



# International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129  
P-ISSN: 2394-0506  
(ICV-Poland) Impact Value: 5.62  
(GIF) Impact Factor: 0.549  
IJFAS 2017; 5(1): 247-252  
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www.fisheriesjournal.com  
Received: 07-11-2016  
Accepted: 08-12-2016

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## Assessment of fluctuations of the physico-chemical parameters of water from Krishna estuarine region, East Coast of India

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### Abstract

Estuaries, exhibit a wide range of human effects directly or indirectly because of rapid population growth and uncontrolled developmental activities in coastal zones. The high level environmental problems playing estuaries require remedial actions to improve the viability and health of these valuable coastal ecosystems. The role of the anthropogenic activities indicates that the water quality in estuaries, particularly aquaculture and industrial development changes leads to the accumulation of chemical contaminants. The various physico-chemical parameters as temperature, salinity, pH, dissolved oxygen of the environment are the factors which mainly influence the production and successful propagation of aquatic organisms' life in the coastal areas. Physico-chemical changes may have a tendency to mount up in the various organs of estuarine fauna especially fish which may, in turn enter into the human metabolism through consumption causing serious hazards. Hence the present study was carried out to determine the physico-chemical parameters of water sampled from different points on were during January to December 2014. The temperature was found to be maximum in summer months and minimum during the winter and rainy months. The salinity recorded highest in summer months and range goes to 10-25ppt. The total alkalinity and total hardness were slightly monthly variations and ranges were 152-220 ppm and 172-239 ppm respectively. The pH of the water found in an alkaline condition in the summer months and its range was 7.1-8.3. DO, nitrates and phosphates were found the slight monthly variations. The study indicates that fluctuations of physico-chemical parameters in the Krishna estuarine region influence the feeding and breeding activities of estuarine fauna.

**Keywords:** Physico-chemical parameters, Krishna estuarine region

### 1. Introduction

The total life of the world depends on water and hence the physico-chemical parameters of water are very much essential to understand the relationship between its different tropic levels and food webs. The increasing population, urbanization, and industrial sources are given rise to environmental stress and pollution all over the world. In fact, most of the developed countries have already realized that human existence on the earth may be endangered if suitable steps are not taken for the abatement; the pollution of the water bodies causes a serious threat to the mankind [1]. Leight *et al.*, [2] reported that the estuaries are complex and dynamic environmental components which receive large amounts of contaminants from urban and industrial sites. Industrialization and urbanization of the coastal region often lead to a decrease in coastal resource and destruction of natural defense structures [3]. Discharge of agricultural wastes, industrial effluents, and urban activities is considered to be the primary sources for increasing nutrient load in nearby aquatic water bodies. India is bestowed with a long coastline of 8,129 km and of this 6,000 km is rich in estuaries, creeks, brackish water, lagoons, and lakes. The east coast of India is an important stretch of coastline, where many major rivers drain into the Bay of Bengal and they are richer in marine fauna and flora. Estuaries constitute a major interface between land and the oceans have been regarded as one of the most important aquatic systems. The progressing of large industries in nearby areas has become a threat to the health of estuarine and coastal water environment [4]. Eutrophication is of great environmental distress, leading to complicity in the aquatic environment, causing problems such as the formation of algal blooms, which results a reduction in oxygen levels, leads to mortality of aquatic fauna and flora and eventually loss of biodiversity. The natural processes, such as precipitation inputs, erosion, weathering of crustal materials, as well as the

anthropogenic influences like urban, industrial, and agricultural activities, calling for increasing exploitation of fresh water resources, together determined the quality of surface in a region. Rivers play a major role in assimilation or carrying off municipal and industrial wastewater and runoff from agriculture land, aquaculture activities constitutes the constant polluting source whereas the later its seasonal phenomenon. Further, the changes are brought about due to global change impacts like sea level rise, change in climate and oceanographic conditions. The process and events controlling the environmental characteristics in tropical and temperate estuaries are very different. The environmental conditions such as topography, water movement and stratification, salinity, dissolved oxygen, temperature and nutrients characterizing particular water also determining the composition of its biota [5]. The shore waters and estuaries, they exhibit considerable seasonal variation depending on the local conditions of rainfall, tidal incursion, various abiotic and biotic processes, the quantum of fresh water inflow affecting the nutrient cycle of the different coastal environment [6].

The natural distribution of the flora and fauna in the aquatic system are mainly controlled by the fluctuation of the physical and chemical characteristics of the water body [7-9]. In recent decades, many investigation reports have been documented [2, 3] and these contaminants might be transported widely through the atmosphere and eventually pollute all over the world. Such a worldwide spread and transition is expected to affect the current status of global contamination and pose a threat to human beings and wildlife, particularly early stages. The physico-chemical parameters of the water of Bay of Bengal have been reported by many workers [10-14]. The abundance of larvae, juveniles, adults fish can however, be influenced by the physical condition of salinity, temperature, pH and turbidity that vary in time, largely due to seasonal variation in freshwater input [15, 16]. Higher salinity would cause a profound impact on an animal such as plankton, fungi, fish, shrimp and crab and their larvae. The following authors who contributed the knowledge of physico-chemical parameters of waters in different estuaries [17-19]. The main objectives of the present study were to evaluate the seasonal variations in physico-chemical parameters and to identify the intensity of degradation that caused deterioration of water quality due to aquaculture, agriculture and industrial activities in this area.

## 2. Materials and Methods

For the study of the physico-chemical parameters of the Krishna estuarine region of the surface and bottom water samples were collected in morning 8.00 AM and stored in clean polyethylene container of 500 ml content. Temperature, pH, salinity, Dissolved oxygen, total alkalinity, total hardness, Phosphates, and Nitrates are recorded at the Krishna estuarine region and samples for dissolved oxygen were fixed immediately in the collection point water analysis was performed as the methods described in standard methods [20].

**2.1 Statistical analysis:** The data of physico-chemical parameters during the January 2014 to December 2014 were subjected to Statistical analysis for which SPSS 16.0 version was used. For the conventions of the computing data average value of physico-chemical parameters were taken and presented. Among the parameters correlation and cluster analysis also analyzed.

## 3. Results

The average physico-chemical parameters water of the Krishna estuarine region recorded from January 2014 to December 2014 and presented Table No: 1. and their correlation was given in table 2.

**3.1 Temperature:** In the present study atmospheric temperature ranges from 27 to 34 °C. Minimum recorded in the month of December and Maximum in the month of May 2014. The temperature is an important factor, which considerably fluctuated during the study period.

**3.2 pH:** pH is the most important chemical factor of water and it is controlled the solvent property. In the present study, highest pH 8.3 recorded in the month of March whereas lowest 7.1 recorded in the month of December 2014.

**3.3 Salinity:** Salinity has been acting as one of the prime environmental factors which profoundly influences the utilization of the organisms in the coastal regions. In this study highest 25 ppt salinity recorded in the month of whereas May where as lowest 10.0 ppt recorded in the month of January 2014.

**3.4 Dissolved oxygen:** DO is a sole of the hydrological parameters of the water that needed to keep the organism alive and health of the water body in terms of trophic status and biotic status. Further, that the oxygen content is needed of many organisms as its affects the solubility and availability of many nutrients of the productivity of the aquatic ecosystem. In the present study Dissolved oxygen ranges in between 4.8 to 6.9 mg/l. The highest (7.4 mg/g) D.O recorded in the month of March and lowest (4.8 mg/l) recorded in the month of October 2014.

**3.5 Total alkalinity and Total hardness:** The highest total alkalinity 220 ppm recorded in the month of April and lowest 152 ppm was recorded in the month of July. The hardness recorded highest 239 ppm in the month of April and lowest 172 ppm in the month of July 2014.

**3.6 Nitrates (µg/l):** Nitrates are an important factor for controlling the occurrence and abundance plankton. Higher concentration of nitrates is an indicator of organic pollution and eutrophication. In this study, it ranges between 0.08 and 0.41 µg/l.

**3.7 Phosphates:** Phosphorus is the major limiting nutrient of a water body. It is an important constituent of biological systems may also be present in the organic forms. Phosphorus is utilized by organisms, followed by its subsequent release from the organic debris. The higher concentration phosphorus, therefore indicator of pollution in the present study it ranges from 1.42 to 2.85 µg/l.

## 4. Discussion

Estuaries have been the target of considerable human exploitation because of their formidable resources and economic importance. The increasing population in the coastal areas will exert even greater demands and pressures on estuarine systems during the next 30 years. Water parameters play an important role in the structuring the fish species in mangrove swamp, estuaries, and coastal areas. Salinity and temperature are important hydrological

parameters influencing the occurrence, density, and growth of larvae of fish and shellfish in coastal areas [21, 22], and water depth can also influence fish distribution. Large piscivorous fish prefer to stay in deeper area where they can feed more efficiently [23, 24] are more likely to stay in deeper areas. The basis was predominantly influenced by the seasonal reversal of the monsoon resulting in the input of large quantity of fresh water from major rivers. Further, winds and stratification influence phytoplankton productivity in the bay [25].

In India, the temperature is quite high during the dry pre-monsoon season but with the advance of the south-west monsoon (June-September) water temperature reaches its lower values. The temperature variation is also one of the factors in the coastal and estuarine system, which may influence the physico-chemical characteristics and also influence the distribution and abundance of flora and fauna. The observed high value of temperature in May was due to the intensity of solar radiation and evaporation freshwater influx and cooling, mix up with ebb, and flow from adjoining neritic waters. The observed low value of December was due to strong land sea breeze and precipitation. Lower temperature in the above months due to cloudy sky and rainfall brought down the temperature to the minimum [26-28].

Hydrogen ion concentration is another important factor in the aquatic ecosystem. The variation of pH of the water was less pronounced throughout the study period. Davis [29] have emphasized that pH is the most important chemical factor of water and it controls the solvent property. Thus, pH is used in the measurement of alkalinity, CO<sub>2</sub> and many other acid-base equilibrium [30]. Generally, its seasonal variation is attributed to factors like removal of CO<sub>2</sub> by photosynthesis through bicarbonate degradation, dilution of seawater by the freshwater influx, low primary productivity, reduction of salinity and temperature and decomposition of organic matter [31]. The recorded high summer pH might be due to the influence of seawater penetration and high biological activity [32] and due to the occurrence of a high photosynthetic activity [33]. The obvious seasonal change of pH was mainly due to the rainfall and freshwater inflow. Sasamal *et al.*, [34] reported that from North Western Bay of Bengal surface waters are more alkaline and mesohaline in nature. In the present study highest pH recorded in the month of March 2014 and lowest 7.1 recorded in the month of December.

Dissolved oxygen (DO) is one of the most important abiotic parameters influencing the life in the estuarine environment. Dissolved oxygen concentrations were above 5mg/l which was adequate enough to support aquatic life [35]. This is because of the oxygen is consumed more by the aquatic animals due to effluent stress. Normally high dissolved oxygen is encountered in polluted. Further, depletion of DO to the level of anaerobic is the most critical manifestation of pollution [36]. The observed high monsoonal values might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing as suggested by Das *et al.*, [37].

Salinity is one of the important factors which profoundly influenced the abundance and distribution of the organisms in the coast estuarine environment. In the present study, the lower salinity was recorded during the winter months due to the large quantity of fresh water inflow from creeks and other sources of water [38, 39]. In the present study, the salinity was higher in the months of April to June due to low rainfall, decreased freshwater inflow, and rise in temperature. The salinity acts as a limiting factor in the distribution of living

organisms and its variation caused by dilution and evaporation is most likely to influence the fauna in the coastal ecosystems [40, 41]. The minimum salinity was recorded during the monsoon season and the maximum was recorded during the summer season as reported earlier by [39].

The total alkalinity and total hardness are the parameters of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining the suitability of water for domestic, industrial, and drinking purpose attributed to the presence of bicarbonates, sulphates, chloride, and nitrates of calcium and magnesium [40]. In the present study, the highest values of hardness recorded 239 ppm in the month of April and lowest 172 ppm in the month of July. High values of hardness are probably due to the regular addition of large quantities of detergents used by the nearby residential localities into lakes that drain into estuaries. Singh *et al.*, [41] stated that the alkalinity of water is a measure of weak acid present in it and of the cations balanced against them. Total alkalinity is the total concentration of bases in water usually bicarbonates and carbonates [42]. The amount of total alkalinity recorded highest 220 ppm in the month of April and lowest in the month of July. Safari *et al.*, [43] reported the total alkalinity depends on the concentration of the substance which would raise the pH of the water. High levels of alkalinity indicate the presence of strongly alkaline industrial wastewater and sewage in the estuary. The degradation of plants, living organism and organic waste in the estuary might also be one of the reasons for the increase in carbonate and bicarbonate levels, shows an increase in alkalinity value [44].

Highest and lowest levels of Nitrates were noticed during January (0.08 µg/l) and July (0.41 µg/l) respectively. The higher concentration of nitrate could be attributed due to the variation in phytoplankton, excretion, and oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and also due to bacterial decomposition of planktonic detritus present in the environment [45, 46]. The recorded low nitrite values during summer season may be due to less freshwater inflow and high salinity [45, 46]. Further, the increased nitrates level was due to freshwater inflow, mangrove leaves (litterfall) decomposition and terrestrial runoff during the monsoon season [48, 49]. In the present study, highest phosphate recorded 2.85 µg / l in the month of August and lowest 1.42 µg / l in the month of May. The recorded high concentration of phosphates during monsoon season might possibly be due to the intrusion of upwelling seawater into the creek, which in turn increased the level of phosphate [50]. Low summer values could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton [51]. The phosphate content during winter month was higher and lower in summer months [52]. The correlation between temperature and salinity pH and total alkalinity, total hardness was noted highly significant (P<0.01). Total alkalinity showed negative and highly significant with nitrates and phosphates. Total hardness showed negative and highly significant (P<0.01) with nitrates and phosphates. Nitrates are positive and significant (P<0.05) correlation with phosphates.

The variation of physico-chemical parameters mainly depends on monsoon rains and also other sources of freshwater. The fluctuations in physico-chemical parameters influence the biological activity and productivity of aquatic organisms. Water is the basic need for the life sustaining medicine for the propagation of aquatic organisms especially larvae and juveniles. The continues discharge of effluents to the estuarine ecosystem may directly or indirectly influence the

organisms. There is an urgent need to control or restore the discharge of domestic sewage and other industrial effluents to restore breeding ground of finfish and shellfish, secondary and tertiary productivity in the estuarine water body for the

benefit of Krishna estuarine region. The most importantly, the key to successful estuarine revitalization hinges on education programmed that inform the public of its responsibility as a steward of these valuable coastal systems.

**Table 1:** Average Physico-chemical parameters of from January 2014 - December 2014

Month	1	2	3	4	5	6	7	8
January	27.5	7.9	5.4	219	225	10.0	0.08	2.0
February	28.4	7.8	6.5	215	230	15.2	0.158	1.9
March	32.2	8.3	6.9	212	224	19.5	0.186	2.3
April	33.8	8.2	6.6	220	239	24.5	0.121	1.91
May	34	7.4	6.8	217	219	25	0.17	1.42
June	33.2	7.5	6.4	188	198	24.8	0.21	1.87
July	32.5	7.2	6.2	152	172	23.2	0.41	2.76
August	32	7.2	5.2	169	182	19.5	0.35	2.85
September	32.1	7.3	5.2	186	196	15.4	0.21	2.25
October	31.2	7.5	4.8	190	209	11.5	0.31	2.12
November	29.4	7.6	5.3	186	205	10.8	0.29	2.15
December	27	7.1	5.8	190	201	10.4	0.20	2.56
Min-Max	27-34	7.1-8.3	4.8-6.9	152-220	172-239	10-25	0.08-0.41	1.42-2.85

1 = Temperature (°C)

2 = pH

3 = DO mg/l

4 = Total alkalinity (ppm)

5 = Total Hardness (ppm)

6 = Salinity (ppt)

7 = Nitrates (ug/l)

8 = Phosphates (ug/l)

**Table 2:** Correlation matrix among Physico-chemical parameters of water from Krishna estuarine region. Correlations

Temperature	Temperature	Salinity	DO	pH	Total Alkalinity	Total Hardness	Nitrates	Phosphates
	1	.866(**)	.390	-.086	-.108	-.113	.210	-.191
Salinity		1	.616(*)	-.020	-.039	-.067	.075	-.196
DO			1	.552	.461	.494	-.334	-.472
pH				1	.757(**)	.839(**)	-.669(*)	-.343
Total Alkalinity					1	.966(**)	-.916(**)	-.760(**)
Total Hardness						1	-.842(**)	-.703(*)
Nitrates							1	.666(*)
Phosphates								1

\*\* Correlation is significant at the 0.01 level (2-tailed).

\*Correlation is significant at the 0.05 level (2-tailed).

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