ANALYSIS OF PHYSIOCHEMICAL PARAMETERS TO EVALUATE THE
WATER QUALITY IN KUDUVAIYAR ESTUARY, SOUTHEAST COAST OF
INDIA

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ABSTRACT

A study has been undertaken to enlighten the water quality parameters of coastal water of Kuduvaiyar estuary, east coast was selected as the reference site. The concentration of water quality parameters like temperature, pH, salinity, dissolved oxygen, total hardness, total alkalinity, electrical conductivity, biological oxygen demand (BOD) and chemical oxygen demand (COD) were done triplicate in the laboratory as per the standard methods. The reason for chosen the coastal water level due to the continuous discharge of agricultural, domestic sewage and industrial effluent in the estuary.

Keywords: Physicochemical parameters, Biological Oxygen Demand and Chemical Oxygen Demand.

INTRODUCTION

Estuarine and coastal areas are complex and dynamic aquatic environment. India has a long coastline of 8,129 km and of this 6,000 km is rich in estuaries, creeks, brackish water, lagoons and lakes. The southeast coast of India is an important stretch of coastline, where many major rivers drain into the Bay of Bengal and they are also richer in marine fauna and flora (Rajkumar et al., 2011). Agricultural, industrial and urban activities are considered to be major sources of addition of nutrients to aquatic ecosystems posing a big threat to fish stocks (Kucuksezgin et al., 2006). Eutrophication is of great environmental distress, leading to diverse problems such as toxic algal blooms, loss of oxygen, fish mortalities and eventually loss of biodiversity (Yadav et al., 2007; Zaggia et al., 2007). The impacts vary relatively minor to major disruptions due to bioaccumulation and biomagnifications processes (Unlu et al., 2007; Altun et al., 2008).

Estuaries, the main contributors of fisheries in India, suffer from severe damage which receive large amount of contaminants due to increased industrialization and urbanization along the coastal areas by continuous discharge of domestic sewage and industrial effluents. Overloading of the estuaries with contaminants for a longer period of time has resulted in the significant buildup of pollutants with a resulting impact on water properties (Padmini et al., 2004). Paramisivam and Kannan (2005) reported that factors related to water quality such as temperature, pH, salinity, dissolved oxygen, total organic carbon and nutrients are particularly important for determining the biota and ecosystem functions in coastal waters. Hence, the present study was therefore undertaken with a view to provide much needed information on the water quality parameters in the coastal water of Kuduvaiyar estuary was selected as the reference site.
MATERIALS AND METHODS

Description of the study area

Kuduvaiyar estuary is situated in the South east coast, near Nagapattinam, India (Station: Lat 10° 45’ N, Long 79° 96’ E. The Kuduvaiyar River is a tributary of the major river, ‘Cauvery’ of South India. The Kuduvaiyar estuary has a year-round connection with the sea and is subjected to semidiurnal tides with maximum tidal amplitude of about 1m. The river Cauvery flows (from western part of Tamil Nadu) for a distance of 380 km through area of red, sandy, leached and laterised black soil in a loamy red soil and finally confluences the Bay of Bengal. The width of the estuary at the mouth is about 85 m and the tidal flushing area extends to a distance of about of 10 km.

Location of sample Collection

The water sample was collected from Kuduvaiyar estuary, Nagapattinam, Tamil Nadu, India. The present study was carried out for Kuduvaiyar estuary. During the study period (2018-2019), samples of water were collected fortnightly; the data were pooled seasonally to understand the seasonal effect. The Kuduvaiyar estuary is formed by the tributaries of Cauvery river and opens into estuary on the South East coast of India. The three distinct seasons were pre-monsoon, monsoon and post-monsoon periods. The samples were collected from five different points of each site and were mixed together to prepare an integrated sample. The water temperature and pH were analyzed immediately on the spot after collection, whereas the analyses of salinity, dissolved oxygen, total hardness, total alkalinity, electrical conductivity, biological oxygen demand (BOD) and chemical oxygen demand (COD) were done triplicate in the laboratory as per the standard methods.

Physiochemical parameters

The methods used for the analysis of various physio-chemical parameters were the same as given in Standard Methods for the examination of water (APHA, 1967, 1980; APHA-AWWA-WPCF, 1976); Golterman et al.,(1978) and National Environmental Engineering Research Institute (NEERI, 1986).

RESULTS AND DISCUSSION

Pollution of the aquatic environment and its effects on the living resources, especially the fishery resources, has assumed considerable interest as well as importance in the recent times. Most of the rivers which discharge large quantities of water into the coastal marine environment are polluted and these pollutants obviously end up in the inshore coastal waters. The vast marine environment has long been used as a site for the disposal of wastes.

In some cases the polluted material is discharged directly into the sea and in other cases the pollutant reaches the rivers and Estuaries and finally ends up in the sea. Estuaries, the important contributors of fisheries in India, suffer from severe loss of fish production due to increased industrialization and urbanization along the coastal zone by continuous discharge of industrial effluents (Padmini et al., 2004). Under the influence of a variety of inter-related biotic and abiotic structural compounds and intensive chemical, physical and biological processes, estuaries are highly variable systems (Madhupratap, 1987). Data on the range of atmospheric and surface water temperature, pH, salinity, dissolved oxygen, total hardness, total alkalinity, electrical conductivity, biological oxygen demand (BOD) and chemical oxygen demand (COD) are given in the Fig 2 to 7.

Temperature is an important limiting factor, which regulates the biogeochemical activities in the aquatic environment. Generally water temperature correspond with air temperature indicating that the samples collected from shallow zones has a direct relevance with air temperature, shallow water reacts quickly with changes in atmospheric temperature (Rajkumar et
Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water (Vincy et al., 2012). Surface water temperature varied with the seasons as lowest in post-monsoon months (27.32°C) and highest during pre-monsoon (28.12°C) (Fig. 2). Similar findings were also recorded by Ravichelvan et al. (2015) and Eshwaralal and Angadi (2002).
Fig 5 Physicochemical characters electrical conductivity in Pre monsoon, Monsoon and Post monsoon of Kuduvaiyar estuary

Fig 6 Physicochemical characters Alkalinity in Pre monsoon, Monsoon and Post monsoon of Kuduvaiyar estuary

Fig 7 Physicochemical characters hardness in Pre monsoon, Monsoon and Post monsoon of Kuduvaiyar estuary
pH of water is an important environmental factor, the fluctuation of pH is linked with chemical changes, species composition and life processes. It is generally considered as an index for suitability of the environment (Rani et al., 2012). Ellis (1937) has observed that a pH range of 6.7 to 8.4 is suitable for the growth of Aquatic biota. In Kuduvaiyar estuary pH ranged from (8.76 to 9.87) indicating slight alkaline nature of water. pH varied with the seasons as lowest in post-monsoon months (7.87) and highest during pre-monsoon (9.2) while monsoon pH was 8.76 (Fig 3). Our findings are in concordance with Mohan Raj et al. (2013) and Ravichelvan et al. (2015).

The salinity acts as a limiting factor in the distribution of living organisms, and its variation caused by dilution and evaporation and influence the fauna of the intertidal zone (Gibson, 1982; Balasubramanian and Kannan, 2005). Generally, changes in the salinity in the brackish-water habitats such as estuaries, backwater and mangrove are due to the influx of freshwater from land run off caused by monsoon or by tidal variations. In the present study, salinity was high during post monsoon (26.78 ppt) and low during monsoon (25.314 ppt) (Fig 2). Present finding is similar to the Mohan Raj et al. (2013) and Ravichelvan et al. (2015). Higher values during post monsoon could be attributed to the heavy tidal influence after monsoon and high degree of evaporation of the study area. In monsoon season due to formation of sand bars and retention of the city domestic sewage water influence the reduction in salinity. Thus the variation of salinity in the study sites could probably be due to mainly freshwater runoff entering the creek systems as reported by Vijayalakshmi et al., (1993).

The value of dissolved oxygen is remarkable in determining the water quality criteria of an aquatic ecosystem. The Dissolved oxygen is regulator of metabolic activities of organisms and thus governs metabolisms of the biological community as a whole and also acts as an indicator of trophic status of the water body (Saksena, 1994). Maximum dissolved oxygen was recorded during monsoon months (3.97mg/l) which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall. This could also be because of freshwater mixing from Kuduvaiyar estuary and low metabolic rate of organisms. Minimum dissolved oxygen were recorded (Fig 4) during monsoon and post monsoon months (3.94 and 3.10 mg/l respectively) might be due to high temperature, availability of huge quantity of untreated domestic sewage with enriched inorganic reductant and high metabolic rate of organisms. Similar observation were drawn by Ravichelvan et al. (2015) and Sahu et al., (2000). Dissolved oxygen is regulator of metabolic activities of organisms and thus governs metabolisms of the biological community as a whole and also acts as indicator of trophic status of the water body (Saksena and Kaushik, 1994).

Tarzell (1957) has suggested that a minimum of 3 mg/l dissolved oxygen is necessary for healthy fish and other aquatic life. The present study showed minimum values of dissolved oxygen during post monsoon and pre monsoon which are not sufficient for most of the aquatic organisms. Interestingly even when DO was much below the optimum level, the rotifers were present in abundance indicating their wide range of tolerance. One of the reasons for the fatality of many teleost’s observed during pre-monsoon in Kuduvaiyar estuary might be the low level of dissolved oxygen. Dissolved oxygen is the most important indicator of the health of a water body and its capacity to support a balanced aquatic ecosystem of plants and animals. Waste water containing organic pollutants depletes the dissolved oxygen and may lead to impact benthic communities by producing acute changes in their distribution, abundance, and diversity of species (Raffaelli, 2000). The lower dissolved oxygen also implies that the estuaries were more polluted downstream.
### Table 1 Seasonal variations in the physico-chemical parameters studied in the Kuduvaiyar estuary (From March 2018 to December 2019)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-monsoon (March to May)</th>
<th>Monsoon (June to Sept.)</th>
<th>Post-monsoon (Oct. to Dec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>28.12 ± 1.892</td>
<td>27.98 ± 1.845</td>
<td>27.32 ± 1.564</td>
</tr>
<tr>
<td>pH</td>
<td>9.2 ± 0.642</td>
<td>8.32 ± 0.601</td>
<td>7.87 ± 0.563</td>
</tr>
<tr>
<td>EC (MS CM⁻¹)</td>
<td>418 ± 27.23</td>
<td>376 ± 25.32</td>
<td>465 ± 32.52</td>
</tr>
<tr>
<td>DO (mg/l)</td>
<td>3.32 ± 0.251</td>
<td>3.94 ± 0.273</td>
<td>3.10 ± 0.213</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>24.12 ± 1.60</td>
<td>24.75 ± 1.581</td>
<td>24.95 ± 1.641</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>2.75 ± 0.211</td>
<td>3.54 ± 0.250</td>
<td>3.14 ± 0.231</td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>132.02 ± 8.865</td>
<td>139.08 ± 8.133</td>
<td>136.46 ± 8.064</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>26.05 ± 1.643</td>
<td>25.314 ± 1.60</td>
<td>26.78 ± 1.801</td>
</tr>
<tr>
<td>Hardness (mg/l)</td>
<td>1620 ± 11032</td>
<td>1589 ± 104.32</td>
<td>1614.89±111.23</td>
</tr>
</tbody>
</table>

Average values of water samples collected monthly (n = 3).

EC: Electrical conductivity; DO: Dissolved oxygen; COD: Chemical oxygen demand; BOD: Biological oxygen demand.

Chemical Oxygen Demand (COD) is a measure of pollution in aquatic ecosystems. It estimates carbonaceous factor of organic matter. In present study obtained in the range of 4.20mg/L and above the permissible limit set by WHO (10mg/L). Biological Oxygen Demant (BOD) is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction or stabilization of organic water. It is a very important indicator of the pollution status of a water body. In the conducted experiments, BOD was high in Domestic and Industrial Effluent due to high organic load and excessive growth of total microorganisms (Kandhasamy and Santhaguru, 1994). This may be as a result of escape of organic matter (organic) into the river mostly from faecal waste deposition by the surrounding urban area and human settlements. Control Sample revealed BOD value below detection limit, because it was distilled water and had no organic load. Highest COD values were found in Domestic Effluent which may be due to the incessant inflow of sewages from urban areas (Mishra et al., 1990). In the present study, COD was lowest in pre monsoon months (24.12 mg/l) and highest during post monsoon (24.95 mg/l) while monsoon COD was 24.75mg/l. The BOD was lowest in pre monsoon months (2.875 mg/l) and highest during monsoon (3.54 mg/l) while post-monsoon BOD was 3.14 mg/l (Fig 1 and 4).

Highest EC was recorded in high during post monsoon (465 Mscm⁻¹) and low during monsoon (376 Mscm⁻¹) while Pre monsoon EC was 418 Mscm⁻¹ (Fig. 5). The highest value may be due to the Industrial Effluent because it contained many chemicals, salts and dissolved solids (Mishra and Saksena, 1993). Higher EC indicates the presence of high amount of dissolved inorganic substances in ionized form (Murhekar, 2011). Domestic Effluent also showed moderate to high value of EC. Electrical Conductance in monsoon was found below detection limit because it is distilled water and in distilled water presence of ions and chemicals is in minute quantity so; EC is found below the detection limit.

The alkalinity of water is its capacity to neutralize acids. Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them (Singh et al., 2010). Total
alkalinity is the total concentration of bases in water usually bicarbonates and carbonates (Ouyang et al., 2006). Alkalinity varied with the seasons as lowest in pre monsoon months (132.02 mg/l) and highest during monsoon (139.08 mg/l) while post monsoon Alkalinity was 136.46 mg/l (Fig. 6). 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 waste water and sewage in the estuary (Safari et al., 2012). The degradation of plants, living organism and organic waste in the estuary might also be one of the reasons for increase in carbonate and bicarbonate levels, shows an increase in alkalinity value (Wang et al., 2006). Our result agrees with the earlier report (Mohan Raj et al., 2013).

Total hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphates, chloride and nitrates of calcium and magnesium. In the present study, salinity was high during post monsoon (26.78 ppt) and low during monsoon (25.31 ppt). The hardness was lowest in monsoon months (1589 Mg/l) and highest during pre-monsoon (1620 Mg/l) (Fig 7). Present finding is in agreement with Mohan Raj et al. (2013). High values of hardness are probably due to regular addition of large quantities of detergents used by the nearby residential localities into lakes which drains into estuaries.

**Conclusion**

In the present study disrupts normal functioning of the ecosystem, causing a variety of problems such as a lack of oxygen in the water, needed for fish and shellfish to survive. During the rainy season, the increased flow of freshwater results in the appearance of freshwater species. However, the majority of dry season species cannot survive in these low salinities and migrate to higher salinity areas offshore. Salinity is extremely important from the standpoint of monitoring water quality. The purpose of this study has been to determine the effect of drainage system and type of land use on the load of mineral nutrient compounds derived from soil environment and present in water ecosystems. As water originating from rain and snow is the main medium shaping soil processes and transport of minerals, particular attention has been paid to variations in atmospheric precipitation during the analyzed time period. Increased human activities over the recent past are imposing a greater stress on these ecosystems, resulting on changing their water quality and loss of biodiversity. In the present study tidal and diurnal variations in a large spectrum of physico-chemical fraction was irrigates for this coastal environment.

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