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Study on Physico-Chemical Properties of Coleroon River, Tamil Nadu, India

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ABSTRACT

The study was conducted in Coleroon River from Upper Anaicut to Lower Anaicut Thanjavur District, Tamil Nadu. It is the drainage carrier of Cauvery, branching out near Upper Anaicut. Normally, the entire floodwaters of Cauvery, surplus from Mettur dam are being diverted to Upper Anaicut and Coleroon directly and also through Grand Anaicut. Four stations were selected for collection of water samples and it was analysed for its water quality parameters. The air temperature varied between 28oC and 38oC during the period of investigation. The conductivity was a factor related to the present study points to its significant relationship with water temperature, phosphate and silicate. During summer, the dissolved oxygen level was reduced because of the decomposition of organic matter, resulting in increased COD and BOD. Sulphate was found to have significant correlation with DO, BOD and COD. Phosphate was found to have significant correlation with silicate, BOD and COD. Similarly, Phosphates was observed in the river were within the suitable range for supporting a productive ecosystem. Silicates show significant correlation with Air temperature, Conductivity, DO, BOD and COD. This data was computed with the value of National Sanitation Foundation Water Quality Index (NSFWQI), mostly applicable in USA and India. The results of NSFWQI of Coleroon river indicates that its water quality as 'Good'. Based upon the results, the existing conservation measures have been reviewed and additional measures are suggested.

Keywords: *Water quality parameters, Water quality index, Coleroon River, Temperature.*

INTRODUCTION

Rivers is the sources of drinking water, irrigation, fishery and energy production. Almost all the fresh water bodies are being polluted by expanding human population and in consequence, industrialization, intensive agricultural practices and discharges of massive amount of waste water which result in deterioration of water quality. The main pollutants that pose to natural water quality problems are organic wastes, bacteria, nutrients and other chemical substances. There is an intricate relationship between the external and internal factors in aquatic environments. The physio-chemical parameters have major influences on biochemical reactions that occur within the water. Sudden changes of these parameters may be indicative of changing conditions in the water. The physico-chemical parameters of different freshwater systems have been studied by various researchers[1,2,3,4,5].

However, no comprehensive work has been done till yet to explore the seasonal variation in physiochemical parameters on the water quality of Coleroon river. Keeping this in view, our work was done during the period June 2014 to May 2015, to measure some physiochemical parameters of Coleroon river water in different seasons.

Coleroon river from Upper Anaicut to Lower Anaicut Thanjavur District, Tamil Nadu is located at 10.830° N and 78.818° E and 11.138° N 79.451° E. is selected for the present study. The river Coleroon is the drainage carrier of Cauvery, branching out near Upper Anaicut. Normally, the entire floodwaters of Cauvery, surplus from Mettur dam are being diverted to Upper Anaicut and Coleroon directly and also through Grand anaicut. The total length of river Coleroon is 257 KM from Upper Anaicut and it flows through the districts of Trichy, Perambalur, Ariyalur, Thanjavur, Cuddalore, and Nagapattinam, finally, falls into the Bay of Bengal.

OBJECTIVES

The study was carried out with the following objectives:

- Seasonal variations in the water quality characteristics.
- Mathematical relationship of water quality parameter

MATERIALS AND METHODS

The present study was carried out over a period of one year from June 2014 to May 2015 in different four stations Water sampling was carried out in early hour of the morning throughout the study period at four stations. Generally two liters of water sample in 2.5 litre polythene can is sufficient for most of the physical and chemical examinations. The water samples were collected from a depth of 0.5m and collected up to the top with the mouth facing slightly upward in the direction of the current. The container was properly labeled; the samples were transported to the laboratory in an ice box to avoid unpredictable changes in physicochemical and biological characteristics. Sampling and analysis were carried out according to standard methods prescribed by APHA[6].

RESULTS AND DISCUSSION

Season dependent variations in air temperature of the four stations of the Coleroon River are presented in table 3 and Figure 1. It divulges that the patterns of deviation in all the four stations are alike throughout the phase of research. The air temperature varied between 28°C and 38°C during the period of investigation. Seasonal variations of the water temperature in the four stations of Coleroon River are presented in table 3 and Figure 2. The maximum water temperature of 34°C was documented during Apr'15 in SIII and the lowest water temperature of 23°C during Dec '14all the stations were hot during the months from Feb'14 to Jul'14 and Feb'15 to May'15. The temperature dropped in Oct'14 to Dec'14 gradually in all the stations. Variation in the same months may be due to the changes in the weather factors and difference in the time of observation. The variations between the air and water temperature went hand in hand. Further, the water temperature was not parallel with air temperature during Oct'14 to Dec'14. In view of it could be assumed that the cooler water flowing into the river has reduced the water temperature more than the local air temperature. The maximum difference of 6 °C between the air temperature and water temperature was recorded in December'14 at all the stations. The outflow was low and there was only little inflow. The correlation of the air temperature and water temperature of Coleroon river showed positive relationship (figure 11 and 12). A similar correlation between air and water temperature was reported[3,7,8,9]. The variations in air and water temperature is similar to other rivers and reservoirs of Tamil Nadu as reported[10,11,12].

Table1: *Geographical location of the study area*

Station	Place	Latitude	Longitude	Altitude (ft)
SI	Upper Anaicut	10°49'10.30" N	78°49'10.30" E	224
SII	Thirumanur	10°55'54.62" N	79°06'16.92" E	122
SIII	Neelathanallur	11°02'57.68" N	79°21'38.02" E	74
SIV	Lower Anaicut	11°08'17.28" N	79°26'48.62" E	65

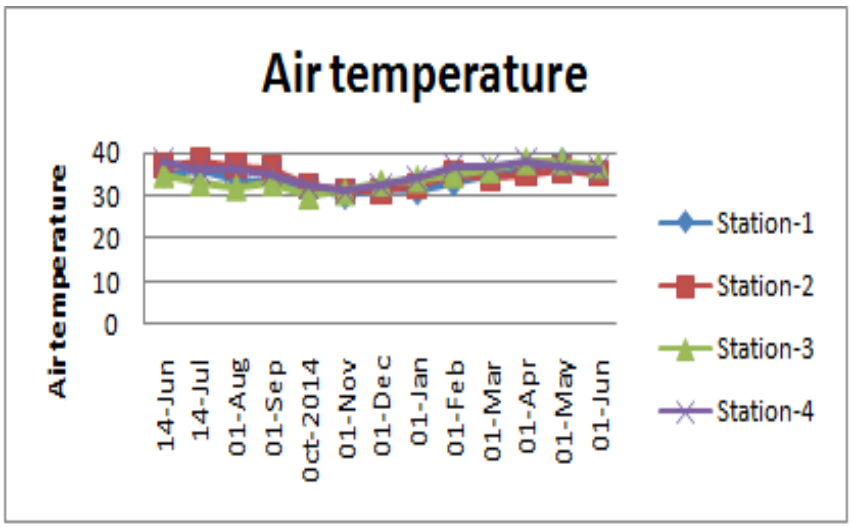

Figure1: *Seasonal variation of Air temperature (oC) in four stations during the study period.*

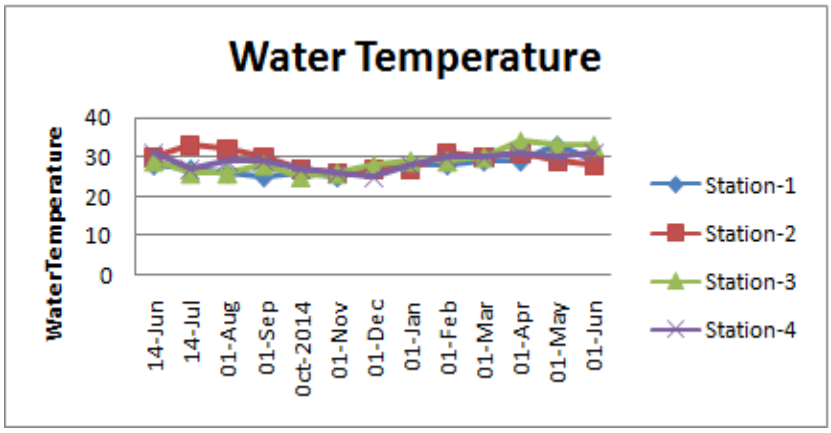

Figure2: *Seasonal variation of Water temperature (oC) in four stations during the study period.*

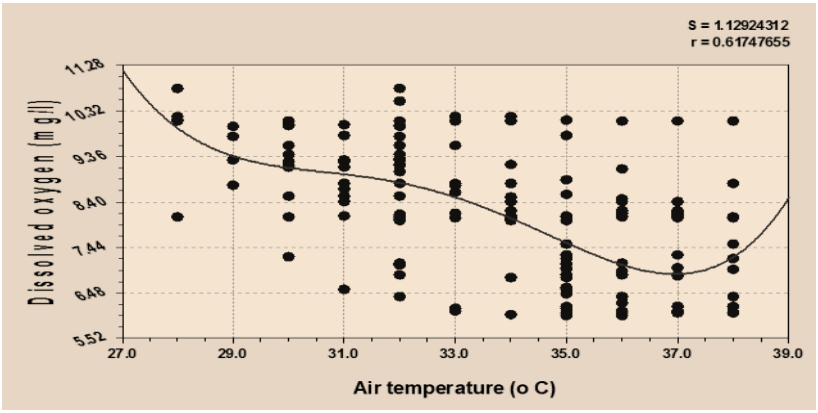

Figure11: *Polynomial fit showing the mathematical relationship between Air temperature and dissolved oxygen.*

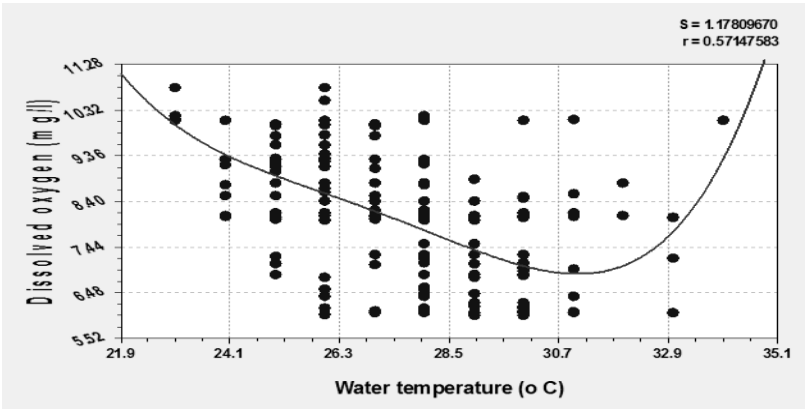

Figure12: *Polynomial fit showing the mathematical relationship between water temperature and dissolved oxygen***.**

Variations in the pH of four stations are presented in table 3 and Figure 4. The pH of the four stations was between 7.2 and 8.3. The pH show significant changes during the months of the study period in Coleroon River. During Apr'15 to May'15 period pH was found to increase towards neutral in all the stations. A similar observation was earlier reported[11,12] . According to Srivastava *et al.*, [13]increase in pH is related to increase in production. This synchronizes with observation made in Coleroon River. A minor reduction in pH was observed during Jan'14 to May'14 month's period. This reduction is in agreement with the earlier observation in Cauvery river[3,9]. According to Rajagopal *et al.*, [14]the environment from which water drains into the catchment determines its pH. During the above months inflowing water influenced the pH to some extent as the natural rain water is of 7.2 – 7.3. This may be one of the reasons for the low pH during the raining season. Further alkaline nature of the water may be due to the presence of limestone deposits along the bank of the river as Ariyalur formation of cretaceous period lies adjoining to the river.

Table2: *List of physicochemical parameters and their methods*

Sl.No	Parameters	Method /instrument
1.	Temperature	Celsius thermometer
2.	pH	pH meter (Hanna Pen type) made in Portugal
3.	Conductivity	Conductivity meter (Henna pen type) made in Portugal
5.	Dissolved oxygen	Winkler's iodometric method
6.	Phosphate	Colorimetric (Molybdophosphoric acid method)
7.	Sulphate	Turbidimetric at 420nm
8.	Silicate	Colorimetric (Molybosilicate method)
9.	BOD	Winkler method after incubation for 5 days
10	COD	Titrimetric method

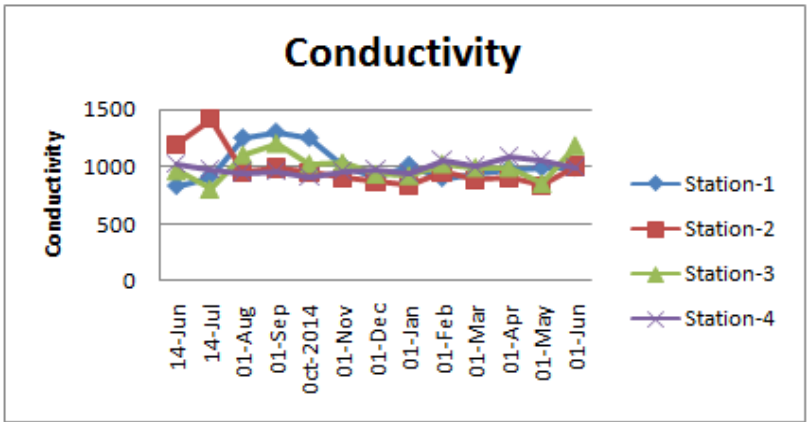

Figure3: *Seasonal variation of Conductivity in four stations during the study period.*

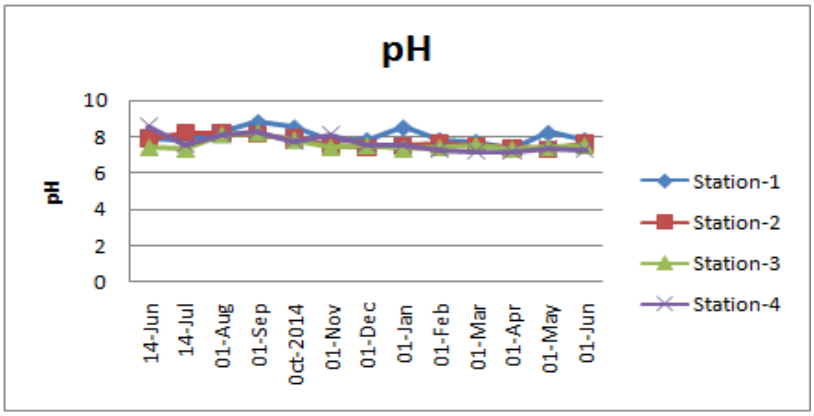

Figure4: *Seasonal variation of pH in four stations during the study period.*

The electrical conductivity of the four stations ranged from 800 µSie – 1420 µSie are shown in table 3 and figure 3. The low electrical conductivity (730 µSie) was observed in the SIII in Sep'13 and Oct'13 and the maximum in SII in Jul'14.Conductivity is an index of the amount of water soluble salt presents in water indicating that the salt of mineralization in an aquatic ecosystem. The measurement of dissolved ions having wide bearing on the productivity. Majority of Indian rivers have lower values of conductivity as compared to Coleroon River. The presence of salts and nutrients in the water may be the reason for conductivity. The result of the present study reveals that the conductivity of all the stations seems to be suitable for Agriculture and aquaculture practices.

The minimum amount of dissolved oxygen of 8.28 mg/l was recorded in Mar'13 in SII and Jun'14 in the SIV. The maximum amount of DO was observed from SIV (10.85 mg/l) during Dec'13 and Feb'15 and given in table 3 and figure 5. The dissolved oxygen showed insignificant difference among the different stations studied. Among the chemical parameters dissolved oxygen is one of the very important factors for the existence of plants and animals in an aquatic environment. The amount of dissolved oxygen is an indicator of quality of water and its suitability for aquatic life. The dissolved oxygen content of the water was high in Feb '15 and Mar'15 compared with other months in all the stations. This may be due to high solubility of water with surface water at

low temperature. This finding is in agreement with the observations made [15]. According to Ravichandran and Rakesh Sharma[9] the reduction of dissolved oxygen level implies an index of high productivity. Mahendran[16] reported that tropical reservoir are characterized by low dissolved oxygen levels in the water regardless of eutrophy or oligotrophy. However, it was observed that the variations are of many reasons other than a sign of productivity. According to Sreenivasan and Kotaiah[17], the deficit may be either due to the decomposition of submerged vegetation and bottom mud or due to the oxygen being utilized by the benthic organisms for respiration. High photosynthetic group can fix oxygen to the water mass to a greater extent than through diffusion [4,5]. The result of the present study reveals that the river never suffered from hypoxia or anoxia. The results also reveal its suitability as high productive river and suitability for intensive aquaculture practice.

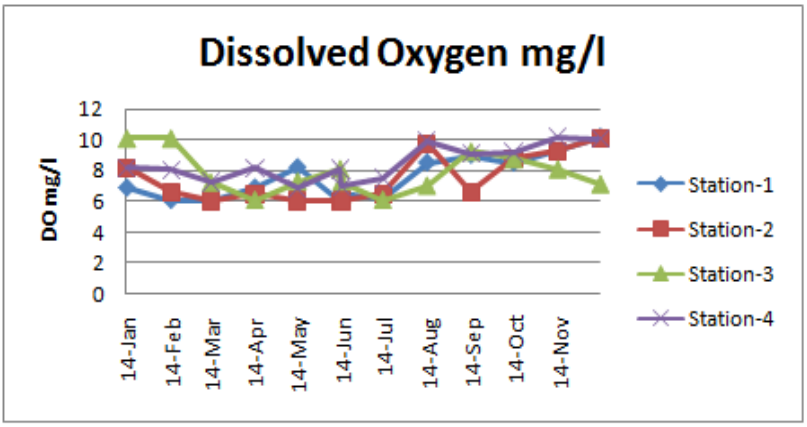

Figure5: *Seasonal variation of dissolved oxygen (mg/L) in four stations during the study period.*

Table3: *The detailed observations for the fluctuation in all the physio chemical parameters are recorded inColeron River*

Sl. no	Parameter	Station-I	Station-II	Station-III	Station-IV
1	Air temperature(°C)	30 - 38	31-38	30 - 38	31 - 38
2	Water temperature(°C)	25 - 33	26 - 33	25 - 34	25 - 31
3	Conductivity	830 - 1300	840 - 1420	800- 1200	910 - 1090
4	pH	7.3 – 8.2	7.3 – 8.2	7.2 – 8.3	7.2 – 8.3
5	Phosphate (mg/l)	0.15- 1.5	0.13-1.25	0.27-2.14	0.12-1.24
6	BOD(mg/l)	32 - 58	31 - 40	30 - 60	29 - 92
7	COD(mg/l)	32.06- 49.1	42.06– 54.12	30.08 – 72.14	35.54– 67.54
8	Dissolved oxygen(mg/l)	9.74- 10.85	9.5- 10.52	8.7 – 10.1	8.28- 10.81
9	Sulphate(mg/l)	5.35- 12.46	5.84- 18.52	4.76-16.06	6.61-26.91
10	Silicate(mg/l)	1.15- 2.5	2.13-3.25	2.27-3.14	2.12-3.24

The aquatic production will be higher if all nutrients are present in optimum concentration. Among the dissolved nutrients, phosphorus in fresh water system is most often found to be a limiting factor. The role of phosphorus in aquatic life has been widely studied and its importance in aquatic ecosystem is well recognized. Accordingly phosphorus concentration was monitored to assess the trophic status of river under investigation. The nutrient flow dynamic and forms the biogeochemical cycles.

The high nutrient levels and nutrient dynamics in the form of nutrient turnover are essential for better production characteristics. The results of the present study reveal a significant relationship between nutrients levels of the sediments and the nutrient levels in water. The mathematical models and relationship established also paved way for developing sustainable strategies for water quality management in the river ecosystem.

The results of the present study reveal that there is a wide fluctuation in the biological oxygen demand of station II that showed a maximum of 92 mg/l (Jun'14 in SVIII) and a minimum of 29 mg/l in SIII during Apr'15 presented in table 3 and figure 6.Seasonal variations in COD reveal the maximum value 72.14 mg/l in station III during Jun'13 and the minimum value 72.14 mg/l in SII Feb'15 presented in table 3 and figure 7.

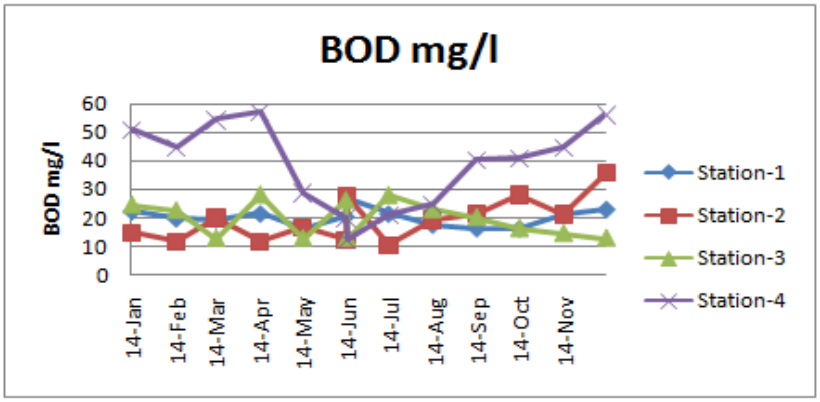

Figure6: *Seasonal variation of BOD (mg/L) in four stations during the study period.*

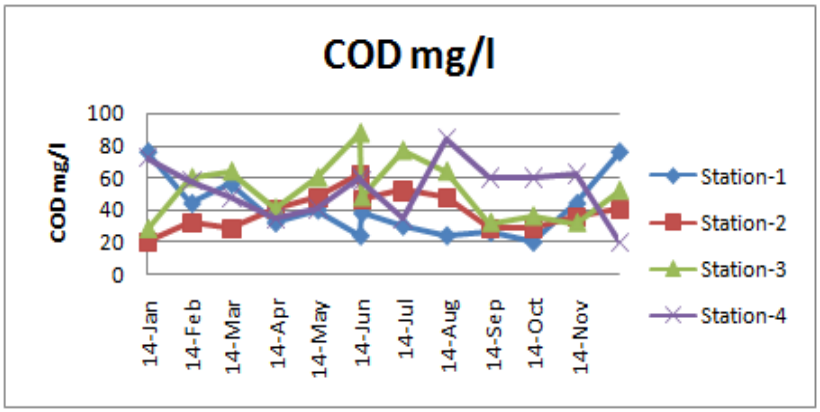

Figure 7: *Seasonal variations of COD (mg/L) in four stations during study period.*

The present investigation revealed that the dissolved phosphate concentration in the river varied widely and it is related to the sediment phosphates. During most of the months the river were characterized by low level of phosphate. Earlier studies revealed such low levels of phosphate content in many of the Indian rivers [4, 5,13] stated that the amount of nutrients in the river is derived from the catchment area through rain washing depends on the soil types of catchment. In this river phosphate content was ranged from 0.012 – 2.14 mg/. In the present study all the stations showed seasonal variation of dissolved phosphate concentration. The values were found high during Oct'14 to Dec' 14.

A similar instance was earlier reported [4,5] in. The high values of dissolved phosphate during monsoon may be due to the rain washings from the catchment through river discharge and flood water as well as seepage from paddy fields. Besides the rain water soil colloids decomposition of aquatic and conversion of insoluble salts appear to show increasing trend in the water column and enrich the water during monsoon [18]. The level of phosphates in the river further reveals that it is a water body without eutrophication and optimum production. Proper management strategies will evolve it as a highly productive water body.

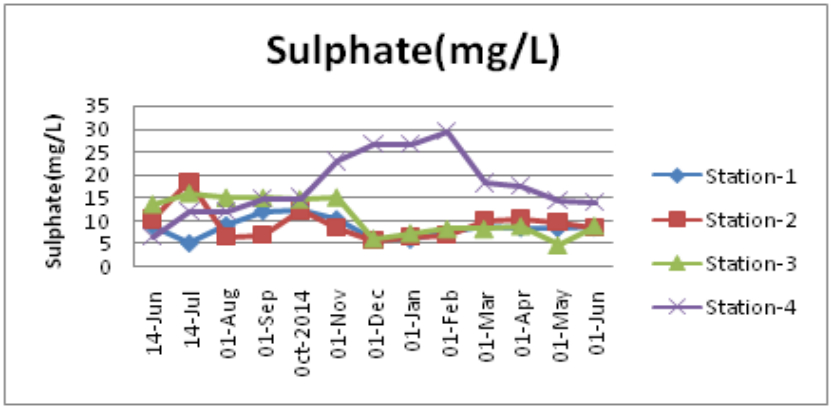

Figure 8: *Seasonal variation of Sulphate (mg/L) in four stations during the study period.*

The minimum sulphate level of 4.76 mg/l was observed in SIV during Aug'13 and Oct'14 and in SIII Sep'13, Jan'14, Nov'14 and Mar'15 and the maximum level of 26.91 mg/l was in SIV in Feb'15 presented in Figure 8.

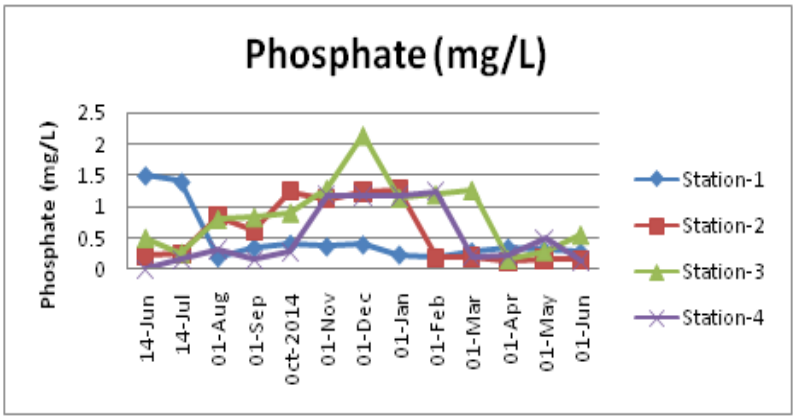

Figure9: *Seasonal variation of Phosphate (mg/L) in four stations during the study period.*

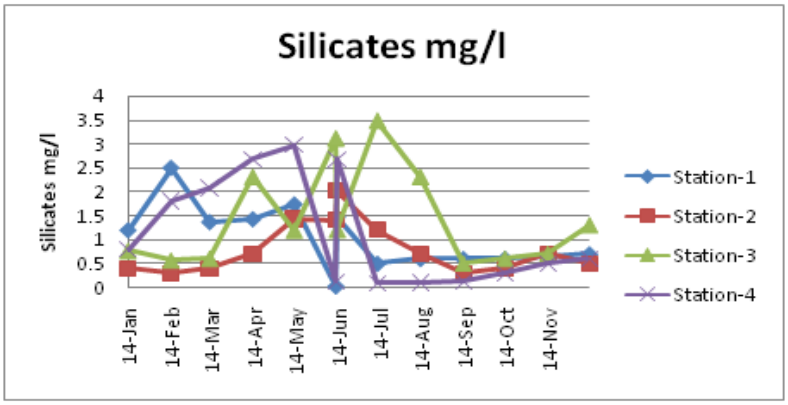

Figure10: *Seasonal variation of Silicates (mg/L) in four stations during the study period.*

Seasonal variations in the silicates of the different stations during the experimental period are presented in Figure 10. Silicates in river water exist mainly in the form silicic acid and reactive polymer. The release of silicic acid depends on the availability of carbon di oxide (carbon di oxide) or bicarbonates. According to Maya et al.,[8]silicate concentration is directly associated with the density of diatom population since diatoms are the main consumers of silicate for the formation of frustules. Nutrient status of the Coleroon River revealed that compared to phosphorus and nitrogen, silicate content is higher in concentration. The silicate concentration was in the range of 1.15 – 3.25 mg/l during the present study. The correlation coefficients of silicate with dissolved oxygen, ammonia, BOD, COD, and dissolved oxygen showed significantly correlated. The observed values are in agreement with the results recorded earlier[4,5,15]. It was observed that the level of dissolved silicate was higher towards station IV.

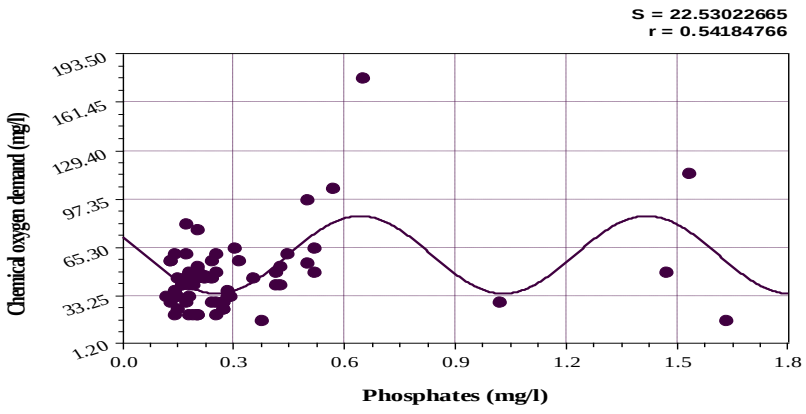

Figure 13: *Polynomial fit showing the mathematical relationship between phosphte and dissolved oxygen*

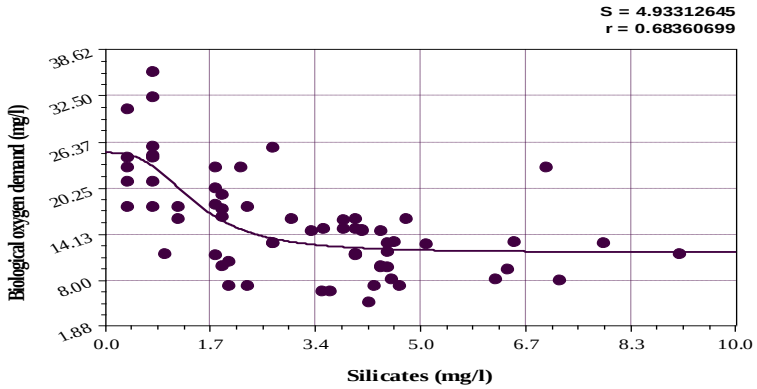

Figure 14: *MMF model showing the mathematical relationship between silicates and biological oxygen demand.*

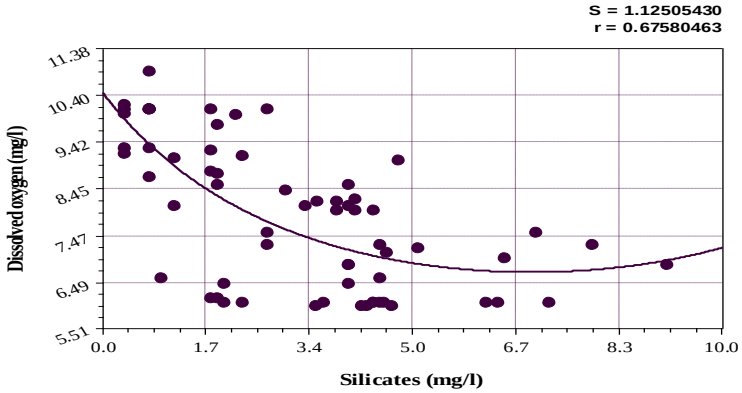

Figure 15: *Polynomial fit showing the mathematical relationship between silicates and dissolved oxygen.*

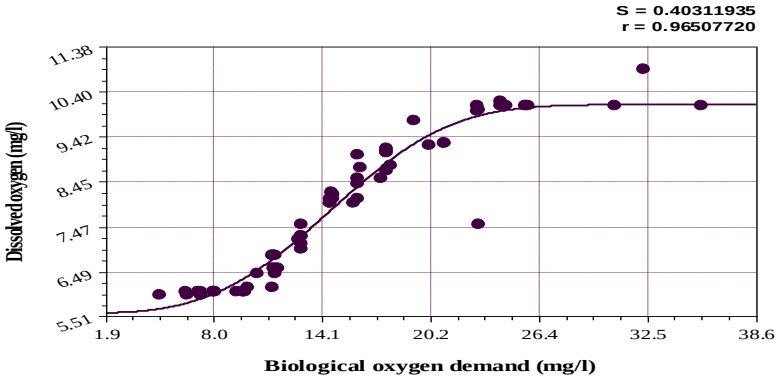

Figure 16: *Reciprocal logarithm fit showing the mathematical relationship between biological oxygen demand and dissolved oxygen.*

CONCLUSION

The results clearly suggest that the dissolved oxygen can be a suitable and easy index to predict air temperature, water temperature, conductivity, pH, BOD,COD, sulphate as well as phosphate of water. Investigations of these nonlinear derivations should be made in different types of ecosystem with different characteristics for deriving a universal nonlinear equation for predicting such parameters. The present study suggested that most of the physical and chemical properties of Coleroon river water were within desirable limits. The quality of water is not stable and it may be changed due to seasonal variations.

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