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Research Article

Assessment of Physico-Chemical Parameters and Its Influence on Marine Organisms along the Nellore Coast, Southeast Coast of India

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Abstract: Twelve water and sediment samples along the Nellore coast, Southeast coast of India were collected. The physicochemical properties from water samples were determined. The results for the studied parameters revealed that the water composition of the study area is pH 7.3-8.8; TDS 36.17-46828 ppm; Salinity 28.92-47.17 ppt; DO 16.56-35.13 ppm; Ca 467.5-1577.5 ppm; Cl 16012-26112 ppm; Na 3225-17355 ppm; K 85.2-218 ppm. The study of benthic foraminifera from the sediments distinctly reveals the occurrence and abundance of foraminifer assemblage dominated by *Ammonia dentata, A. beccarii, Quinqueloculina seminulum, Elphidium discoidale, E. crispum, Pararotalia nipponica,* and *Asterorotalia trispinosa.* This study forms the comprehensive attempt to employ benthic foraminifera as a bioindicator for assessing the environmental stress in the study area.
Keywords: Benthic Foraminifera, Physico-Chemical Parameters, Bioindicator.

Introduction

Benthic foraminifera are shelled, unicellular, eukaryotic microorganisms that are divers and abundant in marine sediments all over the world with more than 40,000 cited species (Loeblich and Tappan, 1987). They are commonly used by the geologists due to their abundance in the geological records from the Cambrian to the present times to study the environmental changes (Buosi *et al.*, 2010; Sreenivasulu *et al.,* 2017). Benthic foraminifera are increasingly used as bio-indicators of environmental stress in coastal and marginal marine environments (Jayaraju and Reddy, 1996; Nagendra *et al.*, 2005; Sundara Raja Reddy *et al.*, 2012; Sen and Bhadury, 2016). Their life span of weeks to months make their populations and assemblages sensitive indicators of environmental fluctuations, when compared to benthic macro fauna (Narayan and Pandolfi, 2010). Hence, changes in benthic faunal abundance, species diversity and variation in morphology of tests provide evidence for changes in environmental parameters (Alve, 1995; Nagendra *et al.,* 2015). Therefore, benthic foraminifera are consistent bio-indicators of natural environment and anthropogenic impacts, and are increasingly used in the monitoring of environmental health and balance in coastal and marginal marine ecosystems (Donnici *et al.,* 2012; Barras *et al.,* 2014). Their community structure provides useful information on the general characteristics of the environment quality and more species are sensitive to specific environmental parameters (Frontalini *et al.,* 2009).

The biochemistry of a water body is heavily influenced by physicochemical characteristics. Subtle changes in physical conditions can have a significant impact on the water quality of the studied system, affecting the geographical and temporal distribution of nutrients and/or biological populations. As a complex system, the marine environment is primarily influenced by physicochemical and biological processes. In recent years, industrial operations, economic upwelling, and urbanization in cosmopolitan city centers across the world have developed fast, and

huge amounts of pollution has been pushed and flushed into rivers, estuaries, and marine marginal water bodies (Ravichandran and Manickam, 2012). The scientific community is paying more attention to estuarine sediment contamination, which is known to contribute greater measure to the ecosystem health stress (Riba *et al.*, 2002). Marine water, which serves as a habitat for many aquatic organisms, is contaminated with a variety of harmful and poisonous compounds, including heavy metals. As a result, they are regarded as key carriers and serve as sinks of pollutants (Ho *et al.*, 2010). This reflects the system's current quality thus providing information on the pollution status and sources. Thus, this serves as a natural archive of recent changes in environmental settings (Kruopiene, 2007).

Study Area

The study area, which includes the Pennar, Uppateru, Swarnamukhi, and Kalangi Estuaries, is depicted on Survey of India topo sheets nos. 66 B/2, 66 B/3, and 66 C/2 at a scale of 1:50,000. Longitudes 80º 08' - 80º 11' 54" E and latitudes 13º35'-14º 36'13" N define the study area (Figure 1). Average annual rainfall in the study area is 1058 mm and the average minimum and maximum temperatures are 22 ^{0}C and 42.6 ^{0}C respectively.

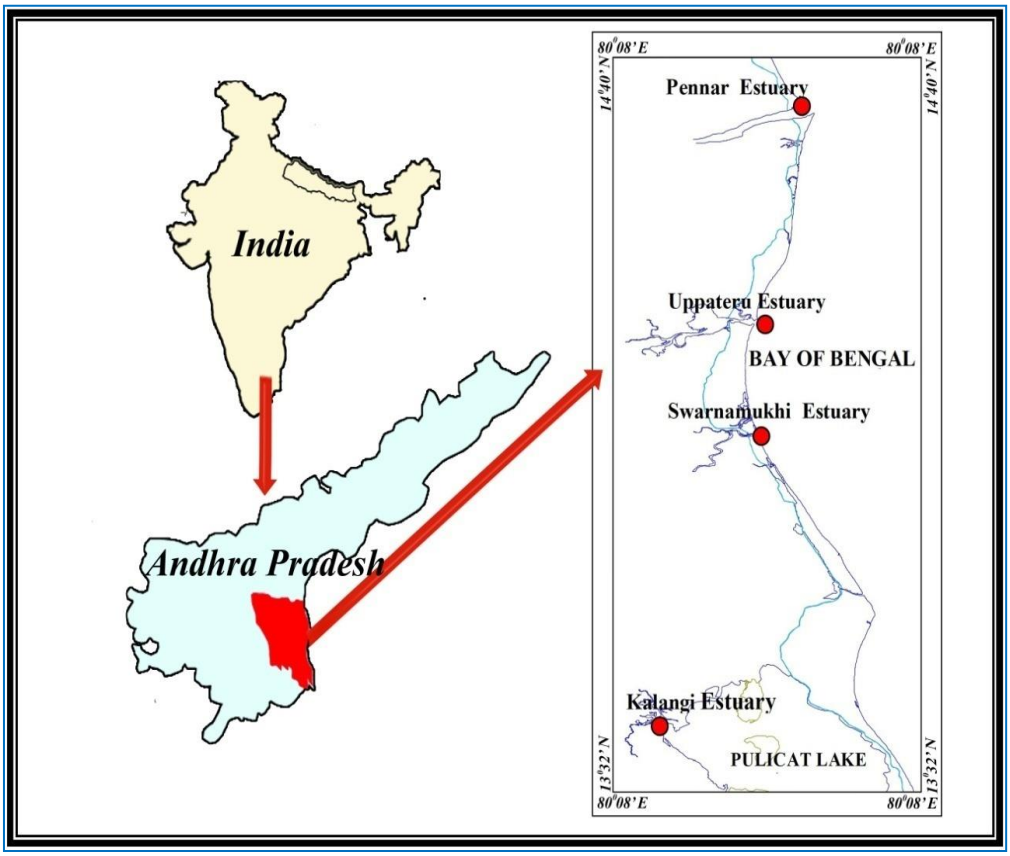

Figure 1. Location map of the study area

Methodology

From the four estuaries chosen for the study, a total of 12 samples of bottom water and sediment were collected using local automated boats. Shallow water samplers were used to capture the bottom water, and samples were then treated with nitric acid to make them acidic. The samples are then purified of particulates and collisions using filter paper before being placed in polyethylene bottles with tight stoppers and screw covers and indexed appropriately. Sediment samples were collected using hand held grab sampler for the benthic formainiferal analysis. For benthic foraminiferal analysis, sediments were washed over a 0.625 mm mesh to obtain samples devoid of fine silt and clay. Then the residue was air dried and nearly 50 g of sample obtained by coning and quartering. All subsamples were examined under a Nikon SMZ25 Motorised Stereo Zoom Microscope and foraminifer tests from each sample were picked using a Winsor Newton Sable Hair brush (“000”)

and identified following the taxonomic classification of Brady (1884), Loeblich and Tappan (1988), Foraminifera and gallery-illustrated catalog (www.foraminifera.eu), World Modern Foraminifera Database (www.marinespecies.org/foraminifera/) and Paleontologia Electronica Webmaster 1998-2015. The quantitative foraminiferal data were used for computing various statistical parameters from the bottom water, salinity was measured using Atago refracto meter (Arumugam and Sugirtha, 2014). Pye Unicam model 292 meter, (after standardization with buffer solution at pH 4.0, 7.0 and 9.0) was used for pH determination. Gravimetric (evaporation) method for TDS and EDTA Titrimetric method for Ca were used. Mohr titrimetric and chloride metric was used for Cl analysis and Flame photometer was used for Na and K. Dissolved Oxygen measured using standard laboratory methods (APHA, 1995).

Results and discussion

Physico-chemical Parameters

Physicochemical properties of marine water were determined according to the standards of the American Public Health Association (APHA) and other standard methods. The common physicochemical parameters of water like pH, Total Dissolved Solids (TDS), Salinity, Dissolved Oxygen (DO), Calcium (Ca), Chloride (Cl), Sodium (Na) and Potassium (K) have been determined. The variation in significant physicochemical parameters along these transects is shown in Tables 1 and Figure 2.

The pH represents the balance among various types of carbonic acid. These changes are accompanied by changes in other physicochemical parameters, which influence water quality. In the present study, pH ranged 7.3-8.8. The average pH of sea water is 8.09 however it can range from 7.5 to 8.5 based on the geographical conditions. TDS is typically low for freshwater sources, at less than 500 ppm. Brackish water and seawater contain 30–40,000 and 500–30,000ppm respectively. Human activities such as agriculture, water use, industry processes and mining can increase the TDS level in water body. Excess amount of TDS is hazardous to aquatic biosphere. In this study, TDS values ranged between 36.17-46824 ppm. Salinity in surface waters is reasonably steady around 3.6 percent, regulated by precipitation and evaporation.

In the study area, the salinity ranged 28.92-47.17. A variation the ranges of salinity were observed among the estuaries. Oxygen is required for respiration of biosphere including phytoplankton. They cannot survive for long in water with dissolved oxygen less than 5 ppm. The low level of DO in water indicates contamination and is an important factor in determining water quality. The highest value of dissolved oxygen 35.13 ppm was reported from the study area. DO range between 16.56 and 35.13 ppm. Seawater is reported to be almost saturated in calcium carbonate in the form of calcite or aragonite. Calcite is found in cooler seas, whereas aragonite is found in tropical conditions. Ca is a conservative element in saltwater, which implies that its concentration in current seawater is rather stable. In the present study, the calcium concentration was reported 467.5-1577.5.

Chloride is primary inorganic anions in both salt and freshwater. It is formed by the dissolution of salts in water, such as NaCl or $CaCl_2$. Contamination of chlorides in bottom water may occur as a result of adjacent salt storage or salty rocks, mixing of freshwater with sea water, dissolving of salty industrial wastes, and other factors. Chloride levels in brackish water in tidal estuaries can range between 500 and 5,000 ppm. The optimum limit of chloride in water is <250 ppm. 16012-26112 ppm was reported from the study area. Sodium (Na) is widely distributed cation in sea water.

Usually, the salts of the seawater are greatly of sodium (Na^+) and chloride (Cl^-) called NaCl. The Na:Cl ratio is usually altered near estuaries. In this study, Na ranged between 3225-17355 ppm. Potassium is the fourth most abundant cation, but its concentration is only a few percent that of sodium. Although K is rarely measured directly, it appears to have a very consistent connection with chlorinity. From the study area K ranged between 85.2 and 218 ppm.

Table 1. Physicochemical parameters from the study area

Sample	pH	TDS (ppm)	Salinity (ppt)	DO (ppm)	Ca (ppm)	Cl (ppm)	Na (ppm)	K (ppm)
1	7.5	40.95	36.1	22.22	1167.5	18437.5	13600	95
2	7.3	36678	28.92	26.66	1257.5	16,012	3518	194
3	7.5	36766	29.19	31.91	1387.5	16,162	3225	209
4	7.5	46878	32.94	16.56	1237.5	18,237	3479	218
5	8.8	36.17	42.56	19.79	1052.5	23562.5	6070	181.2
6	8.6	37.33	47.17	18.98	1577.5	26112.5	6196	180.3
7	8.6	40.95	36.1	22.22	1167.5	19987.5	5655	182.5
8	8.7	40.97	35.79	21.01	1162.5	19812.5	6239	181
9	8.1	41.7	33.3	19.79	467.5	18437.5	5198	104.8
10	8.1	39.49	33.35	18.98	492.5	18462.5	16352	100.7
11	8.2	36.38	33.48	19.79	502.5	18537.5	17355	85.2
12	8.2	41.58	33.3	35.13	452.5	18437.5	13865	106.7

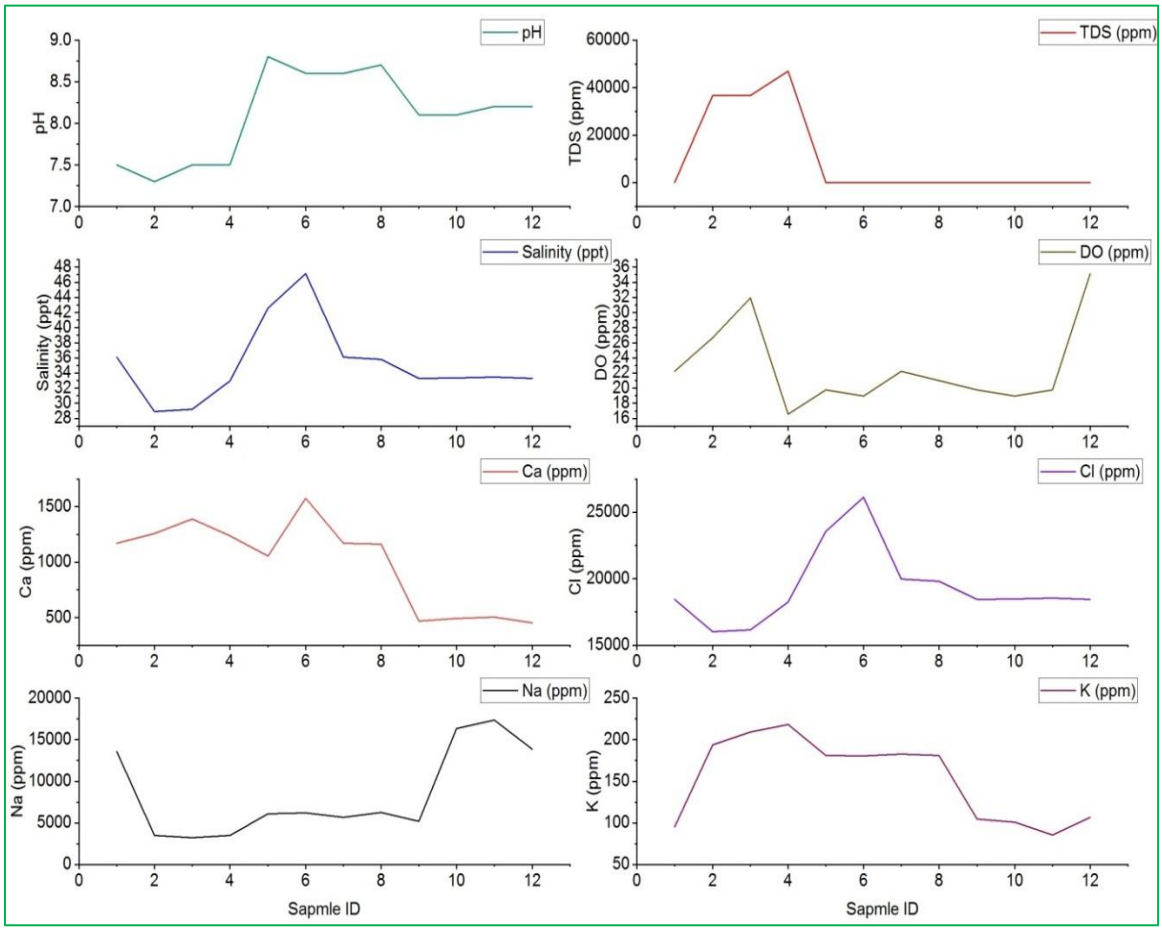

Figure 1. Graphical representation of the distribution of physic-chemical parameters

Benthic Foraminiferal Analysis

A total of 62 species, 23 genera and 3 suborders have been recognized. Total population ranges from 5 to 271 with an average of 57 counts. *Ammonia dentata, A. beccarii, Quinqueloculina seminulum, Elphidium discoidale, E. crispum, Pararotalia nipponica,* and *Asterorotalia trispinosa* were the dominant species. The study area is significant because it supports a large amount of marine life cultivation in and around it. The Uppateru Estuary is utilized for iron ore export, which results in massive amounts of fine iron dust and other pollutants. With such a depressing environment as a backdrop, the health of the study region requires constant monitoring. The current study was undertaken in this context to assess the health of the four vulnerable estuaries. Possible temporal

fluctuations in physicochemical characteristics and/or foraminiferal assemblages are indistinguishable from differences caused by focused sampling. Absolute concentrations of physicochemical parameters in coastal waters are modified by sediment mineralogy, organic content, and anthropogenic enrichment. The various metals' distribution varies over the Bay of Bengal due to the range of natural and manmade sources. The industries that have sprung up along the study area's coastal front are numerous, and their effluents are likewise very poisonous. Typically, these hazardous effluents are discharged untreated into a local body of water, which eventually flows into a river catchment.

Conclusions

The water quality of study area was evaluated using physicochemical criteria. The findings for the investigated parameters indicated that parameters viz. pH, TDS, Salinity, DO, Ca, Cl, Na and K are occurred in the estuaries. In the typical context, water composition may be fresher in some part of upstream and more concentrated near estuary. Foraminiferal census data identified the dominant species assemblages in the study area. They are *Ammonia dentata, A. beccarii, Quinqueloculina seminulum, Elphidium discoidale, E. crispum, Pararotalia nipponica,* and *Asterorotalia trispinosa*. Slightly small size of the foraminiferal tests at Kalangi Estuary area may also be due to higher temperatures of bottom water. This study has helped in understanding the distribution character of foraminifera based on physico-chemical parameters in estuarine bodies along Nellore coast, South India. Measured parameters do not account for all of the biological variability, and further research is recommended to identify other potential controlling factors.

Conflicts of interest: The authors declare no conflicts of interest.

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