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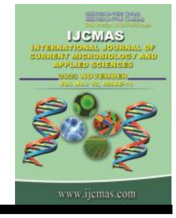

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Spatial Assessment of Water Quality in the Three Reservoir of Cauvery River, Tamil Nadu, India

P. Nithya*, G. Kiruthiga and T. Pooja

Department of Zoology, Vivekanandha College of Arts and Sciences for Women, Tiruchengode - 637205, Tamil Nadu, India

**Corresponding author*

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A B S T R A C T

This study was designed to assess the physico-chemical characteristics of Cauvery river three stations (S1- Sozhasiramani dam (Polluted), S2- –Maynor Dam (Less Polluted) and S3- Mettur Dam (Free from Pollution.) during the study period December 2021 to May 2022. The parameters were analysed such as Temperature, transparency, Total hardness, pH, DO2, BOD, Phosphate, Nitrate, Nitrite, Ammonia, Slicate and CR, NPP, GPP. This study concluded that the water quality of three reservoir of Cauvery River during the study period revealed that the three stations (Sozhasiramani dam, Mayanur dam and Mettur dam). Among these reservoir Mayanur dam and Mettur dam could be rated for good quality of water, which is suitable for consuming purpose but Sozhasiramani dam receiving some of the unauthorized textile dyeing and bleaching units in Eroad and Pallipalayam in above units discharge treated and untreated effluent into the municipal drain along with the domestic sewage reached the river cauvery in station 1 is highly polluted, then the other two stations.

Introduction

Aquatic ecosystem monitoring has been carried out in India based on either chemical or biological analysis. The chemical approach is useful in order to determine the levels of nutrients, metals, pesticides, (Tamizhazhagan and Pugazhendy, 2016) radioactive substances, etc., Aquatic ecosystem is the most diverse ecosystem in the world. Cauvery is one of the biggest water courses of India and it originates in the Brahmagiri hills in Kodagu, Karnataka and subsequent to experiencing 765 km it at last merges with Bay of Bengal (Krishnaswamy *et al.,* 2008). Cauvery resembles a Goddess for the people of Tamil Nadu, the water of Cauvery is utilized to create power generation, to give water for irrigation and also for domestic use. The waterway has assisted irrigated agriculture for over 1000 years and served as the backbone of the ancient Kingdoms and current urban communities of South India. Rivers are important resources, because they are directly used for drinking, bathing, agriculture, transportation, power generation, recreation, and other human activities including waste disposal. But river water is adversely affected due to the discharge of untreated or partially treated industrial effluents, civic wastewater, as well as washing clothes and cattle bathing (Jafar Ahamed and Loganathan, 2017).

The overall productivity of any aquatic ecosystem is simply the most essential one for a proper assessment of biological potential of particular habitat as it gives information related to support bioactivities of the system and also it integrates the cumulative effects of many physiological processes. So many ecobiologist in and around the world emphasis on the importance of primary productivity as an importance functional attribute. Since it form the importance back bone of aquatic food chain, limno-chemistry of tropical wetlands with reference to primary productivity and water quality was well documented by Jayashree Sarma (2016).

Presently these natural wetlands, the priceless, most indispensable life-supporting systems and the most essential systems that provides necessary facilities for the people also acts as media for both chemical and biochemical reactions. Worldwide due to urbanization and development thrust of man the wetland water which serves as internal and external medium of several organisms are noted to have severely been affected by a multitude of anthropogenic disturbances led to serious negative effects on the structure of these ecosystems.

Due to the above discussed issues during the recent years, there has been increasingly greater concern for inland fresh water resources which are affected in different ways by all kinds of human activities. Therefore scientific study needs to review strategies for conservation and better utilization of wetlands due to which studies of fresh water reservoirs globally and in India have gained momentum in recent years. The selected study area (Sozhasiramani dam Mayanur dam and Mettur) too is facing the above discussed problems decline in the quality of water, loss in biodiversity of aquatic organisms decline in asthetic beauty of river. So the present study has been taken up with the objective to physicochemical characteristics of Cauvery river water.

Materials and Methods

Research design

Three different stations (Stn.1, Stn.2 and Stn.3) were selected throughout the wetland as representative of the total area. Selection of experimental stations were on the basis of inflow, depth and accessibility viz pollution load, pilgrims, human activities interventions, sewage inclusion, idol immersion. Sozhasiramani dam (Stn.1), Maynor Dam (Stn.2), Mettur Dam (Stn.3).

Data collection

For the present study sampling was done for a period of six month (December 2021- May 2022) with 30 days interval. Where by triplicate samples were collected during the morning hours (6.00 – 9.00 AM**)** from the three sampling stations as in the research design form the sampling sites during the study period in order to maintain uniformity. The water samples were collected using a pre-cleaned polythene container. It must be capable of being tightly sealed either by stopper or cap. The bottles were disinfected earlier by soaking it with 2% HNO_3 and with 10% HCl for 24hrs and then thoroughly cleaned and rinsed with distilled water because between the time that a sample is collected in the field and until it is actually analyzed in the laboratory, physical, chemical and biochemical reactions, may take place in the sample which will change the intrinsic quality of the sample more over until analysis it is necessary to preserve the samples using icebox before bringing to laboratory to prevent or minimize their changes, so all samples were stored in refrigerator at 4°C for further analysis and the experiments were carried out within 48-72 hours of collection.

Methodologies employed for physicochemical analysis in water samples

Field activities

Hydrological parameters such as air and water temperature was measured using Standard Centrifuge Thermometer (°C), transparency was measured using Secchi disc (Cm), pH was recorded using Portable pH meter and Primary productivity was estimated directly in the field following Gaarder and Gran (1927).

Laboratory analysis

Collected water samples were analyzed for total hardness estimated following Strickland and Parsons, (1972); Dissolved oxygen following Wrinkler's Method (1972), Biological oxygen demand was carried out by APHA, (2010) and nutrients like (Phosphate, Nitrate, Nitrite, Ammonia and silicate; (Phosphate and Silicate) was determined according to Strickland and Parsons (1972).

Data analysis

All the data provided in the tables were the average of three replicates in six month of the study period (December 2021- May 2022). Differences in water quality (physical, chemical, and nutrients in water) parameters among and within sampling stations were tested using standard deviations between all pairs of measured variables to understand the dynamic distribution of different parameters. All the analyzed data were compared using ICMR (1975); BIS (1991); ISI (1991); APHA (2005) and WHO (2010).

Results and Discussion

The results are presented in groups; Group I (Physical parameters) Rain fall (RF), air temperature (AT), water temperature (WT) and transparency; Group II (Chemical parameters) pH, total hardness (TH), dissolved oxygen (DO), biological oxygen demand (BOD); Group III (Nutrients) phosphate (Po_4), nitrate (No_3), nitrite (No_2), ammonia (NH_3) and silicate (SiO_2); Group IV (Primary productivity); GPP (Gross primary productivity), NPP (Net primary productivity) and CR (Cross productivity).

Group I (Physical parameters)

The monthly variation of air temperature at three reservoirs during the year (December 2021-May 2022) presented in the Table (2), In stn.1 the lowest temperature (27.3±1.83˚C) the highest temperature (32.1±1.55˚C) was noted the during the month (March and April). In stn.2 the lowest temperature (26.9±1.69˚C) the highest temperature (31.7±1.17˚C) was noted during the month (March and April). In Stn.3 showed minimum value of temperature (26.2±1.88˚C) in (March) and a maximum of (36.5±1.88˚C) (February) was recorded. The mean values of temperature Fig. (1). In the present study temperature was found to be maximum of (32.1±1.55 ºC) in summer season whereas it was found minimum 26.02±1.88ºC) in postmonsoon season with an annual average of (28.58±5.34˚C). Temperature being the most significant parameters in controlling inborn physical qualities of water also plays an important role in controlling the chemical and biological parameters of water so it is considered as one among the most important factors in the aquatic environment particularly for freshwaters.

The monthly variation of water temperature at three reservoirs during the year (December 2021-May 2022) presented in the Fig (2), In stn.1 the lowest temperature (28.9±1.44˚C) the highest temperature (34.2±1.45˚C) was noted the during the month (February and May). In stn.2 the lowest temperature (28.1±1.53˚C) the highest temperature (33.7±1.55˚C) was noted during the month (February and May). In Stn.3 showed minimum value of temperature (27.8±1.62˚C) in (February) and a maximum of (33.1±1.50˚C) (March) was recorded. The temperature is one of the important factors in the coastal ecosystem, which may influence the distribution and abundance of flora and fauna (Nithya *et al.,* 2018). Water temperature plays an important role in the solubility of salts and gases. Water temperature recorded was noted to be minimum (28.9±1.44˚C) in month of August at Stn.3 and maximum (34.2˚C±1.45˚C) in May at Stn.1. The variation in temperature in the present study may be due to different timings of collection and influence of season (Jayaraman *et al.,* 2003). At all the stations and among seasons maximum air and water temperature was during summer because of bright and long duration of solar radiation, low water level, high temperature and clear atmosphere which was in agreement to the report in the river Palar (Govindswamy *et al.,* 2000) and minimum during monsoon because of lower temperature due to the cloudy sky and rainfall which brought down the temperature to the minimum level (Kannan and Kannan, 1996). Results clearly showed that, water temperature remained lesser then air temperature throughout the study period. Similar kind of observation with similar trends while working on different water bodies was reported by El Badaoui *et al.,* (2015).

Monthly and seasonal variations of transparency in (December 2021- May 2022) study period of three reservoir water were presented in the Fig (3). The maximum and minimum mean value of transparency varied between at Stn.1 (112±2.07cm- 78±1.78cm) at Stn.2 (118±25.5cm – 81±1.84cm) and at Stn.3 (121±2.05-89±1.88cm) were observed. During study period (December 2021- May 2022) the highest mean value of transparency recorded during march season at Stn.3 (121±2.05cm) in (March) and minimum mean value was obtained in the February season at Stn.2 (81±1.84cm). In the present investigation among the three stations the maximum transparency was recorded in the month of (March, February) (121±2.05cm) during march month at Stn.3. High transparency of water in summer seemed to be related to greater amount of sunshine, better penetration of light, moderate velocity of wind, stillness of water and less proportion of dissolved oxygen attributed and to the sedimentation of suspended matter (Chaurasia and Adoni, 1985; Sinha *et al.,* 2002 and Shah and Pandit, 2013) and minimum transparency value was observed in month (February) 81±1.84 cm at Stn.2 during February month which could be attributed to cloudy conditions, poor sunshine and influx of surface runoff laden with silt and different kinds of organic material causing turbidity in water due to increase of suspended particles on account of organic debris's decomposition with higher water temperature and reduced flow.

Group II (Chemical parameters)

Monthly variations in pH mean value of three different stations Stn.1, Stn.2 and Stn3 were presented in Fig. (4). The monthly minimum value of pH (6.2±0.28; 5.5±0.35; 5.1±0.51) and maximum pH value in (7.3±0.73; 7.72±0.75; 8.9±0.55) were recorded in Stn.1, Stn.2 and Stn3. Seasonal variation of pH documented during the present study was observed to be minimum during February season and maximum may season. Over all the maximum value of pH recorded was at Stn.2 (7.72±0.75). Maximum pH recorded during summer may be due to presence of carbonates and bicarbonates of alkali and alkaline earth metals (Bohra, 1976 and Chisty, 2002) decreased decomposition rate owing to reduced microbial activity, overfeeding to fishes and increased decomposition rate leading to acidification which was accordance to the present study report. Low pH value was observed in post monsoon in the present study which may be attributed to influence of fresh water influx, dilution of lake water, organic matter decomposing, decaying aquatic weeds (Zingde *et al.,* 1987). The fluctuation in pH values observed among the selected sites may be due to changes in biotic and a biotic factor, which may be attributed to the dilution on account of the inflow of the runoff and macrophytes cove

Maximum total hardness was recorded maximum in may (216±3.41mg/l) and minimum in February (82.8±1.42) Fig. (5). Minimum and maximum values of total hardness recorded during (December 2021- May 2022) were at Stn.1 (216±1.50-86.4±1.55 mg/l). Monthly mean value maximum analysis showed of total hardness at Stn.1 (216±1.50- 86.4±1.55 mg/l) (May) and minimum total hardness value at Stn.3 (82.8±1.25 mg/l) at Stn.1, Stn.2 and Stn.3 were recorded in month (February).

Hardness of water is due to the presence of certain salts of calcium, magnesium and some heavy metals (Jain, 1988) and is considered very important parameter in decreasing the toxic effect of poisonous element. Mohan and Patra (2001) reported that addition of sewage, detergents and large-scale human use might cause elevation of hardness of water.

In the present investigation the maximum value of total hardness was recorded in the month of (May) (216±3.41mg/l) and minimum value in the month of (February) (82.8±1.21mg/l). Total hardness recorded high during summer may be due to leaching of rocks in catchment area, can be attributed to decrease in water volume and increase in rate of evaporation of water and probably due to regular addition of large quantities of detergents used by the nearby residential localities which drains into it Low level of hardness in water of selected study area during the study period may be due to less discharge of sewage and may be attributed to dilution of calcium in the wetland water by rain Hujare (2008) report too states that total hardness was lower in monsoon and higher in summer.

Maximum mean Dissolved oxygen was recorded in December (8.7±.0.48mg/l) and minimum in may respectively. Maximum dissolved oxygen at Stn.1 (7.8 ±.0.78 mg/l), Snt.2 (8.2 ±0.72 mg/l) and Stn.3 (8.7±0.48) was recorded in December 2021. Minimum at Stn.1 (4.1±0.25 mg/l), Stn.2 (4.3 ±.0.39 mg/l) and Stn.3 (4.9±0.49 mg/l) was recorded in May 2022 shown Fig. (6) respectively. In the present investigation the minimum (4.1±0.25mg/l) dissolved oxygen was recorded at Stn.1 in the month of (May) summer season and the maximum (8.7±0.48mg/l) dissolved oxygen level was observed in Stn.3 month of (Decenber) ie. postmonsoon seasons. Lowest dissolved oxygen was recorded as (4.1±0.25mg/l) during the summer season which can be related to the high temperature, low incoming of freshwater and the addition of sewage and other wastes, biochemical oxidation of organic matter and combined effect of temperature and photosynthetic activity has drastically reduced the dissolved oxygen content.

Minimum dissolved oxygen recorded during summer could be due to the decomposition of biota and uptake of oxygen by the marine organism which are in support to the statement given by Nithya *et al.,* (2018). Maximum dissolved oxygen was recorded during monsoon may be due to cooling of lake water by rain, because of the increased solubility of oxygen at lower atmosphere temperature and low water temperature. Analysis result of that biological oxygen demand parameter in the three reservoir showed highest (2.50±.0.25mg/l) (2.39±0.56mg/l) (2.21±0.25mg/l) in May 2015 and lowest (2.5±0.25mg/l) (2.39±0.56mg/l) (2.21±0.25mg/l) in (March) 2022 at Stn.1, Stn.2 and Stn.3. Among the stations maximum mean biological oxygen demand (2.8±0.25mg/l) was recorded at Stn.1 during March season while (1.12±0.09mg/l) minimum biological oxygen demand value was recorded at Stn.2 during February season Fig.(7) respectively.

During the study period biological oxygen demand was observed to be higher during summer month of (March) (2.50±0.25mg/l) at Stn.1 and low value observed in postmonsoon season in the month of (February) (1.09±0.05mg/l). Maximum biological oxygen demand were recorded in the summer season and minimum biological oxygen demand values were recorded during monsoon season during the study period could be due to the increase in temperature, increase in oxidation rate and enhancement of microbial metabolic activities with increased amount of organic matter discharged due to human activities poor photosynthesis, and hence required more amount of oxygen while the low biological oxygen demand in all samples showed good sanitary condition water was recorded (Rahashyamani Mishra, 2011).

Fig.1 Data on the seasonal variation in physical parameter Air temperature at Three Reservoir for a period of December 2021-May 2022.

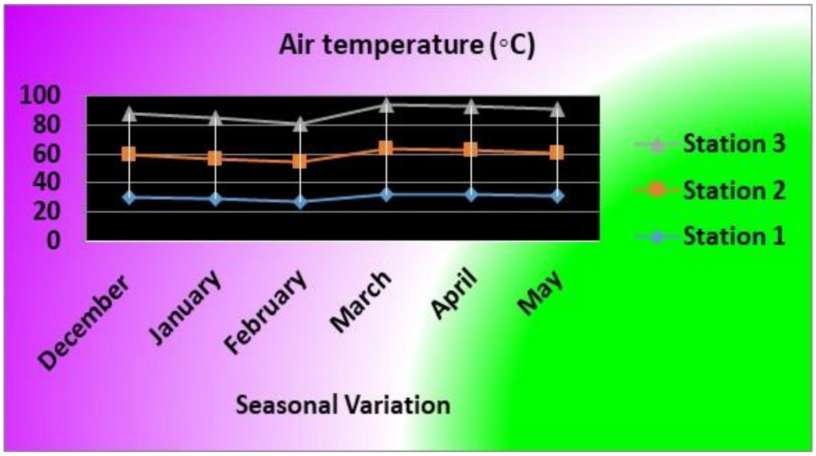
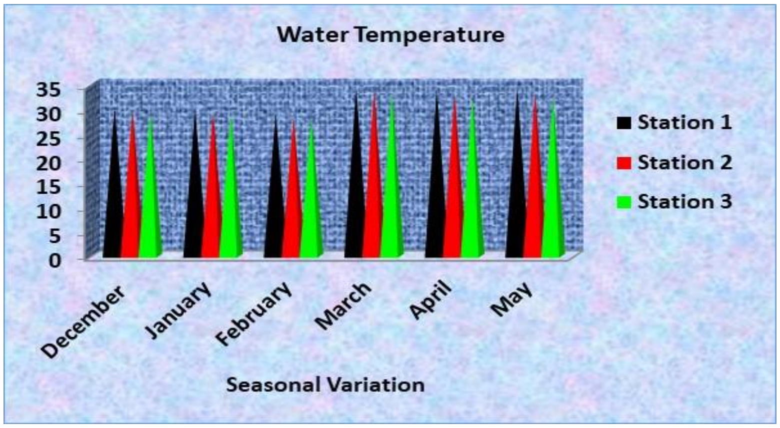
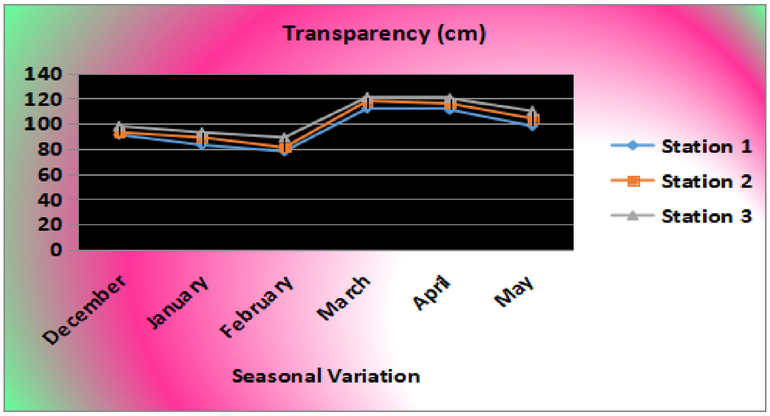


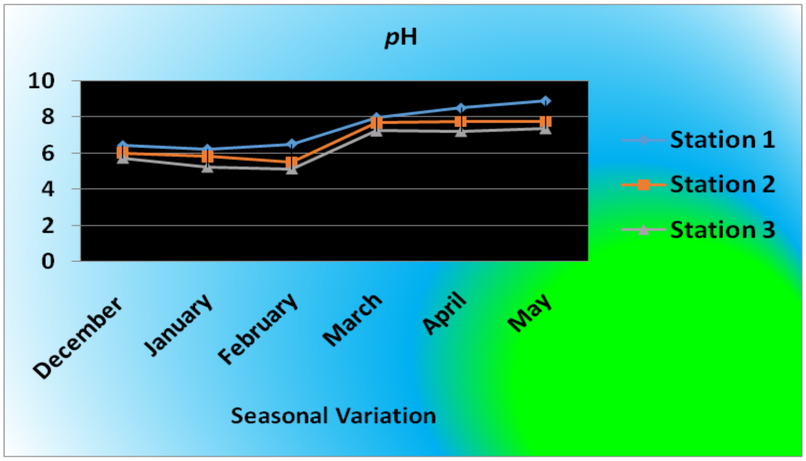
Fig.2 & 3 Data on the seasonal variation in physical parameters such as water temperature and transparency at Three reservoir for a period of December 2021-May 2022.

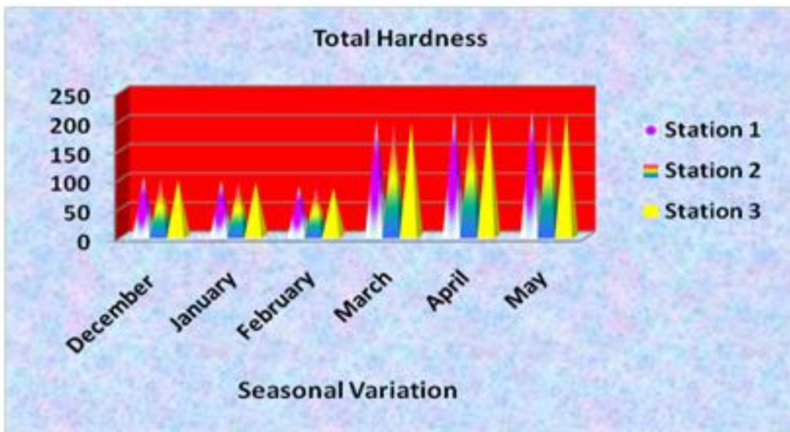




*All the values are mean ± SD of three replicates

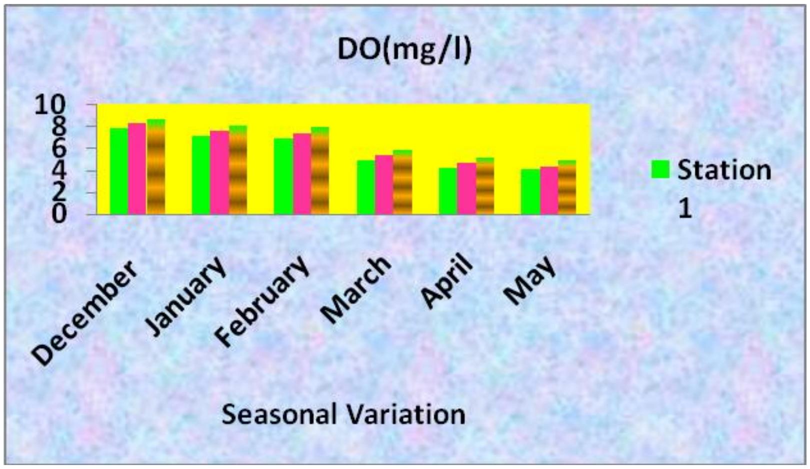
Fig.4 & 5 Data on the seasonal variation in chemical parameters such as pH and TH at Three Reservoir for a period of December 2021- May 2022.

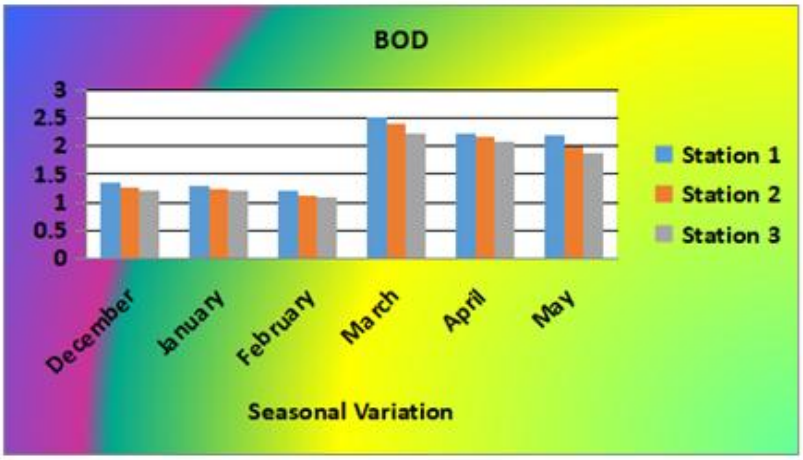




*All the values are mean ± SD of three replicates

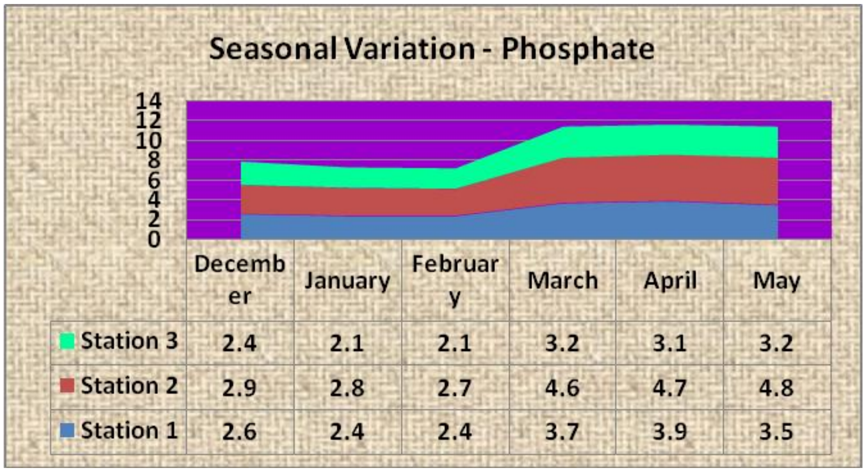
Fig.6 & 7 Data on the seasonal variation in chemical parameters such as DO and BOD at Three reservoir and at three stations a period of December 2021-May 2022.

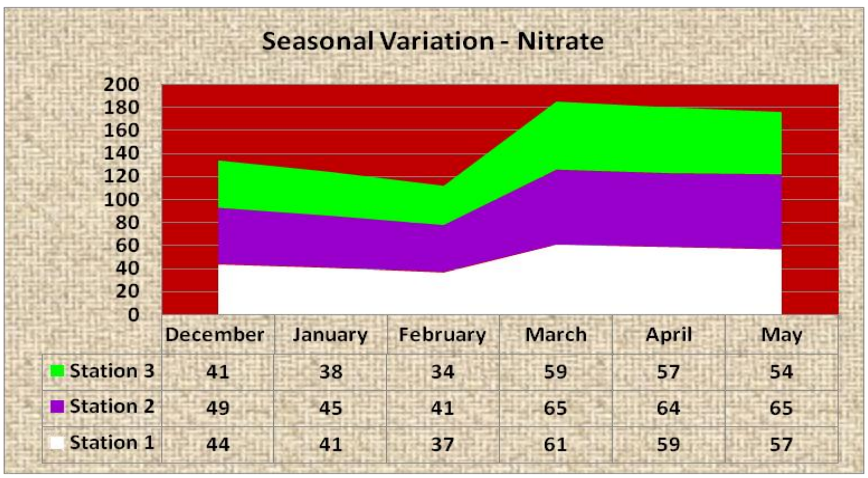


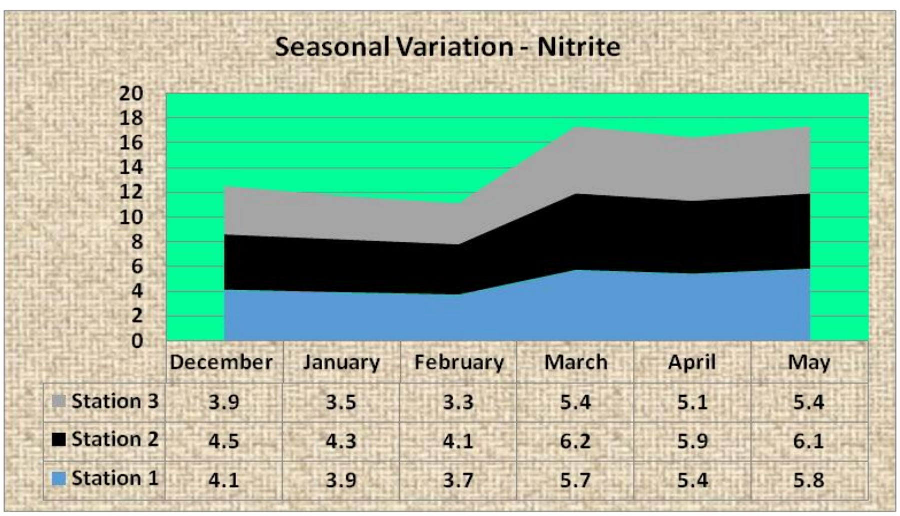


*All the values are mean ± SD of three replicates

Fig.8, 9 & 10 Data on the seasonal variation of nutrient parameters Po4, No_3 and No_2at three reservoirs for a period of December 2021 –May 2022.

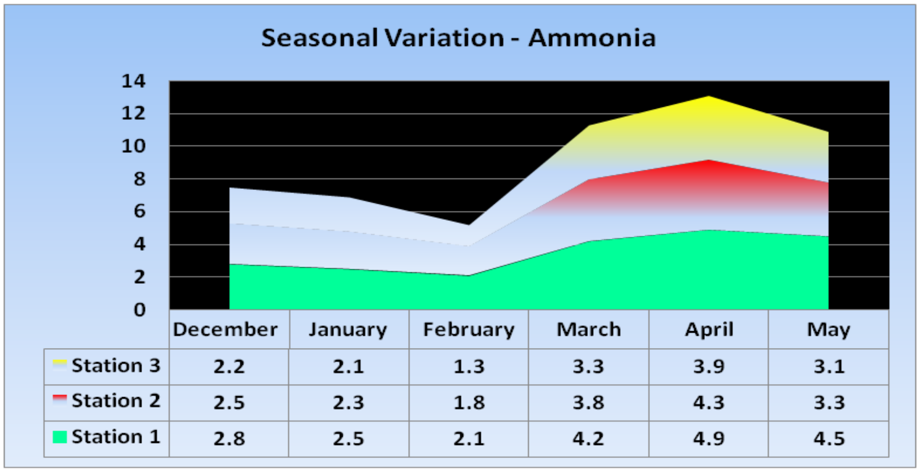


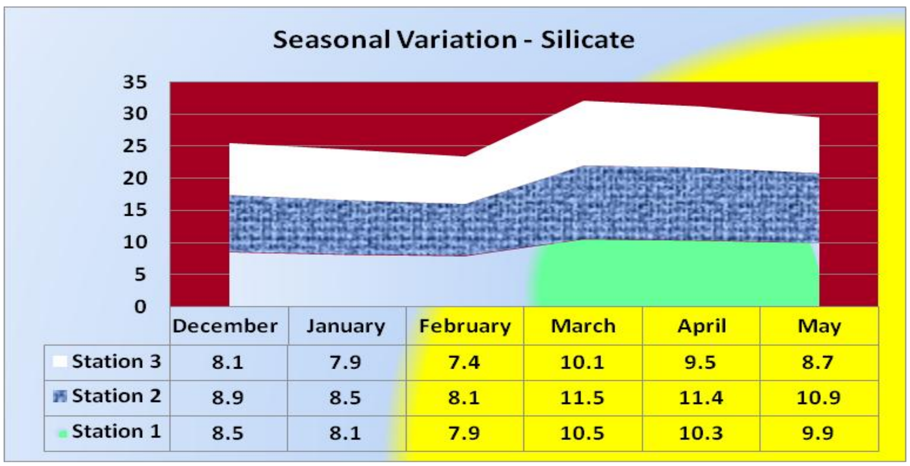




*All the values are mean ± SD of three replicates

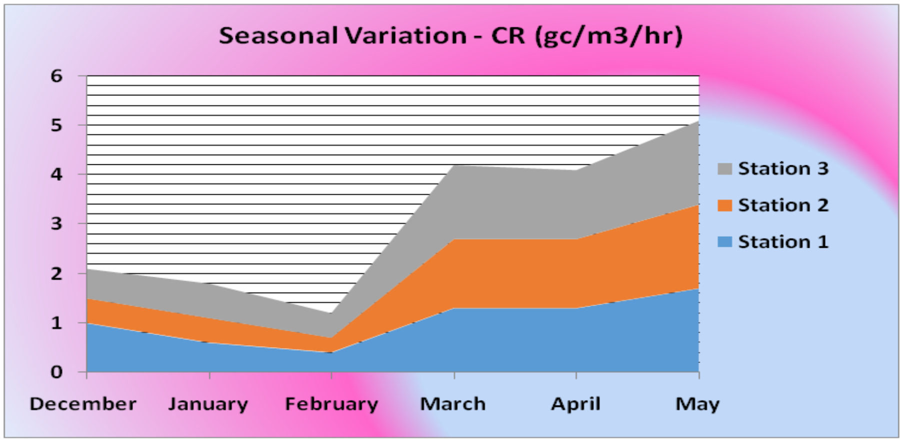
Fig.11 & 12 Data on the seasonal variation in nutrient parameters NH_3 and Si_2 at Three reservoir for a period of December 2021 –May 2022.

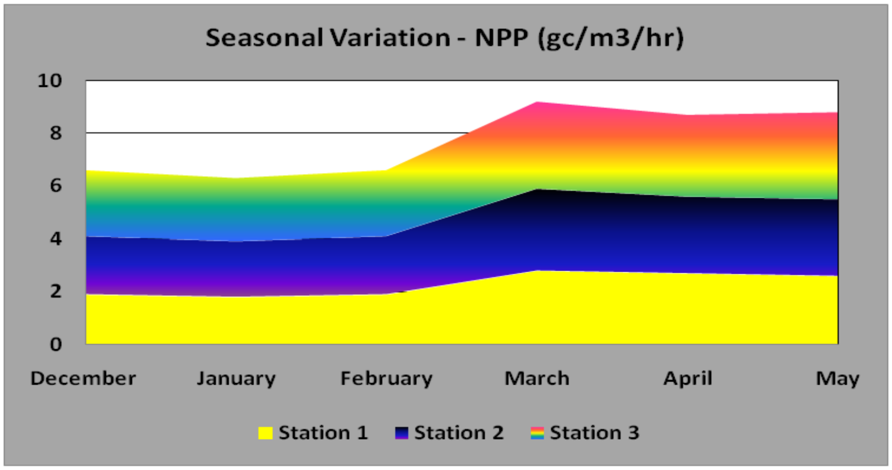


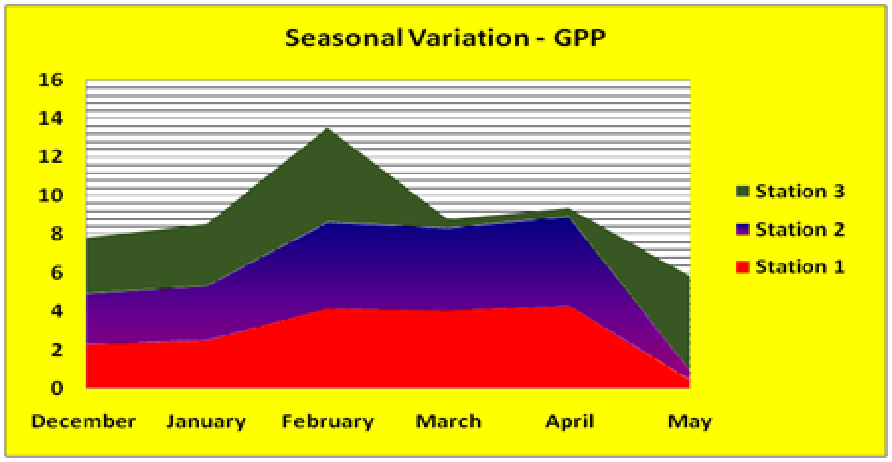


All the values are Mean ± SD of three replicates

Fig.13, 14 & 15 Data on the seasonal variation in primary productivity CR, NPP, GPP at Three reservoir for a period of December 2021- May 2022.







*All the values are mean ± SD of three replicate

Group-III (Nutrients)

Minimum phosphate value was recorded in February (2.1±0.18 mg/l) while maximum phosphate value was recorded in April (3.9±0.44mg/l) respectively. Phosphate concentration was highest (3.9±0.44mg/l) at Stn.1 in (April) and lowest (2.1. ±0.18 mg/l) in (February). Among the stations maximum phosphate was recorded in Stn.2 (4.8±0.46 mg/l) and minimum (2.1±0.18 mg/l) was recorded in Stn.3, Fig. (8).. In the present study minimum organic phosphate (2.1±0.18±0.46mg/l) at Stn.3 and maximum (4.8±0.46mg/l) at Stn.2 were recorded during summer and postmonsoon seasons respectively in study period which may due to immersion of ash and dead bones and rain, surface water runoff high rates of decomposition of organic matter algal bloom and eutrophication reported by Varsha Wankhade (2012). The increase in the concentration of phosphate during rainy season is the results of incoming water from the catchment area of human settlements and the entry of domestic sewage. Lower levels of phosphate are reported in may due to presence of higher phytoplankton biomass (Parinet *et al.,* 2004).

Nitrate concentration was highest (65±0.88mg/l) and lowest (34±0.34mg/l) in Stn.2 (March) and Stn.3 (February), Fig. (9) respectively. Maximum nitrates pollution can be caused by intense agricultural activity (the studied region is known for its agricultural vocation) and misuse of chemical fertilizers around the sewage waste water. Whereas lower concentration of NO_2-N may be due to low water temperature, higher dissolved oxygen content, less deposition of organic matter and greater sedimentation rate (Kaushik and Saksena, 1999).

Fig. (10) revealed that nitrite concentration was highest in march (6.2±0.55mg/l) and lowest in February season (3.3±0.31mg/l). The maximum nitrate concentration at Stn.1 (5.8± 0.58mg/l), Stn.2 (6.2± 0.55Mg/l) and Stn.3 (5.4±0.52mg/l) was recorded during the month of (May) while at minimum nitrite content in Stn.1 (3.7±0.34mg/l), Stn.2 (4.1± 0.43mg/l), Stn.3 (3.3±0.31mg/l) was recorded during the month of (February) in the study area in the year 2022 respectively. Among the stations Stn.1, Stn.2 and Stn.3 maximum nitrate was recorded Stn.2 (6.5±0.78 mg/l) and minimum was recorded in Stn.3 (3.3±0.31mg/l).

Minimum value of ammonia recorded in Stn.1, Stn.2 and Stn.3 (1.8±0.19 mg/l; 2.1± 0.20 mg/l and 3.1±0.28 mg/l) in month of (February) 2022 and maximum value of ammonia recorded (4.3±0.42mg/l; 4.9±0.48mg/l and 3.9±0.35 mg/l) in month of (April) 2022 are shown in Fig. (11). In may month highest value of ammonia recorded in Stn.1 (4.9 ±0.48mg/l), while the lowest ammonia was noted in may (3.1± 0.28mg/l) in Stn.3. Lower values, during Pre and post monsoon season, might be due to slower bacterial activity at low temperature causing inhibition of decomposition activity and so release of ammonia -nitrogen is retarded. Higher ammonia concentration was found to be recorded due to the combined effect of imputed materials from the open waste dump sites (Nithya *et al.,* 2018).

Maximum silicate content recorded (10.5±0.88mg/l) in Stn.1, (11.5±0.98mg/l) in Stn.2 and (10.1±1.02mg/l) at Stn.3 during March 2022. Seasonally recorded high silicate concentration showed in May at Stn.2 (11.5±0.88mg/l) and lowest concentration of silicate in May season (7.4±0.73mg/l) at Stn.3. Silicate content was noted to be minimum in (7.9±0.78mg/l) at Stn.1, Stn.2 (8.1±0.81mg/l) and Stn.3 (7.4±0.73mg/l)) during February 2022, Fig. (12).

Group IV (Primary productivity)

Seasonal and monthly recorded of GPP (gc/m^3/hr) in three reservoirs showed lower in January (2.3±0.25gc/m^3/hr) and higher in may (4.3±0.44gc/m^3/hr) at Stn.1 during the month of (January) and (May). The maximum (4.6±0.47gc/m^3/hr) and minimum (2.6±0.24gc/m^3/hr) GPP at Stn.2 was recorded during the month (January) and (May). Highest GPP (4.8±0.44gc/m^3/hr) in (2.9±0.65gc/m^3/hr) was recorded in Stn.3 in month of (January) and (May) and at Stn.2 and Stn.3 maximum GPP recorded in summer and minimum in postmonsoon and higher GPP recorded in Stn.3 (4.8±0.44gc/m^3/hr) and lower value noted in Stn.1 (2.3±0.25gc/m^3/hr) results shows Fig. (15). In the present investigation the community respiration (NPP) (Fig. 14) exhibited a higher value in may month (3.3±0.32gc/m3/hr) and minimum value in January (1.8±0.13gc/m3/hr) Stn.1 and Stn.2.

In the present investigation the community respiration (CR) (Fig. 13) exhibited a higher value in may month (1.7±0.21gc/m3/hr) and minimum value in February (0.3±0.04gc/m3/hr) Stn.1 and Stn.2. During the study period Stn.3 showed maximum (1.7±0.04gc/m3/hr) productivity followed by Stn.2 (1.7±0.3gc/m3/hr) and Stn.1 (1.7±0.21gc/m3/hr) respectively. In the present investigation seasonal record of primary productivity recorded as gross primary productivity, net primary productivity, community respiration. High and low productivity values of water bodies may be due to the low nutrient content in the water along with several factors like, solar radiation, nutrient content, high seasonal rate of in water level and high flushing rate of discharges which all totally influence influenced the rate of primary production in freshwaters. Primary productivity of different water bodies with reference to water quality in India was analyzed by Koli and Ranga (2011) and Misra *et al.,* (2001).

In the present investigation Gross primary productivity and Net primary productivity and Cross Reproduction of three reservoir were observed to showed monthly and seasonal variations. Maximum gross primary productivity (4.8±0.44gc/m^3/hr) in summer and minimum in (2.3±0.25gc/m^3/hr). Similarly the net primary productivity was also recorded maximum (3.3±0.32gc/m^3/hr) and minimum (0.1±0.0gc/m^3/hr) during the same seasons. The cross productivity varied from (0.3±0.04gc/m3/hr) to (1.7±0.21gc/m^3/hr) with maximum and minimum during summer and postmonsoon season respectively. The present study revealed the gross primary productivity having peak value (Mar) in summer season while lowest rate of production was recorded during post monsoon. The decline in the productivity during rainy season may be due to dilution of water and subsequent reduction of phytoplankton density bimodal Hanifa and Pandian (1978) and higher productivity in summer may be due to the temperature rise in, which enhances the release of nutrients from sediments through bacterial decomposition. The excessive amount of nutrients along with higher temperature favors the maximum growth of aquatic flora, which ultimately increases primary productivity. Sultan *et al.,* (2003) reported that temperature, solar radiation and available nutrients may be important limiting factors for primary production and contributing to seasonal variation in any aquatic ecosystem Koli and Ranga (2011) and Vimal Patel *et al.,* (2013).

From the above analysis, it can be concluded that the water quality of three reservoir of Cauvery River during the study period revealed that the three stations (Sozhasiramani dam, Mayanur dam, and Mettur dam). Among these reservoir Mayanur dam and Mettur dam could be rated for good quality of water, which is suitable for consuming purpose but Sozhasiramani dam receiving some of the unauthorized textile dyeing and bleaching units in Eroad and Pallipalayam in above units discharge treated and untreated effluent into the municipal drain along with the domestic sewage reached the river cauvery in station 1 is highly polluted, then the other two stations.

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