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PRESENT STATUS OF THE WATER QUALITY PARAMETERS OF THE ALIYAR DAM, POLLACHI, COIMBATORE DISTRICT, TAMIL NADU

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ABSTRACT

In the present study, the water samples were collected from three different locations of Aliyar Dam, Pollachi Taluk, Coimbatore District, Tamil Nadu, India for physico-chemical analysis. The laboratory tests of the collected water samples were carried out for the analysis of various parameters such as temperature, pH, Electrical conductivity, Suspended Solids, Dissolved Solids, Total Solids, Total Alkalinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Fluoride, Calcium, Magnesium, Sulphate, Phosphate, Chloride, Nitrate, Iron and Carbonates. The methods employed for analysis as per standard methods recommended by APHA, WHO. The results obtained were compared with BIS standards and the parameters showing slight variations than standards that affects the water quality. These variations may be influenced by sample locations, time of sampling and activities carried out around the dam. Hence, it is recommended that the water can be used for drinking purposes with proper treatment and regular water quality monitoring.

KEY WORDS

Aliyar dam, APHA, BIS, drinking, irrigation, physico-chemical parameters and water quality

INTRODUCTION

Water is essential source and basis for survival of all living organisms. Water provides the medium in organisms in which complex metabolic processes necessary for life take place. Organisms simply cannot function without water and if deprived will rapidly die. Organism not only needs water but also needs the clean water. Human beings are affected by the most subtle variations in water chemistry and supply. According to World Health Organization (WHO) an estimate mentioned that 1200 million people lack a satisfactory or safe water supply [1]. The uses of water include (i) domestic (i.e., drinking, cooking, washing, bathing and gardening etc.,), (ii) public purposes (cleaning streets, recreational purposes like swimming pools, public fountains and ornamental ponds, fire protection and public parks), (iii) industrial purposes (processing, cooling and heating), (iv) agricultural purposes (irrigation) and (v) Power production (hydro power and steam power).

India has long tradition of managing water, but increasing demands and abuse due to population, industrial growth and agricultural development poses new challenge. Surface waters available in rivers, lakes, ponds and dams are used for drinking, irrigation and other purposes. Dams are constructed for different purposes like water needs for urban population, irrigation and industrial use.

Water quality is an important consideration and the concentration and composition of dissolved constituents in water determine its quality for its application [2]. Water quality deterioration in dams is the causes of excessive nutrient inputs, eutrophication, acidification, heavy metal contamination, organic pollution and obnoxious fishing practices [3]. Water quality available for specific uses will decline with pollution. For example with progressive quality deterioration, water uses may successively shift from drinking to bathing water, water for livestock, agriculture and industrial uses and so on.

It has been defined as water that is free from pathogenic agents, free from harmful chemical substances, pleasant to taste i.e., free from colour and odour is usable for domestic purposes. If it does not fulfill these criteria, water is said to be polluted or contaminated. Water pollution occurs when water body is adversely affected due to the addition of undesirable materials to the water. When it is unfit for its intended use, water is considered polluted [4]. Water quality basically refers to the physical, chemical and biological characteristics of water. The physico-chemical methods are used to detect the effects of pollution on the water quality. Changes in the water quality are reflected in the biotic community structure.

Keeping the above facts, an attempt has been made to evaluate the physico chemical quality of water of Aliyar Dam for irrigation and drinking water applications.

MATERIALS AND METHODS

Study area

The study area Aliyar dam was constructed in 1959 - 1969 across aliyar river and is located near Pollachi taluk, Coimbatore district, Tamil Nadu. It is located in the foothills of Valparai, in the Anaimalai hills of the Western Ghats and flows in a north-westerly direction for about 37 kms in Tamil Nadu and enters into Kerala and finally confluence in Bharathapuzha. The Aliyar Reservoir was constructed across the River Aliyar having a Latitude 10 ‘ 29 “ N and Longitude 76 ‘ 58 “ E and it has a gross capacity of 3864 Mcft. Two irrigation canals i.e., Vettaikaranpudur and Pollachi Canals take off from this reservoir. The catchment area at the Aliyar Dam is 76 Sq.Miles. Apart from its own catchments, water can be diverted to this reservoir through the Aliyar Feeder canal and the Contour canal from the Parambikulam group of reservoirs. Fig.1.Shows the location of the present study area.

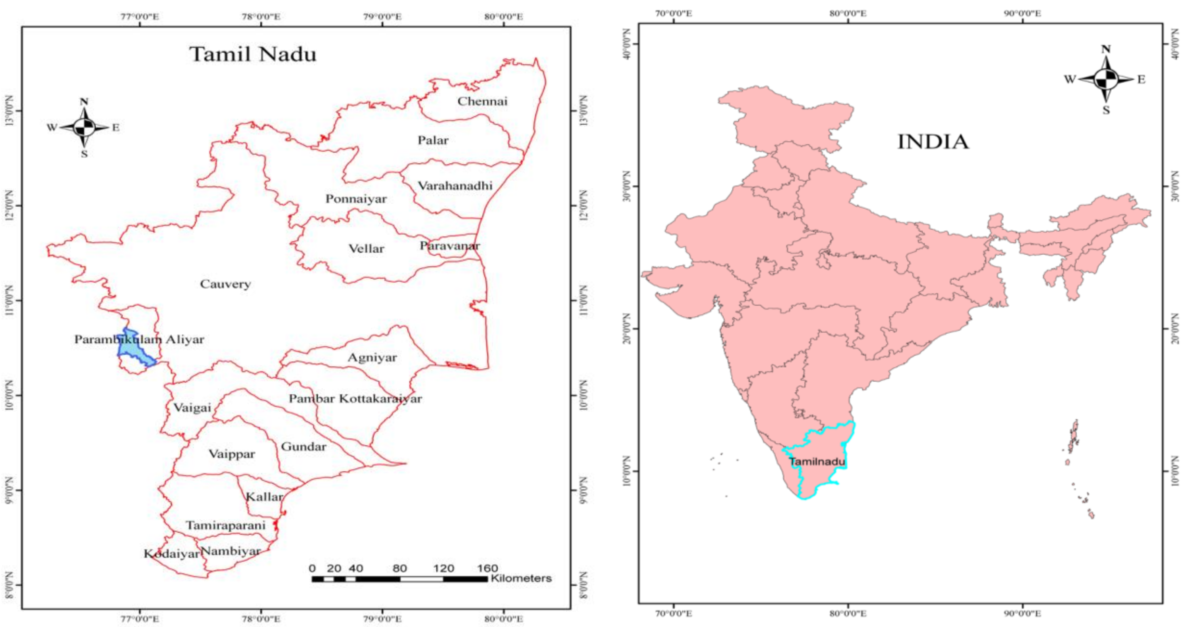
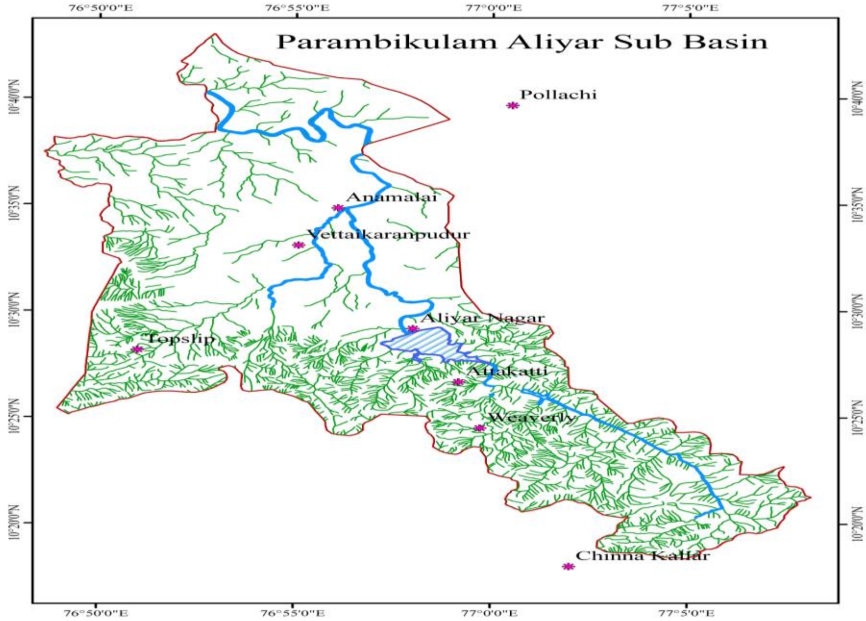


Fig.1. Location of present study area Aliyar Dam



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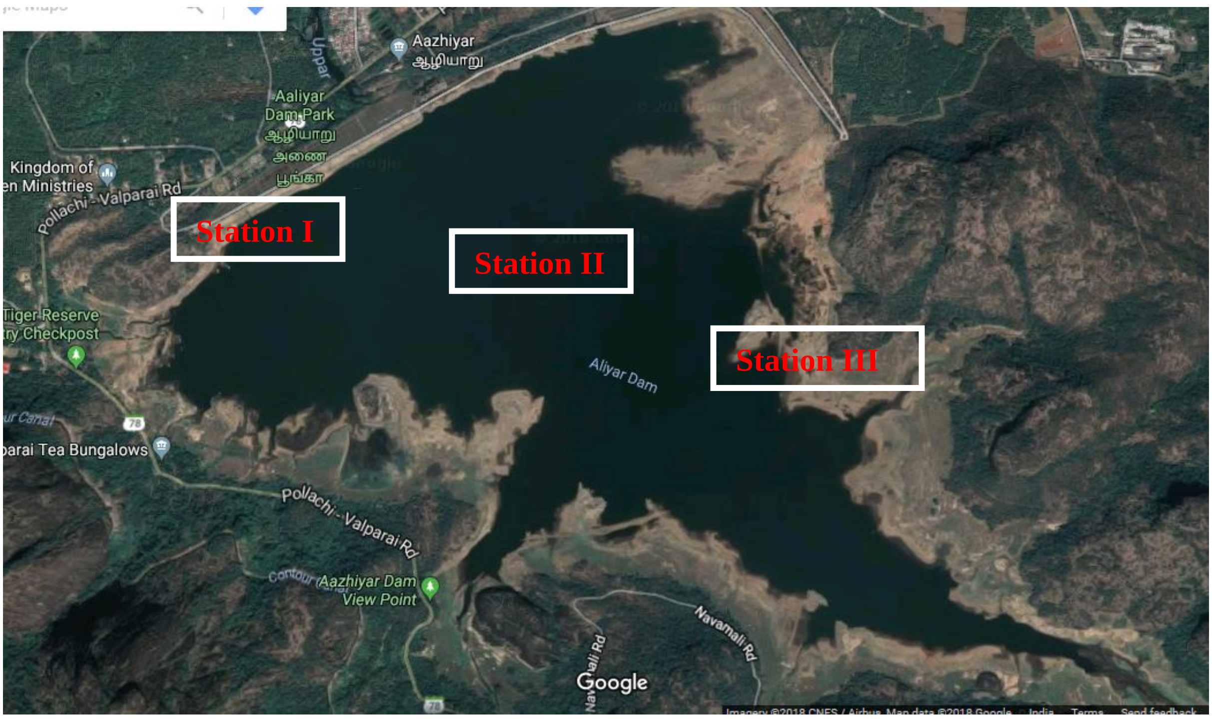

Fig.2. Sampling locations in the present study area

Sample collection

In this study, the samples were collected from Aliyar Dam at three different locations as given below.

Station I: At the point of mixing of sewage water (One end of dam)

Station II: Distance away from the point of mixing of sewage water (middle of the dam)

Station III: After mixing of sewage water (Another end of dam)

The sample locations were shown in Fig.2. The samples were collected once in every month from July 2015 to June 2016 at 11.30 AM to 12.20 PM in order to maintain uniformity. The samples were collected in a clean white polythene container. Great care was taken in the collection of water samples to secure truly representative samples from different locations of dam and also to prevent any extraneous contamination of the samples at the time of collection. The preservation procedure includes keeping the samples in dark, adding chemicals, lowering the temperature to retard reactions or combination of these. Collected samples were brought to the laboratory and kept in the refrigerator for later analysis.

Determination of water quality parameters

The analysis of various physico-chemical parameters namely temperature, pH, Electrical conductivity, Suspended Solids, Dissolved Solids, Total Solids, Total Alkalinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Fluoride, Calcium, Magnesium, Sulphate, Phosphate, Chlorides, Nitrates, iron and Carbonates were carried out as per standard methods. The methods employed for analysis of physico-chemical parameters are given in Table.1.

Table.1. Methods employed for analysis of physico-chemical parameters

S. No	Parameters	Unit	Methods
1	Temperature	°C	Thermometer
2	pH	-	APHA 1995 (Systronic Digital pH meter No. 335) [5]
3	Electrical Conductivity	µmhos/cm	Electrical conductivity meter - 304
4	Suspended Solids	mg/l	Filter paper method
5	Dissolved Solids	mg/l	Evaporation method
6	Total Solids	mg/l	SS+DS = TS
7	Total alkalinity	mg/l	Trivedy and Goel, 1984 [9]
8	Biological Oxygen Demand (BOD)	mg/l	Modified Wrinkler's method (5 days incubation), APHA, 1995 [5]
9	Chemical Oxygen Demand (COD)	mg/l	Liebig Reflux condenser method
10	Fluoride	mg/l	Trivedy and Goel, 1984 [9]
11	Calcium	mg/l	APHA,1995 [5]
12	Magnesium	mg/l	Neil and Neely 1956 [13]
13	Sulphates	mg/l	APHA, 1995 [5]
14	Phosphates	mg/l	Strickland and Parsons, 1965 [15]
15	Chlorides	mg/l	Trivedy and Goel, 1984 [9]
16	Nitrates	mg/l	APHA, 1995 [5]
17	Iron	mg/l	Strickland and Parsons, 1965 [15]
18	Carbonates	mg/l	Trivedy and Goel, 1984 [9]

- **Temperature**

In water ecosystem the temperature controls the rate of all chemical reactions and affects organisms and fish growth. The temperature of samples were taken at the sample location itself using a mercury -in-glass thermometer which was inserted to the depth of 2 cm for about 3 minutes. The readings were expressed in degree Celsius (°C).

- **pH**

pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and waste water treatment is pH dependent [5]. It is defining as -log (Hydrogen iron concentration) and measured as intensity of acidity and alkalinity on a scale ranging from 0 to 14. pH of the samples were determined by using digital pH meter (Make: Systronics Digital pH meter - no.335).

- **Electrical Conductivity**

Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water [6]. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement [7]. Electrical conductivity was measured using Conductivity meter No. 304. The electrode of the conductivity meter is dipped into the sample and the readings were noted for stable values in µmhos or Siemens(s).

- **Total alkalinity**

The alkalinity is a function of carbonate, hydroxide content and also includes contributions for borates, phosphates, silicates and other bases. Alkalinity is a measure of capacity of water to neutralize a strong acid [8]. Total alkalinity was measured using standard method [9]. The sample was titrated against 0.1N hydrochloric acid in the presence of phenolphthalein and methyl orange indicators.

- **Biological Oxygen Demand (BOD)**

Biochemical oxygen demand is a measure of organic material contamination in water expressed in mg/l. BOD is defined as the amount of dissolved oxygen required for biochemical decomposition of organic compounds and the oxidation of certain inorganic materials. The BOD was measured according to modified Wrinkler's method [5]. The principle of the method involves measuring the difference in oxygen concentration of sample before and after incubation for 5 days at 20°C.

- **Chemical Oxygen Demand (COD)**

Chemical Oxygen Demand is another measure of organic material contamination in water specified in mg/L. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. Both BOD and COD are key indicators of the environmental health of a surface water supply**.** The sample was analyzed for COD using Liebig reflex condenser method.

- **Suspended Solids & Dissolved Solids**

Solids refer to the suspended and dissolved solids in water. Total suspended and dissolved solids affect metabolism and physiology of fish and other aquatic organisms. They are products of run offs. They increase with increased rainfall and have adverse effects on dissolved oxygen and carbon dioxide. Suspended solids in water are directly proportional to dissolved solids. Dissolved solids could directly influence water conductivity, the higher the dissolved solids the higher the conductivity [10].

A known quantity of the sample (10 ml) was taken and filtered using What Man No.1 filter paper. The residue was taken out and dried in an oven at a temperature of 105°C for an hour, cooled and weighed. This gives the amount of suspended solids in the water samples.

The filtrate obtained from the above process was evaporated, dried, weighed and recorded as the quantity of dissolved solids in the water samples.

- **Total Solids**

The amount of total solids present in the water samples can be calculated by adding the suspended solids with that of the dissolved solids.

- **Fluoride**

Fluoride at a lower concentration at an average of 1 mg/l is regarded as an important constituent of drinking water [11]. Surface water generally contains less than 0.5 mg/l fluoride. However, when present in much greater concentration, it becomes a pollutant.

- **Calcium**

Calcium is most abundant ions in fresh water and is important in shell construction, bone building and plant precipitation of lime. According to APHA, 1995 the addition of ammonium oxalate solution precipitates calcium present in any solution quantitatively as calcium oxalate. The precipitate was dissolved in acid and the quantity if oxalate was determined titrimetrically against standard potassium permanganate till faint pink colour was obtained.

- **Magnesium**

Magnesium is often associated with calcium in all kinds of water, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll growth and acts as a limiting factor for the growth of phytoplankton [12]. The estimation of magnesium was carried out according to the procedure given [13]. Magnesium is complexed with titan yellow in an alkaline medium and resulting red colour was immediately read in a spectrophotometer at 540 nm against blank.

- **Sulphates**

Sulphate ion is precipitated in the form of barium sulphate by adding barium chloride in hydrochloric acid medium. The concentration of sulphate can be determined from the absorbance of light by barium sulphate and then comparing it with a standard curve [5]. The turbidity was measured against blank at 420nm in Spectrophotometer.

- **Phosphates**

This also measured spectroscopically. Yellow colour is developed from the action of phosphates on molybdate ion under strong acidic conditions. The intensity of colour is directly proportional to the concentration of phosphate in the sample. Phosphate complexes are reduced by weak reducing agents such as ascorbic acid or tartaric acid (potassium antimonyl tartarate). The colour of reduced complex is skyblue.

- **Chlorides**

The chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusion [12]. The estimation of chloride was carried out according to the method followed by [9]. Silver nitrate reacts with chloride, a very slightly soluble white precipitate of silver chloride is formed. At the end point when all chloride gets precipitated, free silver ions react with chromate to form silver chromate of reddish brown colour. The sample was titrated against standardized silver nitrate solution using potassium chromate solution in water as indicator.

- **Nitrates**

Nitrates are contributing to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields [12]. The highest amount of nitrate concentration was known to support the formation of blooms [14]. Nitrate content in water was estimated by Brucine method [5]. The reaction between nitrate and brucine produces yellow colour that can be used for calorimetric estimation of nitrate.

- **Iron**

Concentration of iron in water get increased by corrosion of pipes and by of iron present in soil by acidic water. Kidney stone related problem may develop if calcium and iron contents are high. Iron was estimated using spectrophotometric method.

- **Carbonates**

Whenever the pH touches 8.3, the presence of carbonates is indicated. It is measured by titration with standardized hydrochloric acid using phenolphthalein as indicator. Below pH

8.3, the carbonates are converted into equivalent amount of bicarbonates. The titration can also be done pH metrically or potentiometrically [9].

RESULTS AND DISCUSSION

The variations in physico-chemical characteristics of the dam water at three different locations were summarized in Tables.2. to Tables.7. The interpretations of data has been made using SPSS statistical package.

Table.2. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Temperature (°C)			pH			Electrical Conductivity (µmhos/cm)		
BIS Standards					6.5 - 8.5			300		
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	26.2 ±0.15	26.5 ±0.20	26.6 ±0.24	8.20±0.05	7.82±0.07	7.97±0.09	70.18±0.42	51.53±0.41	62.15±0.45
	Aug	26.4 ±0.24	26.1 ±0.20	26.3±0.14	8.19 ±0.08	7.41 ±0.04	8.04 ±0.08	69.20 ±0.45	40.62 ±0.47	54.70 ±0.51
	Sep	30.5±0.23	30.2 ±0.22	30.3 ±0.18	8.05 ±0.09	7.18 ±0.08	7.89 ±0.08	76.61 ±0.43	51.81±0.48	60.91±0.52
	Oct	30.3 ±0.24	30.0 ±0.15	30.0 ±0.19	8.88 ±0.07	7.07 ±0.09	7.90 ±0.07	78.52 ±0.39	42.56 ±0.49	60.72 ±0.48
	Nov	28.5 ±0.16	28.3 ±0.25	28.4 ±0.20	8.09 ±0.06	7.30 ±0.04	8.02 ±0.05	72.19 ±0.37	48.91 ±0.50	67.20 ±0.54
Winter	Dec	27.2 ±0.19	26.8 ±0.14	27.0 ±0.17	8.58 ±0.05	7.38 ±0.05	8.28 ±0.07	78.21 ±0.41	52.84 ±0.49	65.32 ±0.52
	Jan	28.7 ±0.17	28.2 ±0.16	28.5 ±0.25	8.63 ±0.05	7.23 ±0.06	8.52 ±0.05	79.90 ±0.48	52.21 ±0.43	69.49 ±0.45
	Feb	30.6 ±0.15	30.1 ±0.18	30.4 ±0.15	8.33 ±0.04	7.19 ±0.04	8.06 ±0.07	79.34 ±0.50	45.37 ±0.42	58.41 ±0.44
	Mar	30.9 ±0.12	30.3 ±0.18	30.6 ±0.24	8.74 ±0.08	7.64 ±0.08	8.62 ±0.08	75.10 ±0.47	42.54 ±0.43	54.61 ±0.48
Summer	Apr	31.9 ±0.16	31.7 ±0.17	31.8 ±0.26	9.78 ±0.05	7.37 ±0.07	8.41 ±0.09	78.51 ±0.39	44.57 ±0.48	59.10 ±0.50
	May	30.1 ±0.18	29.5 ±0.16	30.0 ±0.24	9.04 ±0.07	8.29 ±0.08	8.76 ±0.07	70.34 ±0.40	45.22 ±0.47	56.42 ±0.57
	Jun	28.3 ±0.16	28.0 ±0.15	28.1 ±0.23	8.52 ±0.06	7.78 ±0.04	8.47±0.07	75.50 ±0.47	46.56 ±0.49	54.40 ±0.56

Values were expresses as mean ± SD of three replicates using SPSS statistical package

Temperature:

The temperature was ranged from 26.2 ±0.15 to 31.9±0.16 in Station I, 26.1±0.20 to 31.7±0.17 in station II and 26.3±0.14 to 31.8±0.26 in station III. The minimum temperature was recorded during July 2015 in station I and August, 2015 in station II and III and the maximum temperature was recorded during the month of April, 2016 in all stations

In this investigation, there was no great difference between the various sampling locations. Temperature is one of the most important ecological and physical factors which have a profound influence on both living and non-living components of the environment, thereby affecting organisms and functioning of an ecosystem, though the temperature influences the overall quality f water, there are no guideline values recommended for water [16].

PH:

The pH of the water samples were ranges from 8.05±0.09 to 9.78±0.05 during the month of September 2015 and April 2016 in station I, 7.07±0.09 to 8.29±0.08 during October 2015 and May 2016 in station II and 7.9±0.07 to 8.76±0.07 during October 2015 and May 2016 in station III respectively. In this present investigation, the values of pH indicate the alkaline nature of water throughout the period of study, which might be due to high temperature that reduces the solubility of CO_2. The range of pH in water for domestic use recommended by BIS is 6.5to 8.5.

Electrical conductivity:

The electrical conductivity of the water samples were ranges from 69.20±0.45 to 79.90±0.48 during the month of August 2015 and January 2016 in station I, 40.62 ±0.47 to 52.84 ±0.49 during August 2015 and December 2015 in station II and 54.40 ±0.56 to 69.49 ±0.45 during June 2015 and January 2016 in station III respectively. Electrical Conductivity is usually the measure of ionic concentrations present in a water sample. The conductivity of most freshwaters ranges from 10 to 1000 µS cm-1, but may exceed 1000 µS cm-1, especially in polluted waters, or those receiving large quantities of land run-off [17]. Shanmugasundaram reported an electrical conductivity of 52.9 µmhos/cm in dam water [18], which coincides with the results obtained.

Total alkalinity:

The total alkalinity of the water samples were ranges from 224.58±1.88 to 263.44±1.78 in station I, 219.50 ±1.96 to 244.70 ±1.87 in station II and 220.91 ±1.87 to 249.36 ±.89 in station III. The minimum and maximum was recorded during January 2016 and February 2016 in all stations. Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. Alkalinity of water is measure of its capacity to neutralize acids. This is due to the primarily salts of weak acids or strong bases. Bicarbonates represent the measure form of alkalinity. Bicarbonates are formed in considerable amount from the action of carbon dioxide upon basic materials in soil and other salts of weak acids [5, 19].

Biological Oxygen Demand (BOD):

Biochemical oxygen demand was ranged from 2.12 ±0.04 to3.54 ±0.03 in station I, 1.87 ±0.01 to 2.45 ±0.03 in station II and 1.98 ±0.01 to 2.81 ±0.02 in station III. The minimum values were recorded during May 2016, August 2015 and May 2016 and maximum values were during November 2015, January 2016 and November 2015 in station I, II, III respectively. The high value of BOD indicates the presence of domestic, industrial wastes in huge quantities. The level of BOD depends on temperature, density of plankton, concentrations of organic matter and other related factors [20]. Organic matter was indicated by comparatively high BOD level. BOD range was too high, showing wide presence of organic matter, which is not potable. Water with BOD levels < 4 mg/l are deemed as clean, while those > 10 mg/l are considered polluted and unsafe [21]. The BOD level at station I and III were comparatively higher than station II, which might be the organic pollution near the station I and III are high due to human acticities in and around the locations, whereas it is lower in station III in the middle of the dam.

Chemical Oxygen Demand (COD):

COD was ranged from 19.53±0.14 to 26.67 ±0.17 in station I, 15.43 ±0.15 to 18.35 ±0.18 in station II and 18.11±0.18 to 21.24 ±0.20 in station III. The minimum and maximum values of COD was recorded during August 2015 and May 2016 in station I, April 2016 and January 2016 in station II and August 2015 and June 2016 in station III. COD values convey the amount of dissolved oxidizable organic matter including the non-biodegradable matters present in it. The minimum values of COD in sampling stations might be due to low organic matter. While the maximum value in stations might be due to high concentration of pollutants and organic matter. COD is one of the useful indicators of organic and inorganic substance of river water by sewage discharge and anthropogenic activities [22]. Similar to BOD, COD also comparatively higher in station I and III than station II.

Table.3. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Total alkalinity (mg/l)			BOD (mg/l)			COD (mg/l)		
BIS Standards		200								
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	227.52±1.72	223.60± 1.81	224.87± 1.75	2.64±0.04	1.97±0.05	2.05±0.04	21.20±0.15	17.54±0.19	19.31±0.16
	Aug	227.70 ±1.78	224.40±1.80	225.50 ±1.78	2.71±0.05	1.87 ±0.01	2.40 ±0.02	19.53±0.14	16.20±0.16	18.11±0.18
	Sep	228.97 ±1.80	221.55±1.83	225.13 ±1.82	2.87 ±0.08	2.24 ±0.02	2.46 ±0.02	21.08±0.13	17.28±0.15	19.32 ±0.18
	Oct	230.54 ±1.79	223.46 ±1.84	227.66 ±1.90	2.97 ±0.04	2.01 ±0.02	2.20 ±0.01	20.32±0.15	17.43 ±0.17	18.50±0.17
	Nov	230.13 ±1.90	221.00 ±1.85	226.94 ±1.78	3.54 ±0.03	2.18 ±0.02	2.81 ±0.02	19.96±0.13	17.48 ±0.16	19.52±0.13
Winter	Dec	222.95 ±1.78	221.20 ±1.75	222.58 ±1.88	2.55 ±0.04	1.96 ±0.01	2.23 ±0.02	23.87 ±0.14	18.10 ±0.14	20.67±0.19
	Jan	224.58 ±1.88	219.50 ±1.96	220.91 ±1.87	2.98 ±0.06	2.45 ±0.03	2.70 ±0.03	24.46 ±0.16	18.35 ±0.18	20.46 ±0.19
	Feb	263.44 ±1.78	244.70 ±1.87	249.36 ±.89	2.89 ±0.02	2.28 ±.02	2.56 ±0.02	22.68 ±0.17	17.89 ±0.16	19.67 ±0.19
	Mar	259.26 ±1.90	234.47 ±1.82	235.00 ±1.85	2.56 ±0.05	1.89 ±0.01	2.24 ±0.03	21.34 ±0.18	16.75 ±0.14	19.98 ±0.18
Summer	Apr	245.53 ±1.78	235.61 ±1.80	239.64 ±1.78	2.67 ±0.07	2.21 ±0.02	2.26±0.04	23.54 ±0.15	15.43 ±0.15	19.61 ±0.16
	May	253.12 ±1.78	238.90 ±1.90	239.05 ±1.78	2.12 ±0.04	1.94 ±0.01	1.98 ±0.01	26.67 ±0.17	16.87 ±0.13	20.65 ±0.19
	Jun	226.00 ±1.80	223.94 ±1.78	225.18 ±1.96	2.31 ±0.08	2.08 ±0.02	2.14 ±0.02	24.61 ±0.16	17.76 ±0.16	21.24 ±0.20

Values were expresses as mean ± SD of three replicates using SPSS statistical package

Table.4. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Suspended solids (mg/l)			Dissolved solids (mg/l)			Total Solids (mg/l)		
BIS Standards										
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	165.10±1.42	154.03±1.69	163.14±1.48	58.00±0.51	45.15±0.31	5018±0.51	223.10±1.98	199.18±1.98	213.32±1.92
	Aug	158.01± 1.24	148.07±1.48	150.06±1.50	63.01±0.55	40.04±0.24	61.62±0.55	221.02 ±1.78	188.11±1.88	211.68 ±1.98
	Sep	182.05 ±1.35	166.02±1.66	166.23±1.55	50.03±0.52	42.02 ±0.26	45.07 ±0.38	232.08±1.55	208.04 ±1.82	211.30 ±1.92
	Oct	165.05 ±1.45	150.02±1.62	154.04±1.85	55.01 ±0.47	40.35 ±0.28	42.08 ±0.44	220.06 ±1.66	190.37 ±1.72	196.12 ±1.98
	Nov	177.03 ±1.55	160.02±1.52	168.05±1.69	47.00 ±0.63	36.03 ±0.27	46.02 ±0.43	224.03 ±1.75	196.05 ±1.96	214.07 ±1.78
Winter	Dec	169.03 ±1.35	149.03±1.49	168.02±1.48	47.01 ±0.65	42.02 ±0.35	42.02 ±0.47	216.04 ±1.77	191.05 ±1.91	210.04 ±1.93
	Jan	168.02 ±1.48	160.00±1.43	166.05±1.24	58.12 ±0.55	44.10 ±0.34	48.00 ±0.43	226.14 ±1.68	204.10 ±1.93	214.05 ±1.88
	Feb	170.00 ±1.42	160.02±1.69	162.00±1.85	51.14 ±0.48	44.12 ±0.33	48.10 ±0.36	221.14 ±1.62	204.14 ±1.88	210.10 ±1.93
	Mar	170.05 ±1.48	162.05±1.78	162.05±1.74	54.16 ±0.43	44.10 ±0.39	46.14 ±0.37	224.21 ±1.82	206.15 ±1.93	208.19 ±1.78
Summer	Apr	176.06 ±1.35	160.00±1.88	168.06±1.73	55.00 ±0.49	50.00 ±0.40	52.04 ±0.38	231.06 ±1.80	210.00 ±1.97	220.10 ±1.83
	May	178.00 ±1.85	165.00±1.78	166.04±1.68	58.00 ±0.47	50.02 ±0.41	56.00 ±0.35	236.00 ±1.79	215.02 ±1.92	222.04 ±1.86
	Jun	179.05 ±1.48	168.00±1.85	168.01±1.66	55.16 ±0.39	48.06 ±0.44	54.08 ±0.40	234.21 ±1.78	216.06 ±1.93	222.09 ±1.84

Values were expresses as mean ± SD of three replicates using SPSS statistical package

Table.5. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Fluoride (mg/l)			Calcium (mg/l)			Magnesium (mg/l)		
BIS Standards		1.0			75			30		
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	0.54±0.03	0.45±0.01	0.44±0.02	71.33±0.59	60.12±0.35	66.40±0.41	35.83±0.28	19.97±0.12	31.18±0.36
	Aug	0.50±0.01	0.22±0.02	0.41±0.02	70.08±0.55	52.02 ±0.26	65.00±0.48	37.82±0.22	14.71±0.15	34.45±0.25
	Sep	0.48 ±0.02	0.38 ±0.03	0.40 ±0.03	74.06 ±0.45	59.07±0.25	61.01±0.42	38.05±0.23	20.05±0.18	30.02±0.28
	Oct	0.50 ±0.02	0.40 ±0.04	0.48 ±0.01	67.08±0.48	54.04±0.27	59.06±0.47	38.02±0.21	20.15±0.17	27.02±0.36
	Nov	0.54 ±0.01	0.37±0.03	0.45 ±0.02	62.12 ±0.49	60.02±0.28	60.98±0.48	34.06±0.31	21.24±0.21	31.04±0.34
Winter	Dec	0.53 ±0.05	0.30 ±0.04	0.32 ±0.03	68.54 ±0.65	60.01±0.29	62.34±0.46	30.07±0.32	16.80±0.22	22.25±0.33
	Jan	0.55 ±0.06	0.41 ±0.03	0.45 ±0.02	69.67 ±0.64	63.04±0.30	65.12±0.47	34.08±0.26	18.10±0.19	22.16±0.32
	Feb	0.57±0.04	0.37 ±0.04	0.38 ±0.04	71.00 ±0.66	56.12±0.34	65.78±0.50	28.06±0.28	15.14±0.14	20.00±0.31
	Mar	0.61 ±0.06	0.55 ±0.05	0.60 ±0.03	74.98 ±0.47	74.00±0.35	67.16±0.53	34.16±0.27	19.10±0.26	26.14±0.35
Summer	Apr	0.62 ±0.03	0.58 ±0.03	0.59 ±0.03	74.12 ±0.43	55.94±0.36	68.24±0.56	32.12±0.28	14.04±0.25	22.00±0.33
	May	0.58 ±0.04	0.52 ±0.01	0.47 ±0.04	72.00 ±0.77	54.89±0.37	62.15±0.54	31.10±0.29	22.08±0.27	30.14±0.28
	Jun	0.59 ±0.05	0.48 ±0.02	0.50±0.03	71.45±0.78	58.12±0.38	62.10±0.57	30.14±0.33	21.06±0.28	29.00±0.30

Values were expresses as mean ± SD of three replicates using SPSS statistical package

Table.6. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Sulphates (mg/l)			Phosphates (mg/l)			Chlorides (mg/l)		
BIS Standards		200						250		
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	184.11±1.39	169.93±1.72	183.26±1.85	0.042±0.009	0.029±0.014	0.031±0.015	283.05±2.23	174.23±2.36	233.31±2.57
	Aug	197.74±1.55	177.60±1.96	189.55±1.89	0.025±0.004	0.017±0.009	0.022±0.011	342.02±2.78	234.08±2.78	238.08±2.89
	Sep	198.40±1.57	167.72±1.87	188.23±1.88	0.033±0.012	0.014±0.007	0.022±0.011	340.04±2.88	246.03±2.77	246.04±2.78
	Oct	178.20±1.68	157.25±1.83	168.64±1.68	0.021±0.008	0.016±0.008	0.018±0.009	340.03±2.77	237.23±2.88	248.08±2.86
	Nov	189.34±1.62	157.40±1.84	169.13±1.69	0.030±0.015	0.013±0.006	0.019±0.010	338.01±2.89	228.32±2.89	236.09±2.44
Winter	Dec	179.54±1.67	145.50±1.81	177.68±1.77	0.026±0.013	0.020±0.010	0.016±0.008	238.14±2.54	138.67±2.77	235.00±2.85
	Jan	169.14±1.88	145.48±1.79	167.72±1.67	0.038±0.0014	0.024±0.012	0.028±0.014	253.08±2.57	232.01±2.27	239.03±2.55
	Feb	178.10±1.89	155.94±1.75	177.14±1.77	0.034±0.017	0.030±0.015	0.032±0.015	245.05±2.67	136.07±2.65	228.05±2.54
	Mar	177.45±1.90	155.86±1.74	177.10±1.77	0.042±0.021	0.034±0.016	0.038±0.016	246.01±2.68	138.23±2.66	229.00±2.53
Summer	Apr	190.56±1.80	145.74±1.64	187.08±1.87	0.039±0.020	0.029±0.015	0.034±0.017	245.08±2.48	137.12±2.77	218.06±2.48
	May	191.34±1.83	175.45±1.95	187.00±1.87	0.038±0.020	0.031±0.015	0.032±0.016	247.05±2.75	137.07±2.78	220.02±2.88
	Jun	188.35±1.84	165.78±1.65	187.18±1.87	0.038±0.019	0.036±0.016	0.037±0.016	236.06±2.35	139.04±2.88	232.07±2.78

Values were expresses as mean ± SD of three replicates using SPSS statistical package

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Table.7. Seasonal variations of physico-chemical characteristics of Aliyar Dam for the year 2015 - 2016

Season	Parameters	Nitrates (mg/l)			Iron (mg/l)			Carbonates (mg/l)		
BIS Standards		45			0.3			75		
	Months	SI	SII	SIII	SI	SII	SII	SI	SII	SIII
Rainy	Jul	37.42±1.29	23.23±1.22	25.16±1.24	0.24±0.03	0.18±0.02	0.27±0.03	60.07±0.31	48.33±0.26	51.92±0.24
	Aug	30.40±1.66	20.44±1.25	27.17±1.27	0.38±0.01	0.20±0.01	0.20±0.02	58.02±0.28	45.57±0.24	56.15±0.25
	Sep	20.30±1.55	13.30±1.22	18.16±1.24	0.32±0.02	0.24±0.02	0.39±0.02	59.05±0.30	46.45±0.23	56.20±0.26
	Oct	32.36±1.38	19.20±1.25	22.12±1.25	0.32±0.02	0.20±0.02	0.26±0.02	59.07±0.30	50.34±0.25	53.05±0.24
	Nov	22.34±1.27	15.30±1.23	17.11±1.24	0.36±0.02	0.25±0.01	0.30±0.03	64.06±0.32	54.60±0.24	60.00±0.30
Winter	Dec	41.34±1.35	14.31±1.26	34.15±1.32	0.20±0.02	0.20±0.01	0.30±0.04	60.01±0.30	48.52±0.24	52.05 ±0.26
	Jan	35.35±1.32	27.34±1.27	33.14±1.32	0.37±0.02	0.28±0.01	0.24±0.02	55.08±0.25	44.01±0.22	46.10±0.23
	Feb	25.31±1.28	10.31±1.20	20.15±1.25	0.22±0.02	0.26±0.01	0.34±0.04	56.00±0.26	46.21±0.23	50.04±0.25
	Mar	42.35±1.36	21.36±1.25	35.26±1.32	0.20±0.02	0.12±0.01	0.26±0.05	60.02±0.30	48.05±0.24	55.01±0.26
Summer	Apr	30.38±1.30	22.34±1.26	27.25±1.28	0.35±0.03	0.08±0.01	0.30±0.05	68.04±0.34	57.29±0.26	60.10±0.30
	May	27.35±1.24	20.39±1.25	13.18±1.12	0.22±0.02	0.04±0.01	0.12±0.03	69.02±0.35	52.45±0.26	54.05±0.24
	Jun	39.34±1.35	21.38±1.25	32.26±1.31	0.08±0.03	0.05±0.01	0.25±0.02	70.98±0.35	50.14±0.25	52.14±0.25

Values were expresses as mean ± SD of three replicates using SPSS statistical package

Suspended Solids & Dissolved Solids:

The suspended solids of the water samples were ranged from 158.01± 1.24 to 182.05 ±1.35 in station I, 148.07±1.48 to 168.00 ±1.85 in station II and 150.06±1.50 to 168.06 ±1.73 in station III respectively. Similarly, the dissolved solids were ranged from 47.00 ±0.63 to 63.01±0.55 in station I, 36.03 ±0.27 to 50.02 ±0.41 in station II and 42.02 ±0.47 to 61.62±0.55 in station III. The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles. The effect of presence of total suspended solids is the turbidity due to silt and organic matter. Similarly, in water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles [23]. The total concentration of dissolved solids in a water body found useful parameter in describing the chemical density as a fitness factor and as a general measure of edaphic relationship and productivity of the water. Both suspended and dissolved solids were higher in station I, which might be due to more recreational activities nearby station I.

Total Solids:

The total solids of the water samples were ranged from 216.04 ±1.77 to 236.00 ±1.79 in station I, 188.11 ±1.88 to 216.06 ±1.93 in station II and 196.12 ±1.98 to 214.07 ±1.78 in station III respectively.

Fluoride:

The variation in fluoride content of water samples were ranged from 0.48 ±0.02 to 0.62 ±0.03 during September 2015 and April 2016 in station I. For the station II, the range was 0.22±0.02 in August 2015 to 0.58 ±0.03 in April 2016. Similarly, for station III, the fluoride content was 0.32 ±0.03 in December 2015 to 0.60 ±0.03 in March 2016. The fluoride content was within BIS permissible limits and indicates non-pollution of water body.

Calcium and Magnesium:

The sources of Ca and Mg in natural water are various types of rocks, industrial waste and sewage. There is evidence that hard water plays a role in heart diseases [2]. Higher concentration of Mg makes the water unpalatable and act as laxative to human beings. The calcium content of the water samples were ranged from 62.12 ±0.49 in November 2015 to 74.98 ±0.47 in March 2016 at station I, 52.02 ±0.26 in August 2015 to 74.00±0.35 in March 2016 at station II and 59.06±0.47 in October 2015 to 68.24±0.56 in April 2016 at station III respectively. Similarly, the Magnesium content were ranged from 28.06±0.28 in February 2016 to 38.05±0.23 in September 2015 at station I, 14.04±0.25 in April 2016 to 22.08±0.27 in May 2016 at station II and 20.00±0.31 in February 2016 to 34.45±0.25 August 2015 at station III. The Ca and Mg levels in all the stations were within the BIS permissible limits.

Sulphates:

Sulphate is a natural occurring ion found all most in all types of water and its concentration occurs in wide ranges in natures. Sulphate content varies from 169.14±1.88 to 198.40±1.57 in station I, 145.48±1.79 to 177.60±1.96 in station II and 167.72±1.67 to 189.55±1.89 in station III. The minimum value was recorded in the month of January 2016 for all stations and maximum was recorded in September 2015 in station I and August 2015 in station II and III.

Phosphates:

Phosphate is generally recognized as the key nutrient in the productivity of water [24]. Phosphorus is one of the important elements responsible for growth of plants and animals. Phosphates in fewer amounts are helpful for growth of planktons and aquatic plants but in higher concentration causes eutrophication. The phosphate content of the water samples were ranged from 0.021±0.008 in October 2015 to 0.042±0.021 in March 2016 at station I, 0.013±0.006 in November 2015 to 0.036±0.016 in June 2016 at station II and 0.016±0.008 in December 2015 to 0.038±0.016 in March 2016 at station III respectively.

Chlorides:

High chloride ion concentration indicates organic pollution in the water. The chloride concentration on fresh natural water is quite low generally less than that of sulphate and bicarbonates. Chloride is a natural substance present in all portable water as well as sewage effluents as metallic salt. Many researchers reported that rain1fall add chloride directly. It is low in summer as compared to rainy season and occupying the intermediate position in winter [25, 26]. The chloride content varies from 236.06±2.35 to 342.02±2.78 in station I, 136.07±2.65 to 246.03±2.77 in station II and 218.06±2.48 to 248.08±2.86 in station III. The maximum values were recorded in the months of August, September and October 2015 in station I, II, III respectively. The chloride concentration was higher than BIS limit in station I yet it is below maximum permissible limits. The chloride content is below the BIS limit in station II and III.

Nitrates:

Nitrates are very important nutrient factor in aquatic ecosystems, generally, water bodies polluted by organic matter exhibit higher values of nitrates [27]. The variation in nitrate content of water samples were ranged from 20.30±1.55 to 42.35±1.36 during September 2015 and March 2016 in station I. For the station II, the range was 10.31±1.20 February 2016 to 27.34±1.27 in January 2016. Similarly, for station III, the fluoride content was 13.18±1.12 in May 2016 to 35.26±1.32 in March 2016. The nitrates seem to be in prescribed limit in all sampling locations.

Iron:

Iron content varied from 0.08±0.03 to 0.38±0.01during June 2016 and August 2015 in station I, 0.04±0.01 to 0.28±0.01 during May 2016 and January 2016 in station II and 0.12±0.03 to 0.39±0.02 during May 2016 and September 2015 in station III respectively. The permissible limit for iron is 0.3 mg/l as per BIS standards.

Carbonates:

The variation in carbonate content of water samples were ranged from 55.08±0.25 to 70.98±0.35 during January 2016 and June 2016 in station I. For the station II, the range was 44.01±0.22 January 2016 to 57.29±0.26 in April 2016. Similarly, for station III, the fluoride content was 46.10±0.23 in January 2016 to 60.10±0.30

in April 2016. The values were found to be in the BIS limits.

CONCLUSION

The analysis of water quality of Aliyar dam water shows that the pH, dissolved solids, suspended solids and total alkalinity are little higher than the permissible limits. The parameters such as BOD, COD, Fluoride, Calcium, Magnesium, Sulphate, Phosphate, Chloride, Nitrate, iron and Carbonates are well below the desirable limits. Few parameters showed little higher values at station I, which might be due to the human activities nearby that area such as laundry, rearing of animals, fishing, sewage mixing and other agricultural inputs around this area of the dam. The study reveals that, the water quality of dam water is though reasonably good and fit for drinking purposes but needs proper treatment to minimize the contamination before consumption as the concentration of pH, alkalinity, total suspended and dissolved solids, iron and carbonates are higher at sampling locations, may be influenced by sample locations, which might be because of time of sampling and activities carried out around the dam.

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