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Study of physico-chemical parameters of sea water in Tuticorin Coastal area and assessing their Quality, Tamil Nadu, India

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ABSTRACT

Coal has been used extensively in power generation where better technology is employed to ensure that there is a balance between ecology and economics. On the other hand there are also some significant disadvantages of coal fired power plants including the generation of millions of tons of waste and emission of harmful substances. In Tuticorin, the sea water is polluted in many reasons including the ash slurry is discharged into sea water. Sea water samples were collected from three different stations in Tuticorin coastal to study the physico-chemical characteristics. The analysis of different parameters such as temperature, pH, salinity, TDS, nitrite, nitrate, silicate, inorganic phosphate and total phosphate were carried out using standard methods. The studies reveal that the physico-chemical composition of all water samples were collected mainly depends on seasonal variations and discharge of solid waste fly ash from thermal power plant.

Key words: Sea water, physico-chemical characteristics, temperature, salinity, seasonal variations.

INTRODUCTION

Human activities are responsible for a major decline of the world's biological diversity, and the problem is so critical that combined human impacts could have accelerated present extinction rates to 1000–10,000 times the natural rate [1].The introduction by man, directly or indirectly of substances or energy to the marine environment resulting in deleterious effects. These situations have generated great pressure on the ecosystem, resulting in a decrease of water quality and biodiversity, loss of critical habitats [2] and an overall decrease in the life quality of local inhabitants.

In recent years, a number of industries have been developed around Tuticorin coastal region. The effluents from these industries and aquaculture are discharged into sea water. Hence, the present study was undertaken to assess the water quality of Tuticorin coastal water through analysis of physico-chemical parameters of water samples collected from different stations with a view to know the pollution status and to predict its possible impact for future management [3]. Thermal power plant may contribute significantly towards economic growth but they may bring associated ills of environmental pollution. From Thermal power plant the fly ash slurry discharges are bound to have detrimental effects on the hydrograph of the receiving waters Studies show that wet disposal of this waste does not protect the environment from migration of metal into the soil [4]. India ranks fourth in the world in the production of coal ash as by-product waste. Disposal and management of fly ash is a major problem in coal-fired thermal power plants [5].

EXPERIMENTAL SECTION

Study area

Tuticorin Thermal Power Station (TTPS) plant is located along the Tuticorin coast. (Lat. 08º 46! 20" N; Long. 78º 10! 46" E) Environmental Impact Assessment study was carried out by collecting samples from the three stations fixed around 5 km of ash slurry discharge point of power plant from July (2014) to December (2014).

Collection of the water samples and analysis

Surface and bottom water samples were collected from 3 stations fixed from the ash slurry discharge point of power plant in monthly intervals, transported to the laboratory condition and the different physico-chemical parameters of sea water were analyzed using for the "standard methods for the examination of water and waste water" APHA [6], Surface and bottom water temperature were measured using thermometer and salinity was estimated with a hand Refractometer (ATAGO), pH was measured using 'Elico' pH meter respectively. The total dissolved solids by APHA [6], a well mixed sample is filtered and the filtrate is evaporated to dryness in a weighed dish at 98ºC. The increase in dish weight represents the total dissolved solids, thus the TDS was calculated and expressed in g/1. Inorganic phosphate by [7], silicate by [8] and nitrate, nitrite by Bend-Schneider cadmium reduction method [9].

RESULTS AND DISCUSSION

Physico-Chemical characteristics of water are shown in tables 1- 8. Monthly variations in physico-chemical parameters viz. temperature, salinity, pH, total dissolved salt, nitrite, nitrate, reactive silicate, inorganic phosphate in water were recorded for a period of six months from July 2014 to December 2014.

Table 1. Monthly variations of Temperature in ^{0}C

Area	Types of Water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	30.3±0.26	31.0±0.20	34.0±0.20	32.9±0.36	33.8±0.10	31.2±0.17
	Bottom	28.1±0.10	30.1±0.26	34.0±0.26	32.0±0.26	33.4±0.26	30.5±0.26
S 2	Surface	27.6±0.10	29.0±0.26	29.1±0.26	29.2±0.18	30.4±0.36	28.4±0.26
	Bottom	27.5±0.26	29.2±0/26	29.0±0.26	29.0±0.09	30.0±0.26	28.0±0.26
S 3	Surface	27.6±0.10	27.9±0.20	29.0±0.10	28.9±0.26	29.8±0.26	28.1±0.26
	Bottom	27.4±026	27.5±0.26	29.0±0.26	27.8±0.13	29.4±0.26	27.9±0.36

Values are mean ±SD

Table 2. Monthly variations of pH

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	7.49±0.06	7.56±0.02	7.42±0.03	7.98±0.02	8.25±0.03	7.75±0.03
	Bottom	7.52±0.08	7.58±0.02	7.73±0.06	8.12±0.02	8.51±0.02	7.82±0.03
S 2	Surface	7.56±0.04	8.24±0.05	8.19±0.01	8.38±0.02	8.61±0.05	8.29±0.02
	Bottom	7.59±0.03	8.37±0.04	8.29±0.07	8.58±0.02	8.65±0.03	8.32±0.08
S 3	Surface	8.43±0.05	8.42±0.02	8.42±0.03	8.62±0.02	8.69±0.10	8.55±0.05
	Bottom	8.85±0.04	8.72±0.02	8.61±0.02	8.75±0.03	8.72±0.15	8.79±0.10

Values are mean ±SD

Table 3. Monthly variations of Salinity in ‰

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	38±1.80	33±1.80	32±1.32	34±1.32	32±1.32	33±1.32
	Bottom	35±1.32	34±0.80	32±1.32	35±1.32	33±1.32	34±1.80
S 2	Surface	35±1.32	35±1.32	33±1.80	34±1.80	31±1.50	32±1.80
	Bottom	35±1.32	34±1.80	31±1.87	32±1.32	33±1.80	34±±1.32
S 3	Surface	35±1.00	34±1.80	35±1.80	35±1.80	30±1.32	35±1.50
	Bottom	35±1.32	34±1.32	32±1.32	34±1.00	33±1.32	33±1.04

Values are mean ±SD

Table 4. Monthly variations of Total dissolved solids (TDS) in g/L

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	30.09±0.07	29.05±0.08	29.02±0.14	29.45±0.02	27.82±0.03	29.42±0.03
	Bottom	39.17±0.09	32.14±0.10	30.05±0.01	31.5±0.03	29.94±0.03	30.15±0.03
S 2	Surface	39.27±0.11	28.23±0.05	29.45±0.04	30.45±0.04	28.43±0.04	32.43±0.04
	Bottom	44.61±0.09	42.45±0.04	41.5±0.04	42.46±0.03	40.02±0.07	43.45±0.07
S 3	Surface	45.46±0.05	35.42±0.03	42.45±0.02	43.8±0.03	41.37±0.02	44.64±0.02
	Bottom	43.66±0.03	45.4±0.03	43.64±0.03	42.42±0.02	41.82±0.02	43.78±0.02

Values are mean ±SD

Table 5. Monthly variations of Nitrite mg/L

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	1.055±0.01	1.015±0.01	1.250±0.01	1.025±0.01	1.015±0.01	1.02±0.01
	Bottom	0.840±0.01	0.860±0.01	0.840±0.01	0.861±0.01	0.850±0.01	0.845±.01
S 2	Surface	0.738±0.01	0.758±0.01	0.902±0.01	0.758±0.01	0.758±0.01	0.76±0.01
	Bottom	0.799±0.01	0.758±0.01	0.451±0.02	0.799±0.01	0.799±0.01	0.78±0.01
S 3	Surface	0.717±0.01	0.758±0.01	0.717±0.01	0.533±0.01	0.759±0.01	0.74±0.01
	Bottom	0.656±0.01	0.654±0.01	0.676±0.01	0.654±0.01	0.675±0.01	0.66±0.03

Values are mean ±SD

Table 6. Monthly variations of Nitrate µg at/L

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	3.4±0.04	3.35±0.02	3.38±0.02	3.48±0.02	3.34±0.02	3.45±0.08
	Bottom	2.5±0.02	2.5±0.02	2.15±0.03	2.25±0.03	2.6±0.03	2.59±0.02
S 2	Surface	2.4±0.02	2.14±0.04	2.92±0.02	2.82±0.02	2.82±0.02	2.72±0.03
	Bottom	2.2±0.09	2.12±0.02	2.23±0.02	2.34±0.02	2.32±0.01	2.25±0.07
S 3	Surface	3.0±0.06	2.95±0.01	2.65±0.01	2.72±0.01	2.75±0.03	2.78±0.01
	Bottom	2.65±0.02	2.5±0.02	2.50±0.02	2.42±0.03	2.55±0.03	2.49±0.05

Values are mean ±SD

Table 7. Monthly variations of Silicate µg at/L

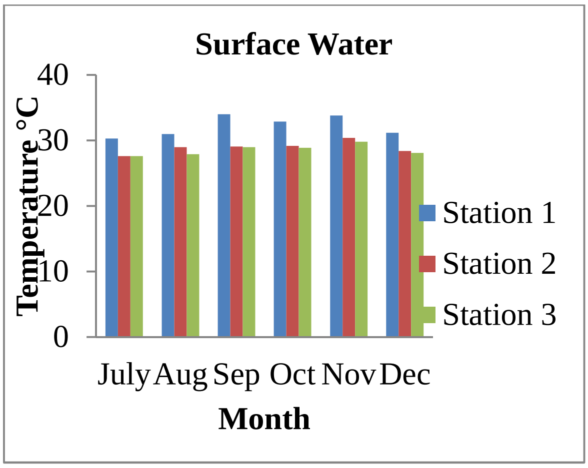
Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	75.6±0.03	62.88±0.03	53.4±0.03	55.8±0.03	65.2±0.03	64.72±0.03
	Bottom	62.88±0.02	52.48±0.02	42.9±0.03	64.8±0.04	55.4±0.02	59.43±0.02
S 2	Surface	76.8±0.03	72.6±0.03	64.14±0.03	75.9±0.02	74.5±0.02	75.4±0.02
	Bottom	139.6±0.02	97.06±0.03	95.04±0.02	98.4±0.02	98.5±0.02	97.8±0.02
S 3	Surface	103.8±0.01	112.4±0.01	129.0±0.03	125.±0.03	122.5±0.01	124.0±0.04
	Bottom	124.9±0.03	134.8±0.02	159.8±0.03	149.8±0.03	134.4±0.03	135.4±0.02

Values are mean ±SD

Table 8. Monthly variations of Inorganic Phosphate µg at/L

Area	Types of water	July 14'	Aug 14'	Sep 14'	Oct 14'	Nov 14'	Dec 14'
S 1	Surface	2.5±0.03	2.35±0.03	2.25±0.03	2.1±0.02	4.95±0.04	4.23±0.03
	Bottom	1.37±50.01	1.285±0.01	1.575±0.01	1.275±0.01	4.575±0.01	4.44±0.04
S 2	Surface	4.280±0.02	2.78±0.03	2.4±0.04	4.275±0.01	5.25±0.04	4.99±0.02
	Bottom	1.78±0.020	2.25±0.03	2.55±0.03	1.65±0.02	5.55±0.05	5.275±0.01
S 3	Surface	4.15±0.02	5.25±0.04	3.0±0.03	6.15±0.03	6.525±0.03	6.520±0.06
	Bottom	2.45±0.03	2.35±0.03	2.325±0.02	2.55±0.02	6.375±0.07	6.279±0.01

Values are mean ±SD



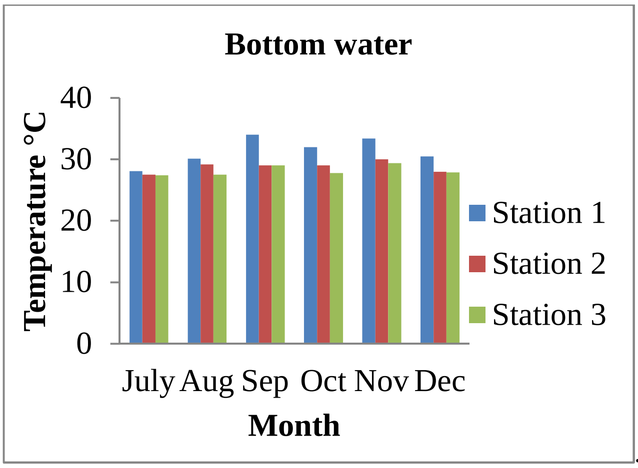


Fig 1: Monthly variations of Temperature ^{0}C **Fig 2: Monthly variations of Temperature ^{0}C**

Temperature

The disposal of fly ash slurry causes the high temperature in station 1.Sea surface temperature in station 1 was high (34±0.20) during September month (Fig. 1). Station 1 is located in fly ash slurry discharging point it causes increases the water temperature and minimum 27.4ºC±026 was recorded in station 3, it is about 5 km far away from the discharging points. Temperature has been decreasing with increasing the distance. During the study period the temperature varied. In station 1 the temperature was higher than other stations due to disposal of fly ash slurry directly into the station 1. Generally, the surface water temperature is influenced by the intensity of solar radiation evaporation, freshwater influx, cooling and mix up with ebb and flow from adjoining neritic water [10]. Earlier, the temperature of 27-34 ºC was recorded in the surface waters of Tuticorin, a part of Gulf of Mannar [11]. Temperature has been decreasing with increasing the distance [12].

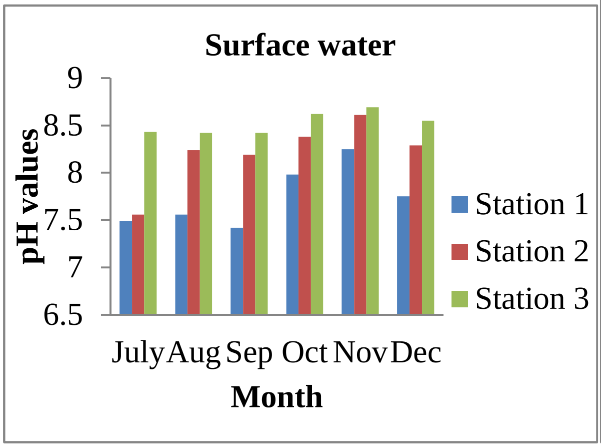


Fig 3: Monthly variations of pH

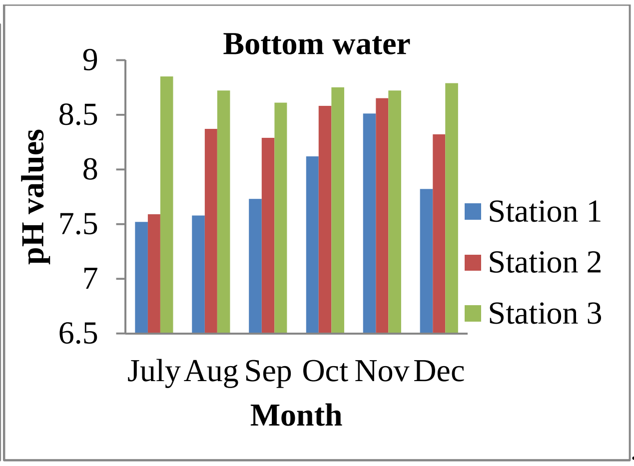


Fig 4: Monthly variations of pH

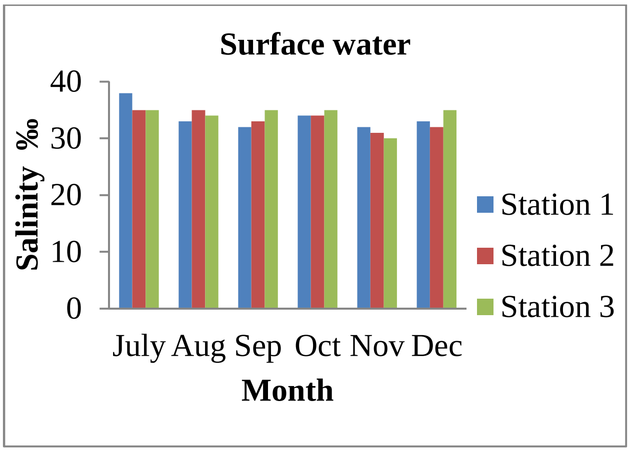


Fig 5: Monthly variations of Salinity

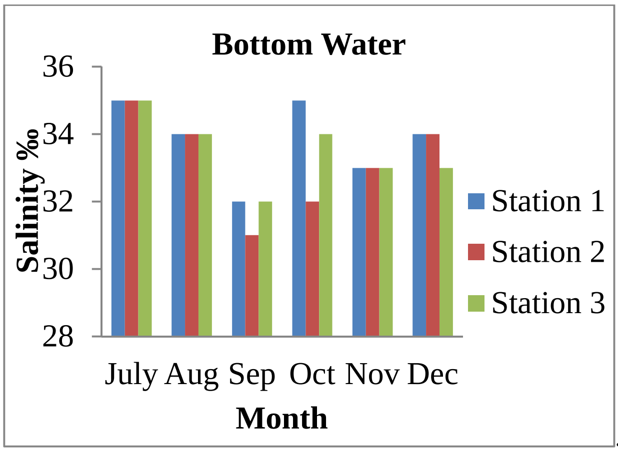


Fig 6: Monthly variations of Salinity

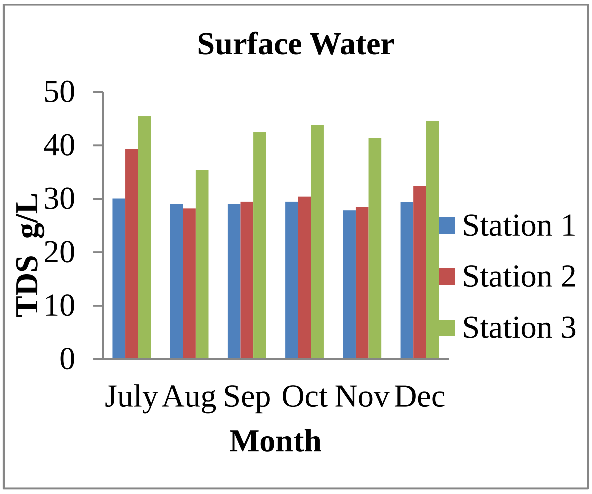


Fig 7: Monthly variations of TDS

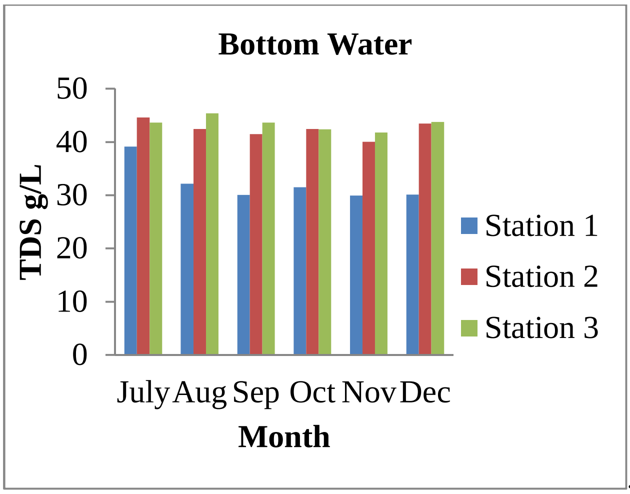


Fig 8: Monthly variations of TDS

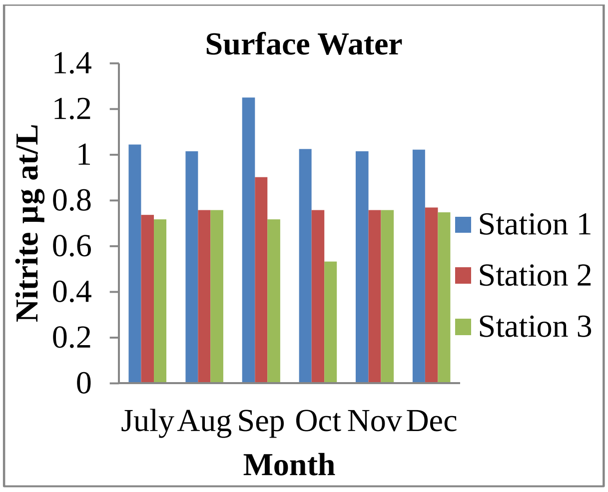


Fig 9: Monthly variations of Nitrite

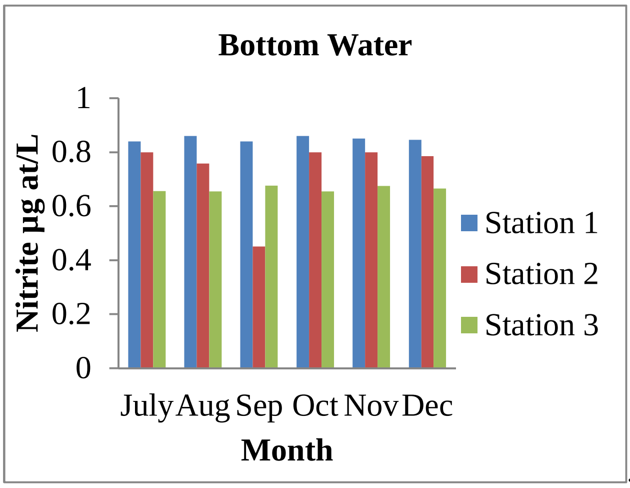


Fig 10: Monthly variations of Nitrite

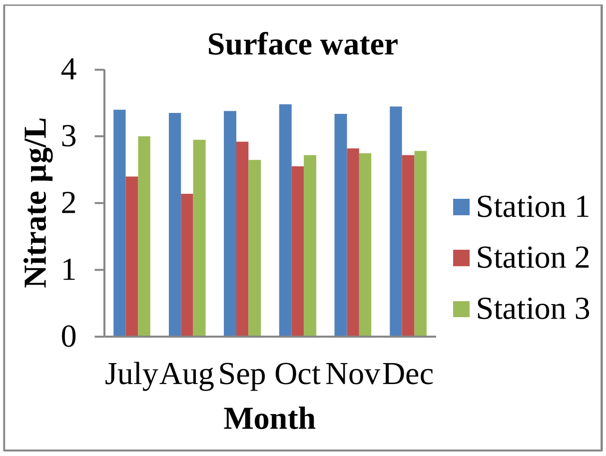


Fig 11: Monthly variations of Nitrate

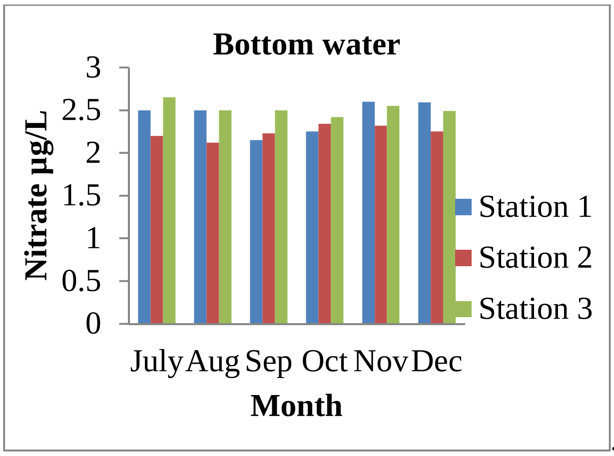


Fig 12: Monthly variations of Nitrate

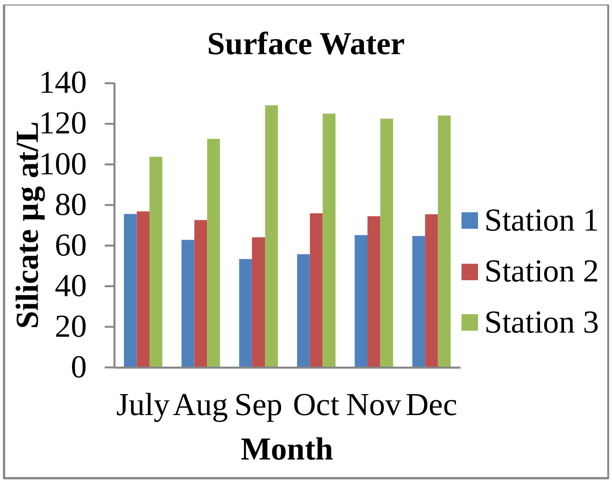


Fig13: Monthly variations of Silicate

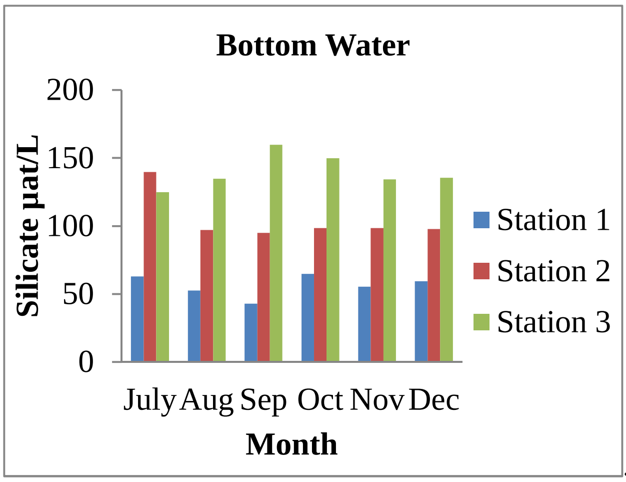


Fig14: Monthly variations of Silicate

pH

pH of the study area was recorded from 7.42±0.03 to 8.51±0.02 both in surface and bottom water in station 1, and minimum 7.42±0.03 was observed in the month of September and maximum of November, in station 2 from 7.56±0.04 to 8.65±0.03 was recorded both in surface (fig 3) and bottom water (fig 4) and minimum of 7.56±0.04 was observed in the month of July and maximum in November. And in station 3 from 8.42±0.02 to 8.85±0.04 was recorded both in surface and bottom water and minimum of 8.42±0.02 (Table 2) was observed in the months of August, September and maximum in July. The recorded high July pH values might be due to the influence of seawater penetration and high biological activity [13]. pH value has been increasing with increasing distance from station 1. Minimum pH was observed in station 1 in the month of September, it may due to as temperature increases, an increased proportion of the water molecules dissociate to H^+ and OH^-, decreasing water pH.

Salinity

Salinity was ranged from 30±1.32 to 38 ±1.80 ‰ in surface water (Fig 5). Minimum was recorded in station 3 and maximum was recorded in station 1. In bottom water 31±1.87 to 35±1.32 ‰ (Fig 6) was ranged. Minimum was recorded in station 2 and maximum in station 1. The salinity was found to be high during the month of July at station 1 and low during the month of November at station 3. The recorded higher values could be attributed to the low amount of rainfall, higher rate of evaporation and also due to neritic water dominance [13, 14]. Drop in salinity during monsoon may perhaps be due to heavy showers and consecutive floodwater from up streams as reported by [15, 16]. Thermal pollution due to disposal in surface water sources disrupts aquatic life [17].

Total dissolved solids (TDS)

Total dissolved solids were recorded from 27.82±0.03 to 45.46±0.05g/L in the surface water (Fig 7). Minimum was recorded in November at station 1 and maximum 45.46±0.05g/L (Table 4) was recorded in July at station 3. TDS of bottom water was recorded from 29.94±0.03 to 45.4±0.03g/L. Minimum was recorded in November and maximum was recorded in August for bottom water (Fig 8). The values were decreasing with increasing distance from disposal area. The reduction in TDS concentration was probably due to chemical interaction.

Nitrite

Nitrite was ranged from 0.533±0.01 to 1.2505±0.01µg at/L in the surface water at stations 3 and 1 respectively (Table 5). Minimum was recorded in the month of October at station 3 and maximum was recorded in the month of September at station 1. In bottom water the values ranged from 0.451±0.02 to 0.861±0.01µg at/L (fig 10) at stations 2 and 1 respectively. Minimum was recorded in the month of September and maximum was recorded in the month of October.

Nitrate

The nitrate value was ranged from 2.14±0.04 to 3.48±0.02 mg/L in the surface water (Table 6). Minimum was recorded at station 2 in the month of August and maximum at station 1 in the month of October. In bottom water the values ranged from 2.12±0.02 to 2.65±0.02 mg/L. Minimum at station 2 in the month of August and maximum at station 3 in the month of July. In marine environment, Nitrogen is present in seawater as dissolved N_2 gas, nitrate, nitrite and ammonia, as well as in organic forms. The higher concentration of nitrate level values is due to the organic materials received in the stream [18]. The maximum values were obtained in station 1. More amounts of nutrients have been recorded in station1 than other stations which can be due to the ash slurry. Coolant water and ash slurry have more nutrients by [19].

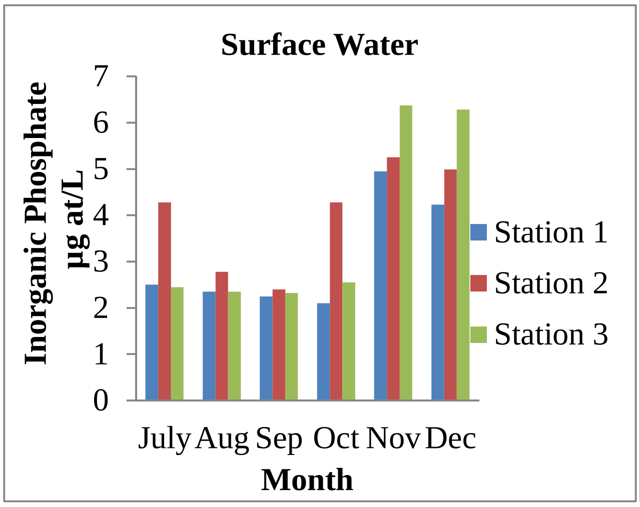


Fig 15: Monthly variations of Inorganic phosphate

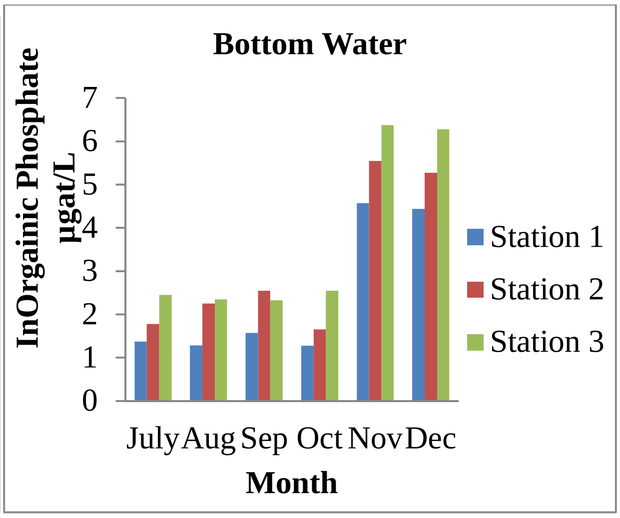


Fig 16: Monthly variations of Inorganic phosphate

Silicate

Silicate silica value of maximum 129.06±0.03 µg at/L (fig 13) was recorded at station 3 and minimum 53.4±0.03 µg at/L was recorded at station 1 in the month of September for the surface water. For the bottom water maximum 159.84±0.03 µg at/L (fig 14) recorded at station 3 and minimum 42.9±0.03 µg at/L was recorded at station 1 in the month of September (Table 7). Due to the turbulent nature of water, the reactive silicate from the bottom sediment might have been exchanged with overlying water [20].

Inorganic phosphate

Inorganic phosphate concentration varied from 2.1±0.02 to 6.525±0.03 µg at/L (fig 15) for the surface water. Minimum was recorded at station 1 and maximum at station 3. In the bottom water the concentration varied from 1.275±0.01 to 6.375±0.07 µg at/L (fig 16). Minimum was recorded at station 1 and maximum at station 3. Both the surface and bottom waters the minimum and maximum values were recorded in the months of October and November respectively (Table 8). High concentration of phosphate was recorded in the present study during monsoon season, might have resulted from the regeneration of phosphate from the bottom mud, and subsequent release of the same in water column by turbulence and mixing caused by heavy winds prevailing during rainy season [20].

CONCLUSION

The present study shows that the addition of fly ash slurry disposal affects the quality of sea water. The nutrient level, temperature were recorded shows high level at station 1. Increased sedimentation rate in this region will affect the marine ecosystem. The disposal, management and proper utilization of waste products has become a concern for the scientists and environmentalists. Proper management of solid-waste fly ash from thermal power plants is necessary to safeguard our environment. Concentrated efforts are needed to utilize fly ash in the manufacture of building bricks, cement and ceramics, and mitigate the unemployment problem as well. Hence, the water from power plant should be treated properly before released into the marine environment.

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