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# Impact of sewage and industrial pollution on the hydrographic conditions of seawater in Gwadar (East Bay), Balochistan

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**Abstract**

Hydrographic conditions of seawater play an important role in the marine ecosystem. Today oceans and seas are under tremendous threat and pressures due to increase in man-made activity around the coastal areas like industrialization. To know the impact of these activities on hydrographic conditions (such as colour, temperature, salinity, pH, dissolved oxygen and biological oxygen demand) in surface seawater and deep seawater of Gwadar East Bay was studied during the month of September, 2017. For this samples were taken from six stations, three stations from each of surface seawater and deep seawater. The hydrographic parameters of seawater showed considerable tidal variations. On the basis of data it was concluded that the variations were found between all six stations of both surface seawater and deep seawater. It is also noted that significant correlations were found in between temperature, salinity and dissolve oxygen. Analysis of variance reveals that the results of each parameter were not constant but varied between stations and collection time. The present study is reveal that physic-chemical composition of Gwadar East Bay seawater depends on tidal, depth and discharge of sewage and waste materials from different sources.

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## Introduction

Studies on the hydrographic conditions or physico-chemical properties of the seawater in different marine areas for various goals are found in the literature. Eswari et al. [1] studied physic-chemical analysis of two different water bodies of Marine Beach Chenna, along the Bay of Bengal whereas Clara Jeyageetha and Kumar [2] described the physico-chemical parameters of seawater in Tuticorin Coastal areas, India. Sekar et al. [3] have studied impact of industrial pollution on the physico-chemical characteristics of seawater in Thoothukudi coastal area, Gulf of Mannar. Khan et al. [4] surveyed the benthic community of Gwadar East Bay of Balochistan. Saleem and Khan (1999) [5] found high concentrations of heavy metals in the sediment of Gwadar East Bay. Nair and Balchand [6] described the hydrographic properties (temperature, salinity, pH, and dissolved oxygen) in the mud bank area of south west of India. Some hydrographic parameters in a tidal creek opening in the Bay of Bengal (India) reported by Mitra et al. [7]. De Sousa and Singbal [8] studied relationship between nutrients and dissolved oxygen in the central basin of the Arabian Sea. Naqvi et al. [9] worked on a relationship between nutrients and dissolved oxygen with special reference to water masses in the western Bay of Bengal. Gupta et al. [10] studied hydrographic features of the Northern Basin of the Arabian Sea. Ganapati et al. [11]

studied the vertical distribution of chemical constituents in the shelf waters off Waltair India.

The Gwadar East Bay is situated at 24°07'35" N 62°19'21" E on the southwestern coast of Arabian Sea, approximately 710 km West of Karachi. It is still undisturbed area and it is not easily accessible although it is chief port and Fish harbour (covered area: 30 hector) due to lack of investment, security concern etc. The area is highly productive and red tide blooms have been observed in the winter monsoon period (Rabbani et al. [12]. Recently a number of industries have been developed around the Gwadar East Bay for example Gel mineral water plant, Al Makran Ice factory, Mir seafood companies and Desalination plant. At the East Bay of Gwadar boat building and repairing is also continues. At Gwadar China Power Company Head Sho set up for 300 megawatts coal based power plant is ready. The hydrographic studies of the Gwadar coast have not been made at the present stations although some studies related to other areas of Gwadar coast have been made [4,5,12] Hence the present study was undertaken to know the seawater quality of East Bay Gwadar through the analysis of hydrographic conditions of seawater samples collected from different stations for describing the pollution status in this area.

## Materials and Methods

### *Site*

Gwadar Port is the third port of Pakistan situated on the South Western coast of Balochistan. The city is located on the shores of the Arabian Sea about 710 km to the West of Pakistan's largest city Karachi. Gwadar is near the border with Iran and is located to the east of the Persian Gulf and opposite Oman. The rocky headland of Gwadar town connected to mainland. The population of Gwadar is over 120,000. More than 50% of the population is engaged in fishing activity. The fishermen's boats occupy a very large stretch of the East Bay where fish landing and boat building and repairs take place. About 400 boats (mostly small) are busy in fishing in the territorial waters. Different type of fauna and flora are found such as Gastropods, Bivalves, Arthropod, Echinoderm, Annelids and algae [4]. In Gwadar heavy metal minerals are found in the range of 1-0.15% (Memon and Ali [13].

### *Sample Collection*

The samples of seawater were collected in the month of September, 2017 from three stations of East Bay of Gwadar near to mini port, Balochistan (Figure 1). The stations were randomly selected in the surface and depth (1.5 M) at low water mark. Temperature and pH were noted on sites. Samples for salinity were collected in salinity bottles where as samples for dissolved oxygen and Biological Oxygen Demand (BOD) were taken in respective oxygen bottles (100 mL).

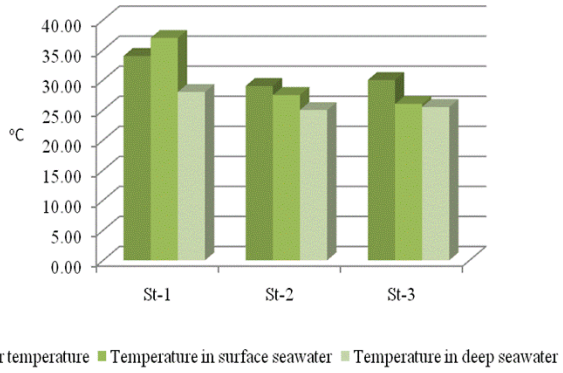


**Figure 1**: Variation in temperature of air and seawater at three stations of Gwadar East Bay.

### *Analysis*

Temperature of air and seawater from all stations of surface and depth were recorded, using mercury thermometer. pH of seawater samples was measured with the help of pH paper at the collection time of each sampling. Salinity was measured by the hand-holding Refractometer. Winkler titration method, used for the determination of dissolved oxygen concentration in seawater Martin, [14]. For determination of BOD the direct method of Rodier, [15] and Marr and Cresser, [16] were used.

## Result and Discussion

There was large variation found in the values of hydrographic conditions of seawaters collected from three stations at each surface and deep seawater of Gwadar East Bay. The detail account of hydrographic conditions for all six stations at surface seawater and in deep seawater of Gwadar Bay is given in Figures 2-6. The seawater colour was greenish blue and odour was more or less stinky. Temperature is the physical property which is most easily measured especially sea surface

temperature by La Fond, [17]. The air temperature was varied from 29°C to 34°C with the mean value of 31 ± 2.64°C at all three stations of surface seawater of Gwadar East Bay throughout the study period. The temperature of surface seawater ranged from 26-37°C with the mean value of 30.17 ± 5.97°C. The temperature of deep seawater ranged from 25.0°C to 28°C and the mean was 26.17 ± 1.61°C. The results of temperature for surface seawater and deep seawater showed that in deep seawater samples, temperature was low as compared to surface seawater (Figure 2).

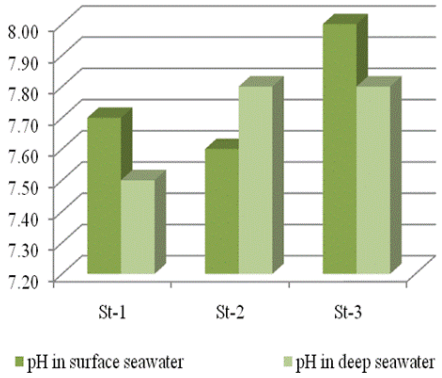


**Figure 2:** Variation in pH of seawater at three stations of Gwadar East Bay.

The pH of surface seawater ranged from 7.6-8 and the mean was 7.8 ± 2.84 and in deep seawater pH range was 7.5-7.8 with the mean value of 7.7 ± 0.17. An increase was observed in pH of surface seawater at stations 1 and 3 whereas at station 2 pH of deep seawater was high as compared to surface seawater (Figure 3). The salinity of surface seawater ranges from 39-41% and the mean was 40 ± 1.0% whereas 37-39% ranges for deep seawater with mean concentration of 38 ± 1 at Gwadar East Bay (Figure 4).

The dissolved oxygen in surface seawater ranged from 1.7-2.84 mL $L^{-1}$ and the mean was 2.27 ± 0.57 mL $L^{-1}$ whereas for deep seawater the dissolved oxygen range was 2.27-2.84 and the mean was 2.6 ± 0.3 mL $L^{-1}$ (Figure 5). In surface water the dissolved oxygen concentration was high as compared to the deep seawater. The BOD of surface seawater of Gwadar East Bay ranged from 0.56-0.62 mL $L^{-1}$ with the mean value of 0.6 ± 0.03 mL $L^{-1}$. In deep seawater BOD ranged from 0.62-0.97 mL $L^{-1}$ with the mean of 0.77 ± 0.18 mL $L^{-1}$ during the study period (Figure 6). At surface seawater BOD value was low as compared to the deep seawater.

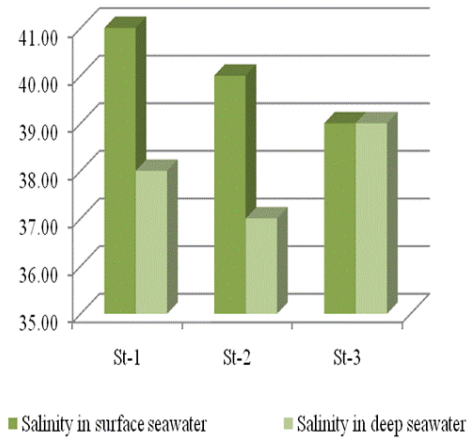


**Figure 3:** Variation in salinity of seawater at three stations of Gwadar East Bay.

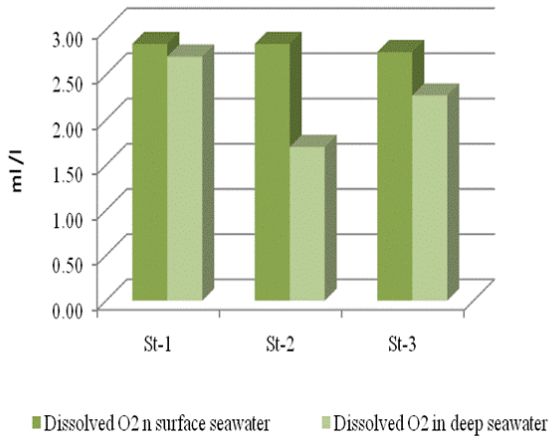


**Figure 4:** Variation in dissolved oxygen of seawater at three stations of Gwadar East Bay.

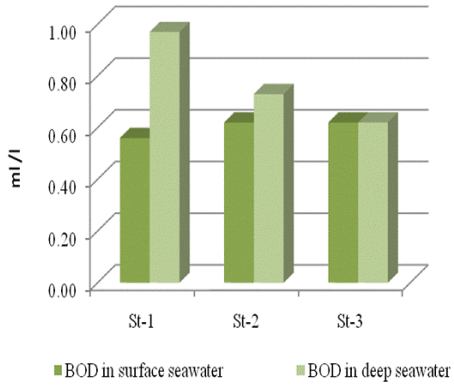


**Figure 5:** Variation in biochemical oxygen demand of seawater at three stations of Gwadar East Bay.

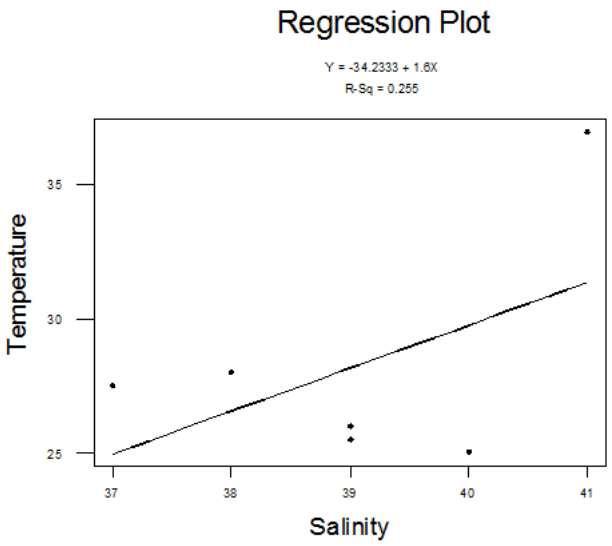


**Figure 6:** Relationship between temperature and salinity of seawater collected from Gwadar East Bay.

The results of two way Analysis of Variance (ANOVA) in hydrographic condition of seawater from all studied stations of Gwadar East Bay show that there was significant variations observed in salinity in between surface seawater and deep seawater ($p<0.05$). There was significant correlation observed in between seawater temperature and salinity ($r^2=0.505$) and temperature and dissolved oxygen ($r^2=0.640$) (Figure 7).

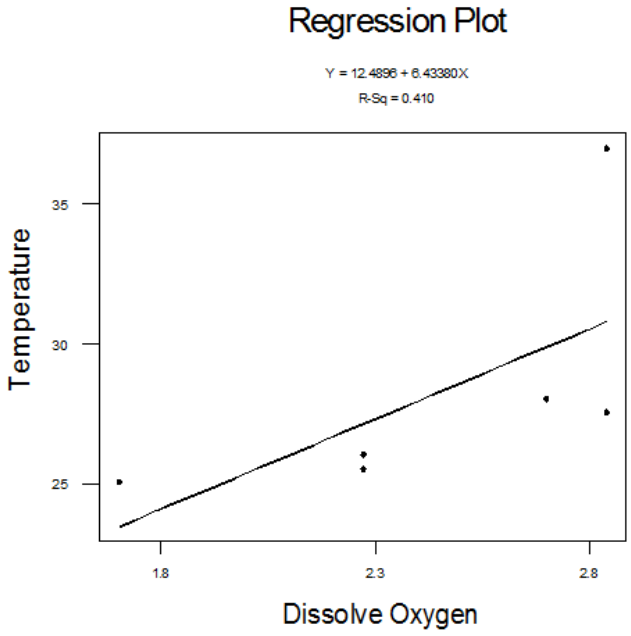


**Figure 7:** Relationship between temperature and salinity of seawater collected from Gwadar East Bay.

The variation in temperature in present study was also similar to the earlier observations made along the coast of Karachi (Qari and Siddiqui, [18]; Hussein and Samad, [19]). The present study result showed that temperature of surface seawater was high like air temperature. Sekar et al. [3] reported that surface seawater temperature is governed by atmospheric temperature. The present results of temperature and pH agree with the previous observation for the same locality made by Khan et al. [4]. The pH (7.5-8) of present work was similar to the values obtained by Sekar et al. [3] for the seawater of Thoothukudi coastal areas in the Gulf for the surface water of Madras, India; for Karachi harbour and Rizvi et al. [20] for Bakran Creek. Precipitation and evaporation are the two processes which affected the salinity concentration. The present study was conducted in the month of September. In Pakistan the period July-September is counted for rainy season and in rainy season salinity decreased due to large amount of fresh water discharge (Hussein et al. [21]. The present result showed high salinity concentration (39-41% for surface seawater and 37-39% for deep water) indicated shallowness of water and the effluent discharged from the industries nearby [3]. Rabbani et al. [12] reported that Gwadar Bay is still has no proper drainage and sewerage system. All effluents and waste material dumped directly into the sea. Hussein et al. [21] described that variation of salinity in surface seawater and deep seawater were related with season. The present results of salinity almost agree with the previous work of Dass et al. [22] for India, Rizvi et al. [20] for Karachi harbour, Hussein and Samad [19] for Sandspit, Karachi and Qari and Siddiqui [18] for Nathia Gali, Karachi. Arabian seawater especially in the Northern part characterized by a relatively low content of dissolved oxygen. In present study low concentration of dissolved oxygen (1.7-2.84 mL $L^{-1}$) may be due to the anthropogenic activities such as industrial wastes and sewage discharged causes eutrophication which is characterized by excessive algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis such as sunlight, carbon dioxide and nutrients [23]. In present investigation the seawater colour was greenish blue and odour was more or less stinky. Which is due to dead algal plants (phytoplankton and seaweeds), when they decomposed by bacterial action produced an aromatic gas Dimethyl Sufide (DMS). The

oxidation of organic material, intense upwelling and high temperature of seawater also reduced the dissolved oxygen in seawater [24].

## Conclusion and Recommendation

The present observation forms a baseline study in the area of Gwadar Bay. The present study shows that a number of industries like Gel mineral water plant, Al Makran Ice factory, Mir seafood companies, China Power Company and Desalination plant salt disposal affect the quality of sea water by direct discharge of effluents which are multi-component waste with multiple effects on water sediments and marine organisms. Apart from this land drainage, sewage and high temperature increased sedimentation rate and affect the marine ecosystem. Hence, it is necessary all effluents should be treated properly before released into the sea for the safety of marine environment.

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