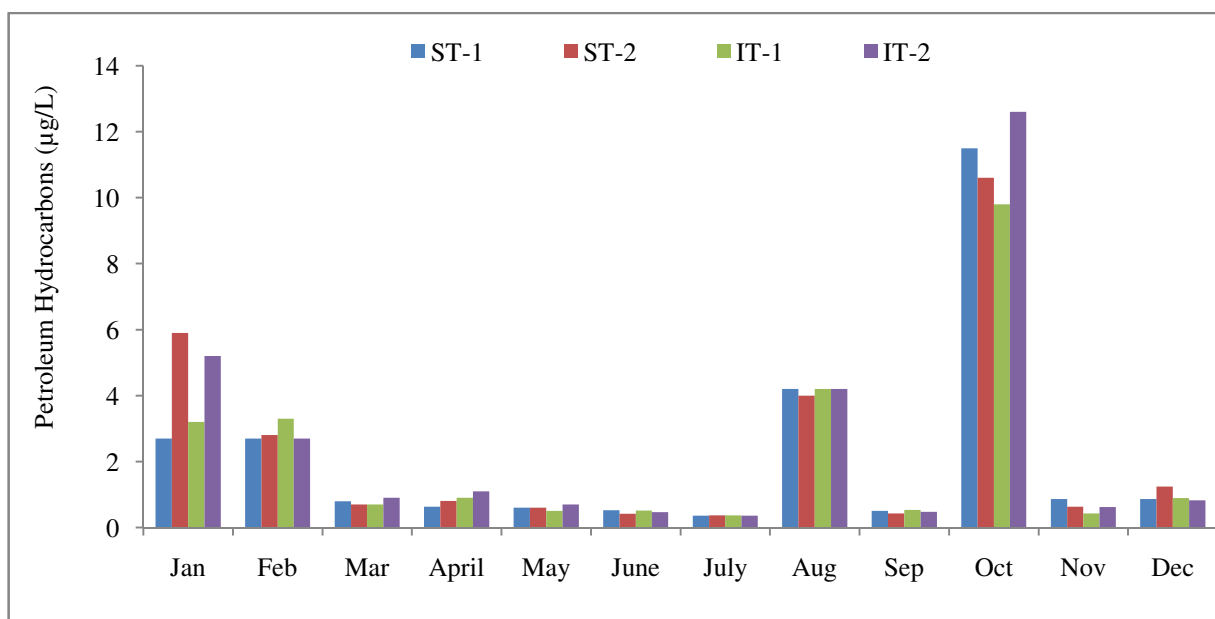


Figure-7: PHC at the study stations for the period of January'16 – December'16.

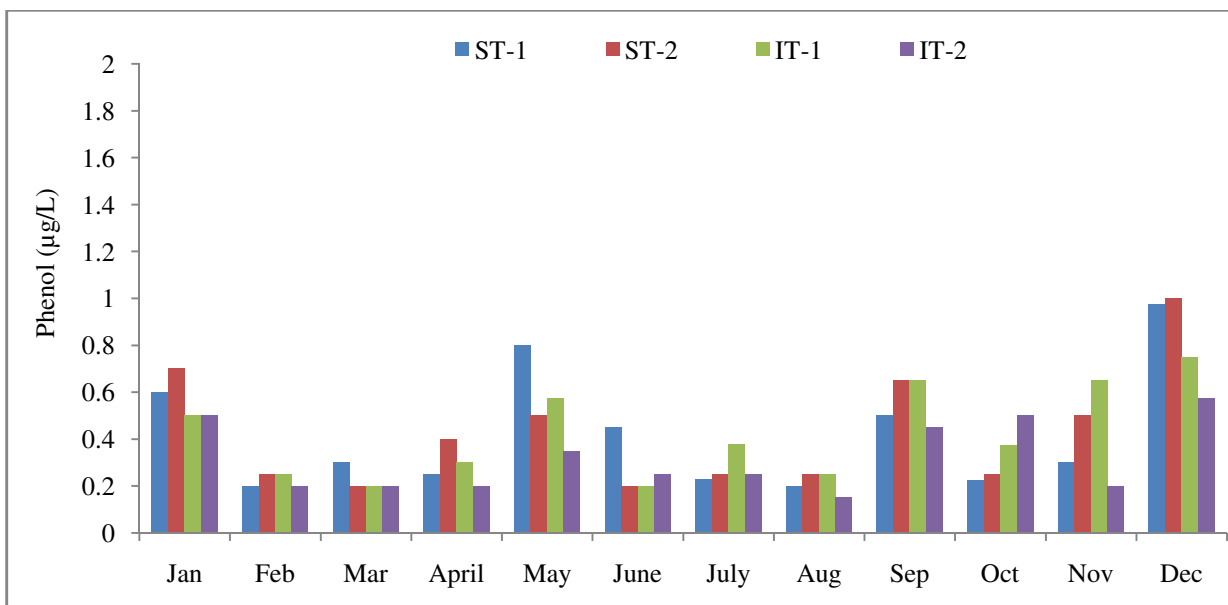


Figure-8: Phenolic compounds at the study stations for the period of Jan'16 – December'16.

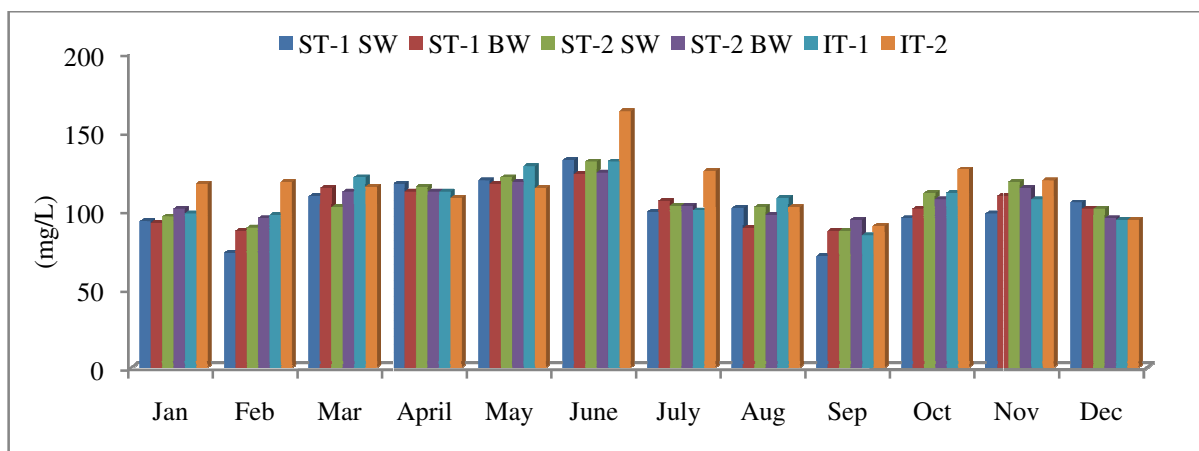


Figure-9: TSS at the study stations for the period of January'16 – December'16.

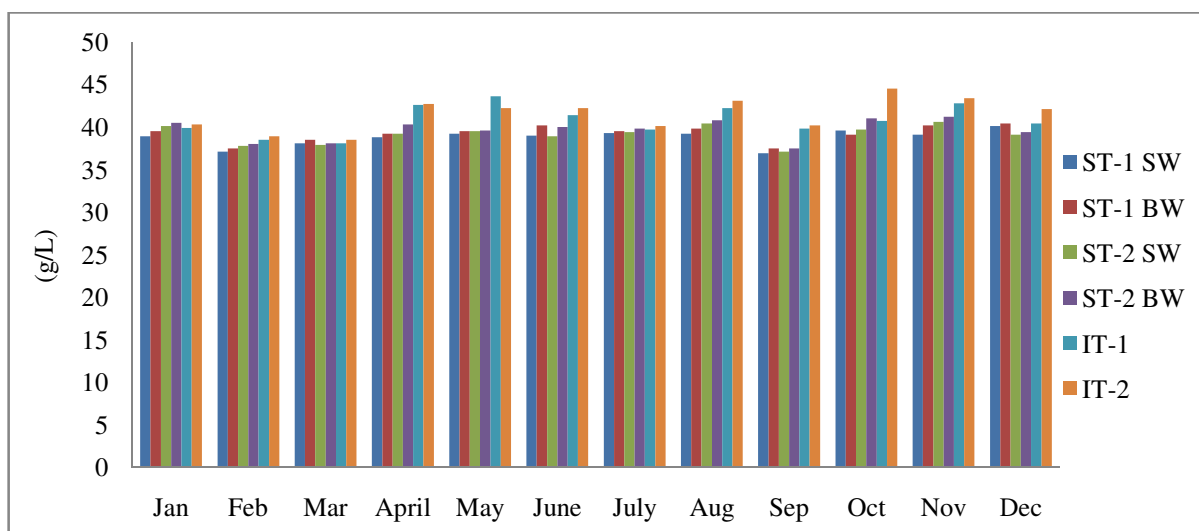


Figure-10: TDS at the study stations for the period of January'16 – December'16.

Petroleum hydrocarbons (PHC) and phenolic compounds were thoroughly studied in Vadinar waters showed the maximum of 12.6µg/L and 1.0µg/L respectively. The results clearly indicated that there is no gross contamination by the industrial pollutants¹³. Total suspended solids were recorded in the range of 71–163mg/L with an average of 106.7mg/L shows the water is more clearly compared with the waters of Kandla which present in Gulf of Kachchh². Due to the increased salinity, total dissolved solids were recorded with an average of 39.86g/L in the Vadinar and Sikka waters and this was compared with the earlier studies conducted in Sikka water showed the average of 37g/L in some sampling sites⁹.

Conclusion

The sampling sites fixed for the present study are in the industrial vicinity of Gulf of Kachchh between Vadinar and Sikka region. Similarly, intertidal locations were also selected considering the influence due to various activities. In this study, 10 different physico-chemical parameters were analyzed in

Vadinar and Sikka waters at four different sites. As a whole, the results revealed that the water quality registered in this region are in a healthy state without any cross contamination due to industrial pollutants.

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