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Environmental Impacts of Point and Non-Point Source Pollution in Krishnagiri Reservoir: A Case Study in South India

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***Abstract*—**Reservoirs are being contaminated all around the world with point source and Non-Point Source (NPS) pollution. The most common NPS pollutants are sediments and nutrients. Krishnagiri Reservoir (KR) has been chosen for the present case study, which is located in the tropical semi-arid climatic zone of Tamil Nadu, South India. It is the main source of surface water in Krishnagiri district to meet the freshwater demands. The reservoir has lost about 40% of its water holding capacity due to sedimentation over the period of 50 years. Hence, from the research and management perspective, there is a need for a sound knowledge on the spatial and seasonal variations of KR water quality. The present study encompasses the specific objectives as (i) to investigate the longitudinal heterogeneity and seasonal variations of physicochemical parameters, nutrients and biological characteristics of KR water and (ii) to examine the extent of degradation of water quality in KR. 15 sampling points were identified by uniform stratified method and a systematic monthly sampling strategy was selected due to high dynamic nature in its hydrological characteristics. The physicochemical parameters, major ions, nutrients and Chlorophyll *a* (Chl *a*) were analysed. Trophic status of KR was classified by using Carlson's Trophic State Index (TSI). All statistical analyses were performed by using Statistical Package for Social Sciences programme, version-16.0. Spatial maps were prepared for Chl *a* using Arc GIS. Observations in KR pointed out that electrical conductivity and major ions are highly variable factors as it receives inflow from the catchment with different land use activities. The study of major ions in KR exhibited different trends in their values and it could be concluded that as the monsoon progresses the major ions in the water decreases or water quality stabilizes. The inflow point of KR showed comparatively higher concentration of nutrients including nitrate, soluble reactive phosphorus (SRP), total phosphors (TP), total suspended phosphorus (TSP) and total dissolved phosphorus (TDP) during monsoon seasons. This evidently showed the input of significant amount of nutrients from the catchment side through agricultural runoff. High concentration of TDP and TSP at the lacustrine zone of the reservoir during summer season evidently revealed that there was a significant release of phosphorus from the bottom sediments. Carlson's TSI of KR ranged between 81 and 92 during northeast monsoon and summer seasons. High and permanent Cyanobacterial bloom in KR could be mainly due to the internal loading of phosphorus from the bottom sediments. According to Carlson's TSI classification Krishnagiri reservoir was ranked in the hyper-eutrophic category. This study provides necessary basic data on the spatio-temporal variations of water quality in KR and also proves the impact of point and NPS pollution from the catchment area. High TSI warrants a greater threat for the recovery of internal P loading and hyper-eutrophic condition of KR. Several expensive internal measures for the reduction of internal loading of P were introduced by many scientists. However, the outcome of the present research suggests for the innovative algae harvesting technique for the removal of sediment nutrients.

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I. Introduction

RESERVOIRS are artificial structures constructed across the rivers for storing water to meet the increasing demand for freshwater. Reservoirs are being contaminated all around the world with point source and NPS pollution. The most common NPS pollutants are sediments and nutrients. Point source pollution is one of the major sources of nutrients to aquatic ecosystem. In most of the developing countries, the treated or partly treated or raw wastewater is disposed in to the nearby natural drains joining rivers or lakes or unused irrigation lands. The point sources of nutrients include municipal sewage treatment plant discharges and industrial effluent treatment plant discharges. Sewage treatment plants provide most of the available phosphorus to surface water bodies.

NPS pollution is characterized as "pollution that is a result of land use activity or disturbance of the stream system" [1]. It occurs as water moves across the land or through the ground and picks up natural and human-made pollutants. NPS pollution of nutrients from the natural processes includes phosphate deposits and phosphate-rich rocks releasing phosphorus during weathering, erosion and leaching. It also includes atmospheric deposition of particulate-bound phosphorus from windblown soils, decaying organisms, waste products from aquatic organisms and wildlife and decaying tissues of plants and animals [2]. Phosphorus and nitrogen often limit the growth of primary producers, so they are referred to as "limiting nutrients". Of these two nutrients, phosphorus is most often considered to be the nutrient that regulates the production of algae in lakes and is most amenable to control. Hence, KR was selected for the present study and the main objective of this study is to investigate the impacts of point and NPS pollutants in KR.

II. Methodology

KR finds its location around 78° 11'15" East Longitudes and 12° 28'00" North Latitudes across the River Ponnaiyar about 10 km from Krishnagiri town in Krishnagiri district, Tamil Nadu, India (Fig. 1). The Ponnaiyar river basin is 12,744 km^2, in which catchment in neighbor Karnataka state is 3638.81 km^2. The area in Karnataka state has several tanks including big reservoirs like Hosakote, Bellandur and Varthur lakes impounding considerable portion of the flood.

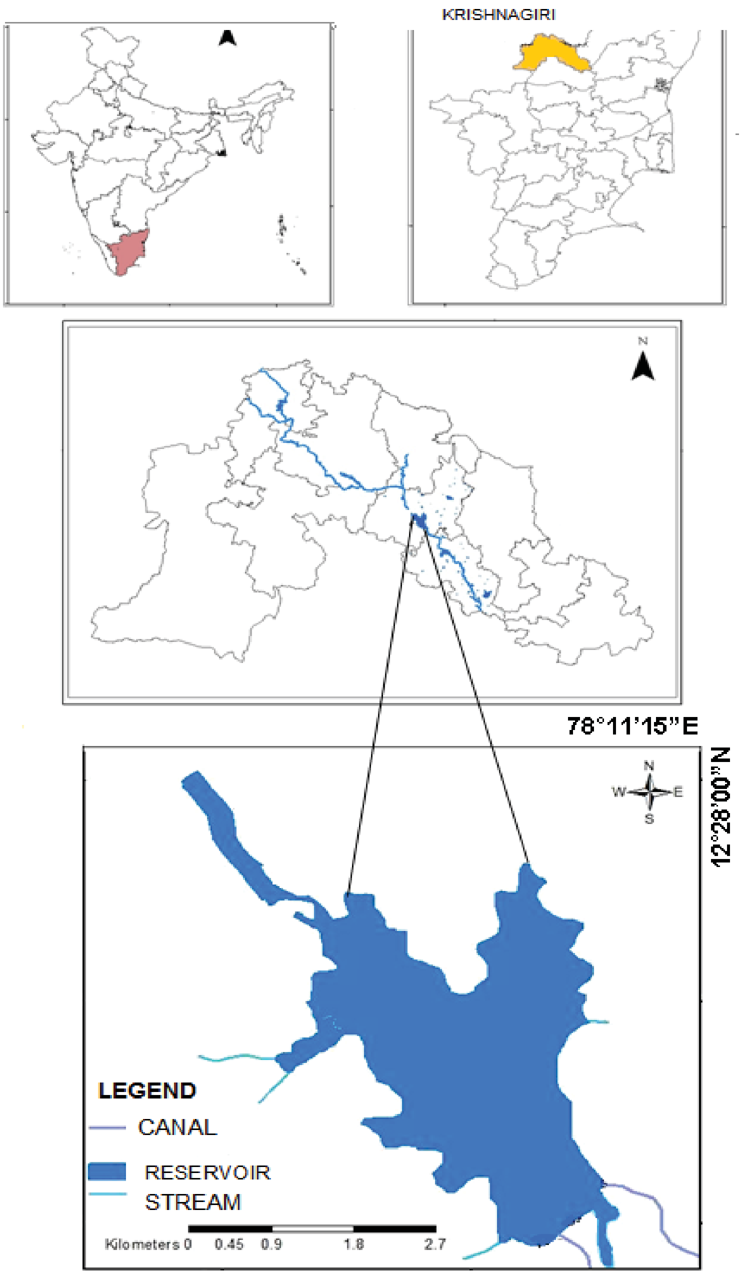

Fig. 1 Location of Krishnagiri Reservoir

In order to have a good understanding of physical, chemical and biological uniqueness of the reservoir, three different zones, called riverine, transition and lacustrine, were identified based on the elevation and flow of water in the reservoir [3]. 15 sampling points were identified as shown in Fig. 2 by uniform stratified method. Sampling locations 8, 9 and 10 are located at the river zone and location 9 is the inflow point of the reservoir. Sampling locations, 3, 4, 5, 6, 7 and 11 are located at the transition zone and locations 1, 2, 12, 13, 14 and 15 are located at the lacustrine zone of the reservoir and location 14 is near Left Main Canal outlet. Location 15 is near to the dam zone and spill way of the reservoir.

A systematic monthly sampling strategy was selected due to high dynamic nature in its hydrological characteristics. Temperature, pH, EC and Dissolved Oxygen (DO) in the water samples were measured *in situ* immediately after the collection of water samples. Surface water samples were collected from all the fifteen locations. The water samples were collected manually and directly from the surface of water with the help of 1 litre acid cleaned and sterilized wide mouth polythene bottles. Appropriate preservatives were added to the samples as per [4]. The water samples were stored at 4°C in ice boxes to avoid changes in physico-chemical characteristics and carefully transported to the Wet Chemistry Laboratory at Centre for Water Resources, Anna University for further analyses.

The physicochemical parameters include turbidity, total dissolved solids (TDS), electrical conductivity (EC), Major ions such as carbonates, bicarbonates, calcium (Ca), magnesium (Mg), chloride, sulphate, sodium and potassium were estimated as per the procedures in [4]. High quality deionised water was used for the preparation of standards and dilution of samples. Nutrients such as nitrate, SRP, TDP, TSP and TP were analysed. Chl *a* is generally common to all photosynthetic organisms and is often used to determine the abundance of phytoplankton. Therefore, Chl *a* was used in the present study as a biological indicator. Statistical Package for Social Sciences Programme, version-16.0 was used for statistical analyses.

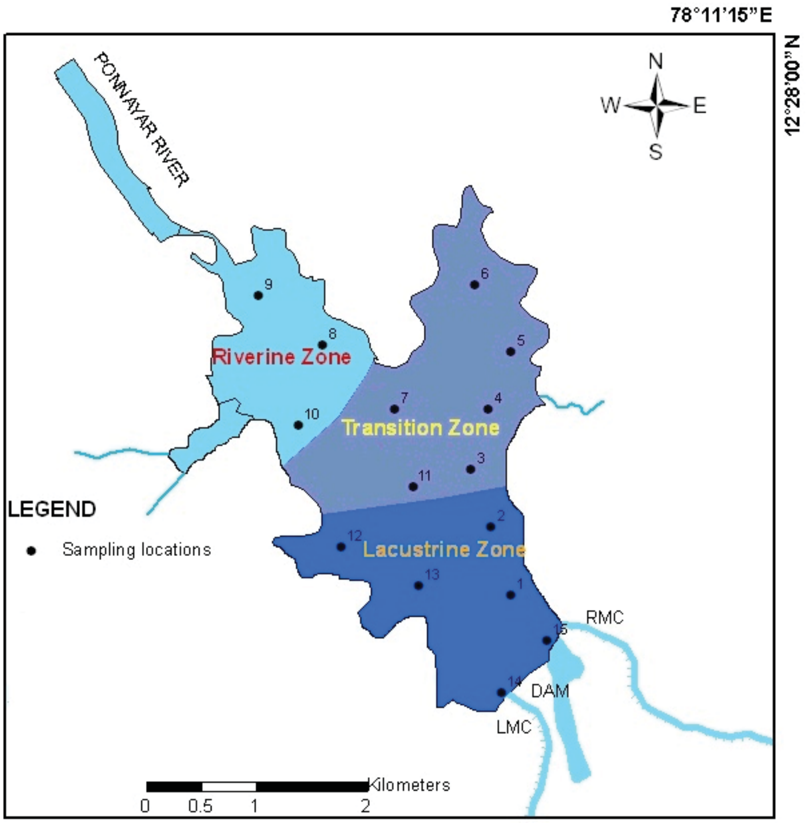

Fig. 2 Sampling locations in KR

III. Results and Discussion

In the present study of Krishnagiri reservoir, monthly data were pooled and alienated into four seasons, Southwest Monsoon (SWM) during June-September, Northeast Monsoon (NEM) during October-December, winter (WIN) during January-February and summer (SUM) during March-May, for getting reliable trends for explaining the dynamics. Tables I and II depict the seasonal variations of general physico-chemical characteristics of the surface water in KR during the investigation period.

The water temperature of a lake or reservoir is more important for the biological activities and chemical reactions. It can influence the solubility of dissolved oxygen and other materials in the water column [5]. The minimum temperature noticed was 21.9°C at location 11 in January month during WIN season and the maximum temperature noticed was 29.2°C at the location 5 in the month of May during SUM season. The inflow point of the reservoir showed the major fluctuation in water temperature, the maximum temperature was (28.6°C) noticed in the month of May and the minimum (21.4°C) was observed in the month of January.

It is clear from the results that there was a significant variation across the locations during different seasons during the study period. Similar trend of values was reported by [6]. for the surface water temperature in Ujjani reservoir, Solapur district, India, with the lowest (20°C) during pre-monsoon and highest (32 °C) during post-monsoon seasons. The seasonal and spatial variations in surface water temperature in a reservoir is generally influenced by the inflow water, rainfall, extent of vertical mixing and exchange of heat with the atmosphere. As far as the Krishnagiri reservoir is concerned, there was a significant difference in temperature over the four different seasons but low variation across different locations.

TABLE I
GENERAL PHYSICOCHEMICAL CHARACTERISTICS OF SURFACE WATER IN KRISHNAGIRI RESERVOIR DURING SWM AND NEM SEASONS

Sl. No.	Variable	Season			
		SWM		NEM	
		Range	Mean ±SD	Range	Mean ±SD
1	Water Temperature ^{0}C	24.4-28.9	27.2±1.9	23.5-24.7	24.1±0.4
2	DO (mg l^{-1})	0.8-8.6	4.7±2.2	2.4-7.6	4.4±1.3
3	pH	7.6-9.1	8.4±0.3	7.5-9.1	8.1±0.5
4	Turbidity (NTU)	35-95	69±18	10-70	30±12
5	EC (μScm^{-1})	870-1190	979±78	790-940	862±49
6	Carbonates (mg l^{-1})	0-9	2±2	0-8	2±3
7	Bicarbonates (mg l^{-1})	305-348	325±8	305-323	314±5
8	Calcium (mg l^{-1})	60-92	76±9	42-68	55±8
9	Magnesium (mg l^{-1})	21-61	38±6	19-45	38±4
10	Chloride (mg l^{-1})	102-145	120±11	95-149	107±9
11	Sulphate (mg l^{-1})	26-71	44±12	14-65	44±9
12	Sodium (mg l^{-1})	128-292	203±60	124-186	158±17
13	Potassium (mg l^{-1})	30-92	57±16	20-70	42±10

TABLE II
GENERAL PHYSICOCHEMICAL CHARACTERISTICS OF SURFACE WATER IN KRISHNAGIRI RESERVOIR DURING WIN AND SUM SEASONS

Sl. No.	Variable	Season			
		WIN		SUM	
		Range	Mean ±SD	Range	Mean ±SD
1	Water Temperature ^{0}C	21.9-23.1	22.5±0.5	25.6-29.2	27.6±1.4
2	DO (mg l^{-1})	2.5-6.3	4.1±1.3	0-3.1	1.7±0.8
3	pH	8.1-8.9	8.5±0.2	7.9-9.9	9.0±0.6
4	Turbidity (NTU)	14-49	34±9	21-144	85±39
5	EC (μScm^{-1})	773-814	795±10	800-1126	913±125
6	Carbonates (mg l^{-1})	1-6	3±2	0-12	4±3
7	Bicarbonates (mg l^{-1})	305-329	314±6	287-329	302±11
8	Calcium (mg l^{-1})	40-54	45±4	60-96	74±12
9	Magnesium (mg l^{-1})	29-42	34±4	33-49	53±9
10	Chloride (mg l^{-1})	50-110	95±15	87-157	117±23
11	Sulphate (mg l^{-1})	26-62	43±8	9-59	32±14
12	Sodium (mg l^{-1})	122-152	137±9	122-296	180±65
13	Potassium (mg l^{-1})	19-45	29±6	10-96	42±27

DO is often used as an indicator of water quality, such that high concentrations of oxygen usually indicate good water quality [5]. During the SWM season, the highest DO of 8.6 mg l^{-1} was observed at the inflow point water in the month of September. Winter season exhibited wider fluctuations in DO values in the surface water with a maximum (6.3 mg l^{-1}) at the Northern side of KR in the month of January minimum of 2.5 mg l^{-1} at the location 15 in the lacustrine zone in the month of February. There was a sharp reduction found in the DO values during the summer season and anoxic condition was recorded at the dam site in the month of April. From the results, it was noticed that there was a significant difference in the values of DO among the different locations in KR. This high variation of DO at the inflow point clearly showed the seasonal variation and this was mainly due to the impact of rainfall and inflow water from the catchment side.

During monsoon seasons, the inflow water showed more oxygen as it travels along the river as well as the dilution with the rain water. Low values of DO at the inflow point during the summer season might be due to the inflow of sewage and effluent water from the catchment side of KR with high dissolved organic load without any dilution with the rainwater. Since DO in water is inversely proportional to the temperature of the water, as temperature increases, the amount of dissolved oxygen decreases [5]. The seasonal patterns of DO in tropical reservoirs are likely to differ from their temperate counterparts because warm tropical waters are more susceptible to oxygen depletion coupled with higher rates of microbial metabolism [7]. This was proved in the present study in KR with low DO during summer season with high temperature.

Since the accumulation of high organic matter at the lacustrine zone sediments observed in this study, low DO in the surface water in KR was agreed with the statement of [5]. The authors stated that many productive lakes experience periods of oxygen depression or depletion in deep waters during warm summer months. High algal production in the surface waters can lead to depleted oxygen concentrations at depth as cells die and settle down to the bottom of the lake, where microorganisms decompose them. The decomposition process consumes oxygen from the water through bacterial respiration.

The pH of an aquatic ecosystem is essential because it is closely related to biological productivity. The pH of surface water in KR in general showed a neutral or more alkaline tendency during all the seasons (Tables I and II). The maximum pH noticed was 9.9 at dam site in April during SUM season and the minimum pH noticed was 7.5 at the inflow point during NEM season. The values of pH in KR are consistent with the pH values of 7.41-8.95 reported for Ramsagar reservoir in Madhya Pradesh, India [8]. It is evident that the low pH value at the inflow point of KR during NEM1 season was due to the dilution of inflow water and as well as reservoir water with rainwater. Rain water is naturally in acidic condition and it is caused by the dissolution of atmospheric carbon dioxide. Reference [9] found that increased surface pH in water bodies is due to increased metabolic activities of autotrophs, because in general they utilize the carbon dioxide thus reducing hydrogen ion concentration. Hence, pH at the dam site was an evidence for more productivity in April during SUM season in KR.

Turbidity refers to water clarity. Greater amount of suspended solids in the water making it appear murkier, which shows high turbidity. In KR, high turbidity value of 144 NTU was noticed at the dam site in April during SUM season when the turbidity of the inflow was only 30 NTU (Tables I and II). The inflow point of the reservoir showed a significant monthly variation in the turbidity values which was ranged between 12 NTU and 132 NTU in February and May in KR. The highest value of turbidity obtained at the inflow point of KR during SWM season might be due to the rainfall which occurred in the first month of SWM season. The turbidity values of KR in the present study are comparatively very high with the turbidity values (6.36 NTU-8.36 NTU) reported for Ramsagar reservoir, Madhya Pradesh, India [8].

Most of the source of sediments includes natural and anthropogenic activities in the watershed, such as natural or excessive soil erosion from agriculture, forestry or construction, urban runoff, industrial effluents, or excess phytoplankton [5]. Hence, it is evident that an increased level of turbidity at the riverine zone of KR was mainly caused by high sediment inflow from the catchment area through Ponnaiyar river. High turbidity values observed at the lacustrine zone of the KR was mainly due to the algal bloom. In KR, the highest average seasonal EC observed during the study was 1126 µS cm^{-1} (SUM) and lowest was 773 µS cm^{-1} (WIN) (Tables I and II). This evidently revealed the higher fluctuation of EC at the inflow point during the study period.

The values of EC in KR were very high when compared with the highest average value of 80 µS mg l^{-1} in Periyar lake, Kerala, India, [10]. But the EC values are lower and consistent with the values reported in Ujjani reservoir, India, as 400 mg l^{-1} to 1800 mg l^{-1} in pre-monsoon, and 288-962 mg l^{-1} in post monsoon [6]. High EC in KR indicates large dissolved minerals, which change the taste and making it unsuitable for drinking.

In the KR, four major cations (calcium, magnesium, sodium and potassium) and the four major anions (bicarbonate, carbonate, sulphate and chloride) in the surface water were studied. Tables I and II clearly elucidate the seasonal variations of major ions in the surface water of KR. Carbonate and bicarbonates were found with maximum (9 mg l^{-1} and 348 mg l^{-1}) at the location 15 in June during SWM season. The results of carbonates and bicarbonates in KR are comparatively very high with the values carbonates (0.27 mg l-1 0.7 mg l^{-1}) and bicarbonate (3.19 mg l-1 and 3.99 mg l^{-1}) reported for the Veeranam reservoir, Tamil Nadu, India [11].

Ca was found maximum at the location 8 and the inflow point with values of 96 mg l^{-1} in May during SUM season. Mg exhibited a maximum (61 mg l^{-1}) value at the inflow point in September during SWM season. Reference [12] observed the range of Ca of 13.76-35.2 mg l^{-1} and Mg of 1.6-14.26 mg l^{-1} in Almatti reservoir, Karnataka, India. Chloride exhibited a range from 50 mg l^{-1} to 157 mg l^{-1} at the inflow point of KR. The minimum and maximum were recorded in January during WIN season and in May during SUM season. High seasonal fluctuations were observed in the values of chloride in KR during the study period. The values chloride in KR in the present study are higher than the values reported for Almatti reservoir (42.4 - 86 mg l^{1-}) and Ramsagar reservoir (1.5 mg l^{-1} - 8.87 mg l^{-1}) by [12], [8].

Hence, this elevated level of chloride is likely from both NPS and from the point sources such as sewage and industrial effluents from the catchment. Sulphate showed a maximum (71 mg l^{-1}) value at the inflow point in September during SWM season and a minimum value (9 mg l^{-1}) at location 12 in March during SUM season. This elevated level of sulphate reveals that the significant input from the catchment of KR could be from the fertilizer runoff, erosion of rocks and disposal of industrial effluents. There was no much seasonal variation in the values of sodium and potassium during the study period in KR. The maximum concentrations of Na (296 mg l^{-1}) and K (96 mg l^{-1}) were obtained at the inflow point in May during SUM season.

The study of major ions in KR exhibited different trends in their values. Hence, it could be concluded in the present study that as the monsoon progress the major ions in the water decreases or water quality stabilizes and during non-monsoon seasons and summer, the concentrations of major ions could increase due to the process of evaporation in the reservoir. The disposal of sewage and other industrial effluents in the catchment area could also have brought in the major ions in the KR especially during winter and summer seasons.

TABLE III
SEASONAL VARIATIONS OF NUTRIENTS IN KRISHNAGIRI RESERVOIR DURING SWM AND NEM SEASONS

Sl. No.	Variable	Season			
		SWM		NEM	
		Range	Mean ±SD	Range	Mean ±SD
1	Nitrate (mg l^{-1})	7.4-23.5	13.2±3.9	8.3-20.1	12.1±3.1
2	SRP (mg l^{-1})	0.32-1.92	0.91±0.43	0.19-0.94	0.49±0.21
3	TDP (mg l^{-1})	0.80-2.20	1.32±0.40	0.3-1.20	0.75±0.31
4	TSP (mg l^{-1})	0.10-2.30	0.90±0.53	0.10-1.20	0.52±0.24
5	TP (mg l^{-1})	1.10-3.30	2.22±0.49	0.50-2.20	1.26±0.47

TABLE IV
SEASONAL VARIATION OF NUTRIENTS IN KRISHNAGIRI RESERVOIR DURING WIN AND SUM SEASONS

Sl. No.	Variable	Season			
		WIN		SUM	
		Range	Mean ±SD	Range	Mean ±SD
1	Nitrate (mg l^{-1})	4.9-12.1	7.9±1.7	4.6-13.1	8.2±2.4
2	SRP (mg l^{-1})	0.2-1.2	0.58±0.28	0.36-3.10	1.56±0.79
3	TDP (mg l^{-1})	0.40-1.30	0.79±0.27	0.50-3.30	1.83±0.81
4	TSP (mg l^{-1})	0.10-1.50	0.50±0.38	0.10-1.60	0.71±0.39
5	TP (mg l^{-1})	0.50-2.50	1.26±0.47	0.80-4.40	2.53±0.98

Environmental sources can manage by regulating direct or indirect inputs of nitrogen and phosphorus to limit of increase the primary production in aquatic ecosystems. Tables III and IV illustrate the seasonal variations of nutrients in the surface water of KR during the study period. Nitrate status in the surface water of KR was widely fluctuating during the study period. In all the seasons during the period of study, inflow point showed comparatively higher concentration of nitrate than other locations. The maximum (23.5 mg l^{-1}) was recorded at the inflow point of the reservoir in September during SWM season. This evidently showed the input of significant amount of nitrates from the catchment side through the agricultural runoff. Throughout the period of study, the lowest nitrate content was noticed at the dam site and the minimum (4.6 mg l^{-1}) was observed in during summer season. Low concentrations of nitrate in the reservoir might be due to the reason as stated by [13], who reported that the process of denitrification was believed to be an eminent route of nitrate loss from the reservoir.

Reservoir water quality and productivity are affected to a large extent by the amount of external and internal nutrient loading to the reservoir. In KR, there was an interesting trend of SRP was observed during the study period. The seasonal variations of SRP are illustrated in Tables III and IV. The inflow point of reservoir experienced wider range of fluctuations in SRP values and the maximum of 1.92 mg l^{-1} was observed during SWM season. An increasing trend in the SRP concentration of the surface water at the lacustrine zone of KR was noticed during summer seasons. The maximum SRP was observed at the dam site during summer season. This evidently reveals the process of internal loading of P from the bottom sediments of KR. As given in the Tables III and IV, TDP was found high during SUM season at the dam site in April with the mean of 1.83 mg l^{-1}. TSP was found maximum (2.3 mg l^{-1}) at the inflow point of the reservoir in September during SWM season. This obviously reveals a significant input of particulate inorganic P along with the sediments in to KR during monsoon seasons. This shows the impact of soil erosion from the catchment area. There was a significant seasonal variations observed in the values of TP. Highest value (4.4 mg l^{-1}) was observed at the dam site in April during SUM season at the dam site. The inflow point KR experienced wider fluctuations in TP values, an increasing trend of TP was observed during summer season and reached maximum during SWM season and again there was a reduction in the TP values during NEM and WIN seasons. This trend of variations at the inflow point clearly indicates the significant input of external phosphorus load into the KR. This result is also agreed with the previous study conducted by [16] on sediment nutrients in KR.

The spatial map as in Fig. 3 illustrates the seasonal and spatial variations of mean concentrations of Chl *a* in KR during the study period. The lacustrine zone of the reservoir showed high concentration of Chl *a* during all the seasons. Dam site exhibited the highest value of Chl *a* (184 µg l^{-1}) in April during SUM season.

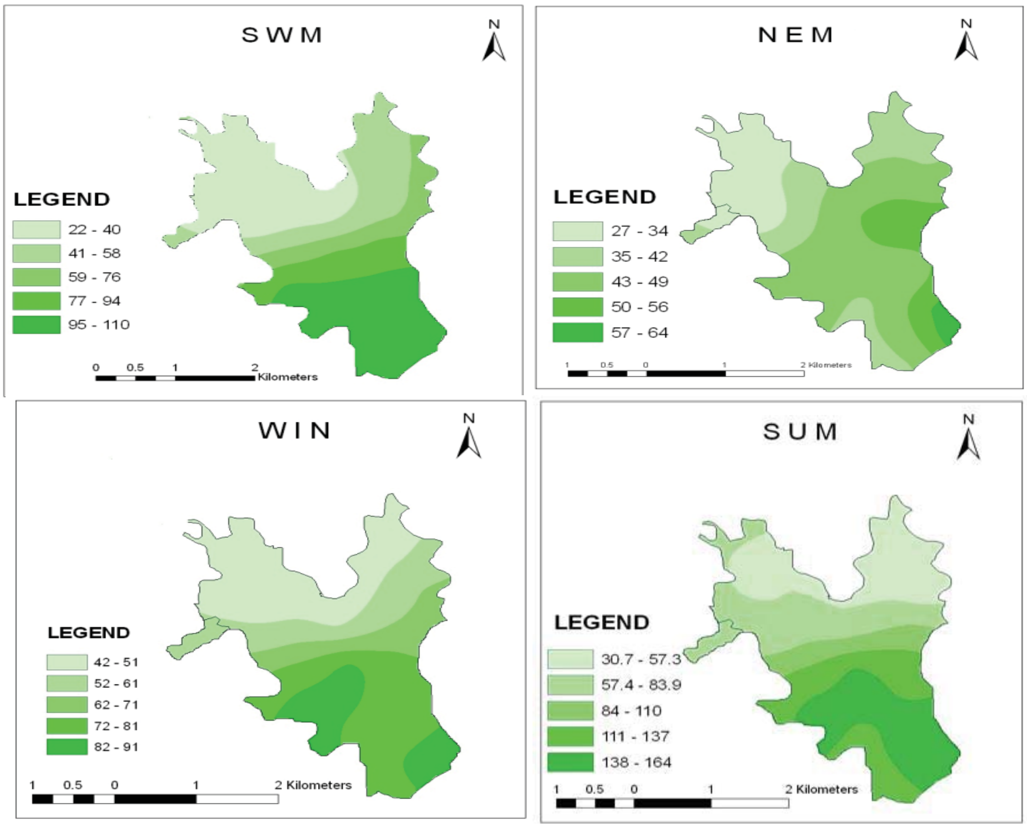

Fig. 3 Seasonal and spatial variation of mean concentrations Chl *a* in KR

The inflow point of the reservoir remained as the location with the low values of Chl *a* and the minimum value (11 µg l^{-1}) was observed in September during SWM season. The riverine and transition zones exhibited high seasonal fluctuations of Chl *a*. The highest mean value of Chl *a* (161 µg l^{-1}) in the present study was threefold higher than the maximum value (51.5 µg l^{-1}) reported by [14] for the summer season. [15] reported that the maximum concentration of 250 µg dm^3 in the Siemianówka reservoir, Poland.

In general, the results of Chl *a* in KR showed that the monsoon season exhibited low values than that of summer and winter seasons. The period of the actual decrease was observed during the onset of the rain in the monsoon season. Increased rainfall, high inflow and low Water Residence Time (WRT) led to a steady decline in the phytoplankton population thereby Chl *a* concentration in KR until the winter season starts. This is agreed with the statement of [17], who stated that the temporal variability of phytoplankton in tropics is driven by seasonal rainfall and mixing). The present study is also an evidence for the occurrence of Cyanobacterial bloom in the KR throughout the study period. High and permanent Cyanobacterial bloom in KR could be mainly due to the internal loading of P from the bottom sediments.

TABLE V
CARSON'S TROPHIC STATE INDEX FOR KRISHNAGIRI RESERVOIR

Sl.No.	Seasons	Carlson TSI	TSI classification for Krishnagiri reservoir
1	SWM	90	Hyper-eutrophic
2	NEM	81	Hyper-eutrophic
3	WIN	84	Hyper-eutrophic
4	SUM	92	Hyper-eutrophic

Carlson's TSI for the KR water quality was ranged between 81 and 92 during the study period as given in Table V. The maximum was observed during SUM season and minimum value was obtained for the NEM season. According to Carlson's TSI classification TSI values of >70 is considered to be Hyper-eutrophic condition. Hence, KR was ranked in the hyper-eutrophic category throughout the investigation period.

Water pollution is an acute problem in all the major rivers and dams in India [6]. Watershed geology, climate, soil, land slope and intrinsic factors such as age of the reservoir, water level fluctuations, morphometry and water residence time may have a significant effect on water quality and trophic state of those freshwater systems [18]. As the KR is being affected by both point and NPS pollution from the catchment area; sediments, nutrients, disposal of sewage and industrial waste water were brought many environment impacts to the KR. It is obvious from the present study that there are major impacts of point and NPS pollution on the water quality in KR.

IV. CONCLUSION

Sediments perform a key role in the dynamics of phosphorus. Construction of reservoirs across the alluvial stream generally results in significant morphometric and ecological transformations. As a consequence, sediments along with other in the water column and trigger the process of secondary eutophication, this results in hyper-eutrophication of a water body. From the present research it is clearly revealed that the sediments of KR can act as a source of nutrients to trigger the secondary eutrophication and maintain the hyper-eutrophic condition in the reservoir for a longer period of time. Many scientists were introduced different techniques for the reduction of internal loading of phosphorus which are very expensive. On the other hand, the present research suggests for algal harvesting technique in an innovative way for the removal of nutrients in the sediments of Krishnagiri Reservoir.

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