Middle-East Journal of Scientific Research 8 (3): 544-554, 2011
ISSN 1990-9233

Studies on the Physico-chemical Parameters and Correlation Coefficient of Harsool-savangi Dam, District Aurangabad, India

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Abstract: The present study dealt with assessment of the physico-chemical parameters and correlation coefficient of Harsool-Savangi dam, Aurangabad [M.S] India. The physico-chemical characteristics and correlation coefficient were studied and analyzed during January-December 2009. Seasonal variations at four different sampling sites of the Harsool-Savangi dam, Aurangabad [M.S] India were observed. The results revealed that the condition of this dam in different seasons showed fluctuations in physico-chemical parameters. Correlation coefficient indicates showed high significant positive and negative relationship ($p < 0.01$ level) and also show significant positive and negative relationship ($p < 0.05$ level).

Key wards: Physico-chemical parameters · Seasonal variations · Correlation coefficient · Harsool-Savangi dam

INTRODUCTION

Water is one of the abundantly available substances in nature, which man has exploited more than any other resources for the sustenance of life. Water of good quality is required for living organisms. Dams are the most important water resource. Unfortunately, the dams are being polluted by indiscriminate disposal of sewage, industrial wastes and human activities. The dams are always the victims of the negative impacts of urbanization. Most water bodies become contaminated due to incorporation of untreated solid and liquid waste. Large towns in India are situated near the dams, their run off and those from agricultural lands find their way to the River and add in dam water which unfit for human use. Nowaday due to increased human population and man made conditions, the water quality is deteriorating every where [1].

Water quality provides current information about the concentration of various solutes at a given place and time. Water quality parameters provide the basis for judging the suitability of water for its designated uses and to improve existing conditions. For optimum development and management for the beneficial uses, current information is needed which is provided by water quality programmers [2]. Unequal distribution of water on the surface of the earth and fast declining availability of usable fresh water are the major concerns in terms of water quantity and quality [3].

The study of different water parameters is very important for understanding of the metabolic events in aquatic ecosystem. The parameters influence each other and also the sediment parameters, as well as they govern the abundance and distribution of the flora and the fauna. Therefore, it has become obligatory to analyze at least the important water parameters when ecological studies on aquatic ecosystems are carried out. Such studies when done from time to time can indicate the favorable or unfavorable changes occurring in the ecosystem.

In India some hydrobiological work on historic shallow water bodies like temple reservoir and village ponds have been done [4-14].

MATERIALS AND METHODS

Water samples for physico-chemical analysis were collected from Harsool Savangi Dam, geographical coordination 19° 56' 14.32? N and 75° 21' 30.56″ E Aurangabad, (M.S) India, at 4 different sites viz., Station 1 (South side), Station 2 (East side), station 3

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(North side) and station 4 (West side) in the early morning between 8 am to 11 am in the first week of every month from January-December 2009. The samples were collected in acid washed five liter plastic container from a depth of 5-10 cms below the surface of water.

The physico-chemical characteristics of the dam water like water temperature, turbidity, transparency, pH, conductivity, total solids (TS), total dissolve solids (TDS), total suspended solids (TSS), total hardness, alkalinity, chloride, phosphate and nitrate were determined in summer, monsoon and winter according to standard methods [15-16].

RESULTS AND DISCUSSION

The seasonwise physico-chemical parameters data of Harsool-Savangi dam, Aurangabad [M.S] India have been presented seasonal mean values, seasonal standard deviation, seasonal coefficient variation of different parameters data has been presented in table 1 and Fig. 1. A to N.

Physico-chemical Characteristic

Water Temperature: Water temperature is very important parameter, because it influences the biota in a water body by affecting activities such as behaviour, respiration and metabolism. It is necessary to study temperature variations in water body, in animals ecophysiological and toxicological aspects because, water density and oxygen content are temperature related and hence temperature indirectly affects osmoregulation and respiration of the animal [17].

The maximum value was recorded 30.66 ± 0.10 (°C) and coefficient variation was 0.32 % recorded during summer; minimum value was recorded 18.33 ± 0.23 (°C) and coefficient variation was 1.25 % recorded during winter. The overall mean was 24.40 ± 6.16 (°C) and coefficient variation was 25.24 % (Table 1 and Fig. 1A). The water temperature was consistently lower than atmospheric temperature.

In the present investigation, the temperature values were maximum during summer and minimum during winter. Low temperature recorded in winter may be due to high water level, lesser solar radiation, low atmospheric temperature and high temperature in summer because of low water level, high solar radiation and clear atmosphere.

Similarly, results have been reported by [18-20] recorded minimum temperature, in winter season and maximum in summer.

Turbidity: Suspension of particles in water interfering with the passage of light is called turbidity. Turbidity is caused by wide variety of suspended matter, which range in size from colloidal to coarse dispersion depending upon the degree of turbulence and also ranges from pure inorganic substances to those that are highly organic in nature. Turbid waters are undesirable from aesthetic point of view in drinking water supplies.

The maximum value was recorded 12.46 ± 0.60 (NTU) and coefficient variation was 4.81 % recorded during Monson; minimum value was recorded 10.14 ± 0.46 (NTU) and coefficient variation was 4.53 % recorded during summer. The overall mean was 11.19 ± 1.17 (NTU) and coefficient variation was 10.45 % (Table 1 and Fig. 1B).

Table 1: Seasonal variations in physico-chemical parameters of Harsool-Savangi dam, (M.S) India. (During January-December 2009)

Parameter	Summer	C.V %	Monsoon	C.V %	Winter	C.V %	Average	C.V %
Water temperature (0°C)	30.66±0.10	0.32	24.22±0.70	2.89	18.33±0.23	1.25	24.40±6.16	25.24
Turbidity (NTU)	10.14±0.46	4.53	12.46±0.60	4.81	10.98±0.98	8.92	11.19±1.17	10.45
Transparency (cm)	20.82±1.35	6.48	9.03±1.48	16.38	13.37±1.43	10.69	14.40±5.96	41.38
pH	8.40±0.04	0.47	8.18±0.09	1.10	8.07±0.08	0.99	8.21±0.16	1.948
Elect. Conductivity (µmhos /cm)	263.05±13.91	5.28	506.03±17.88	3.53	420.38±11.47	2.72	396.48±123.23	31.08
Total solids (mg/l)	399.54±2.70	0.67	459.13±3.74	0.81	451.13±3.21	0.71	436.6±32.34	7.40
Total dissolve solids (mg/l)	390.46±1.96	0.50	446.87±4.19	0.93	440.33±2.95	0.66	425.88±30.85	7.24
Suspended solids (mg/l)	9.07±0.79	8.71	12.26±0.56	4.56	10.79±0.32	2.96	10.70±1.59	14.85
Alkalinity (mg/l)	208.19±7.34	3.52	197.78±16.45	8.31	175.77±6.23	3.54	193.91±16.55	8.53
Total Hardness (mg/l)	389.76±0.88	0.22	524.61±13.98	2.66	431.45±3.44	0.79	448.60±69.04	15.39
Sulphate (mg/l)	19.83±1.49	7.51	17.80±2.00	11.23	14.08±1.03	7.31	17.23±2.91	16.88
Chloride (mg/l)	32.65±0.93	2.84	28.36±1.10	3.87	22.66±1.18	5.20	27.89±5.01	17.96
Nitrate (mg/l)	0.72±0.04	5.55	1.70±0.06	3.52	1.01±0.02	1.98	1.14±0.50	43.85
Phosphate (mg/l)	0.30±0.01	3.33	0.83±0.01	1.20	0.69±0.03	4.34	0.60±0.27	45

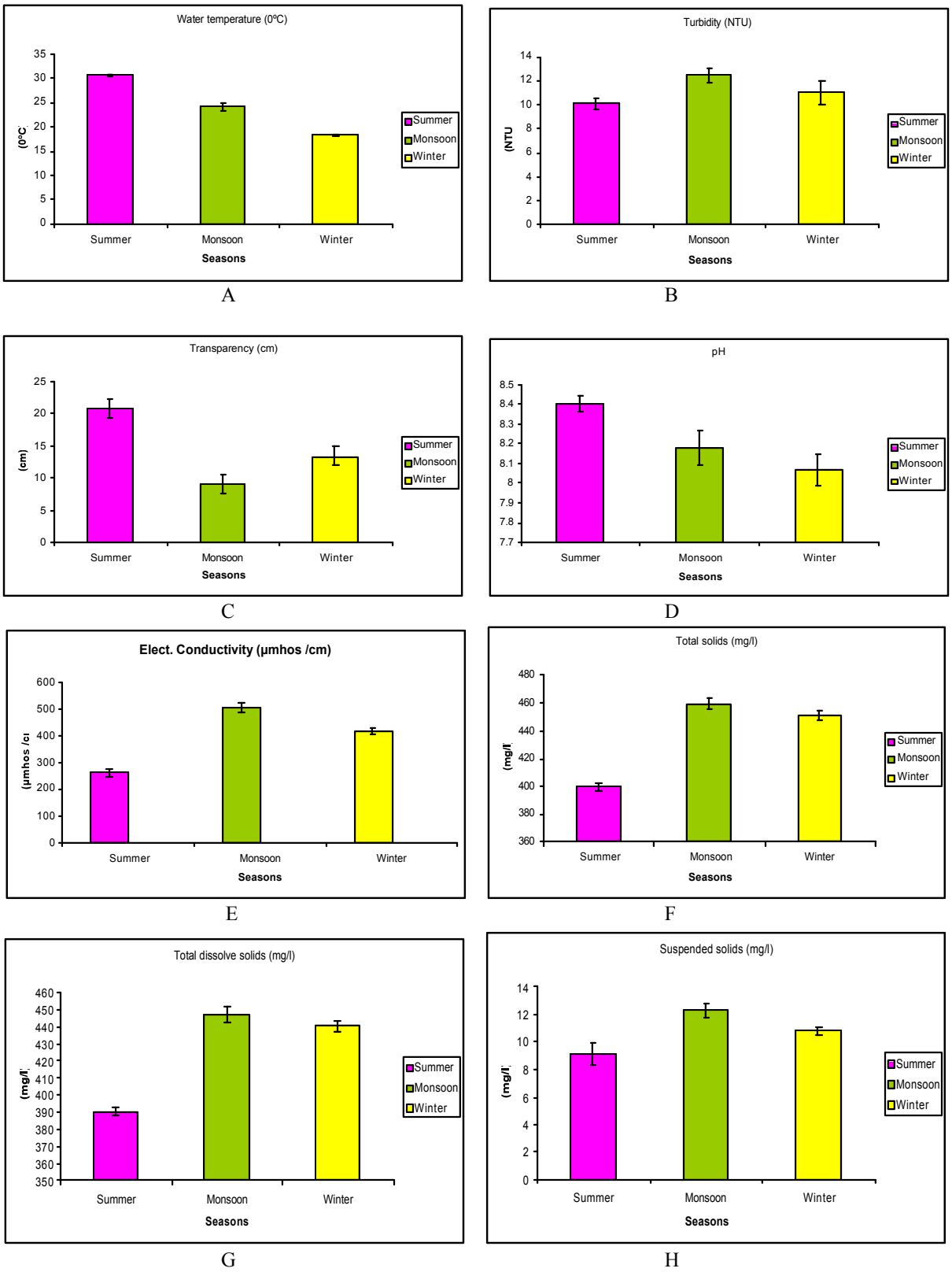

Fig. 1: Continued

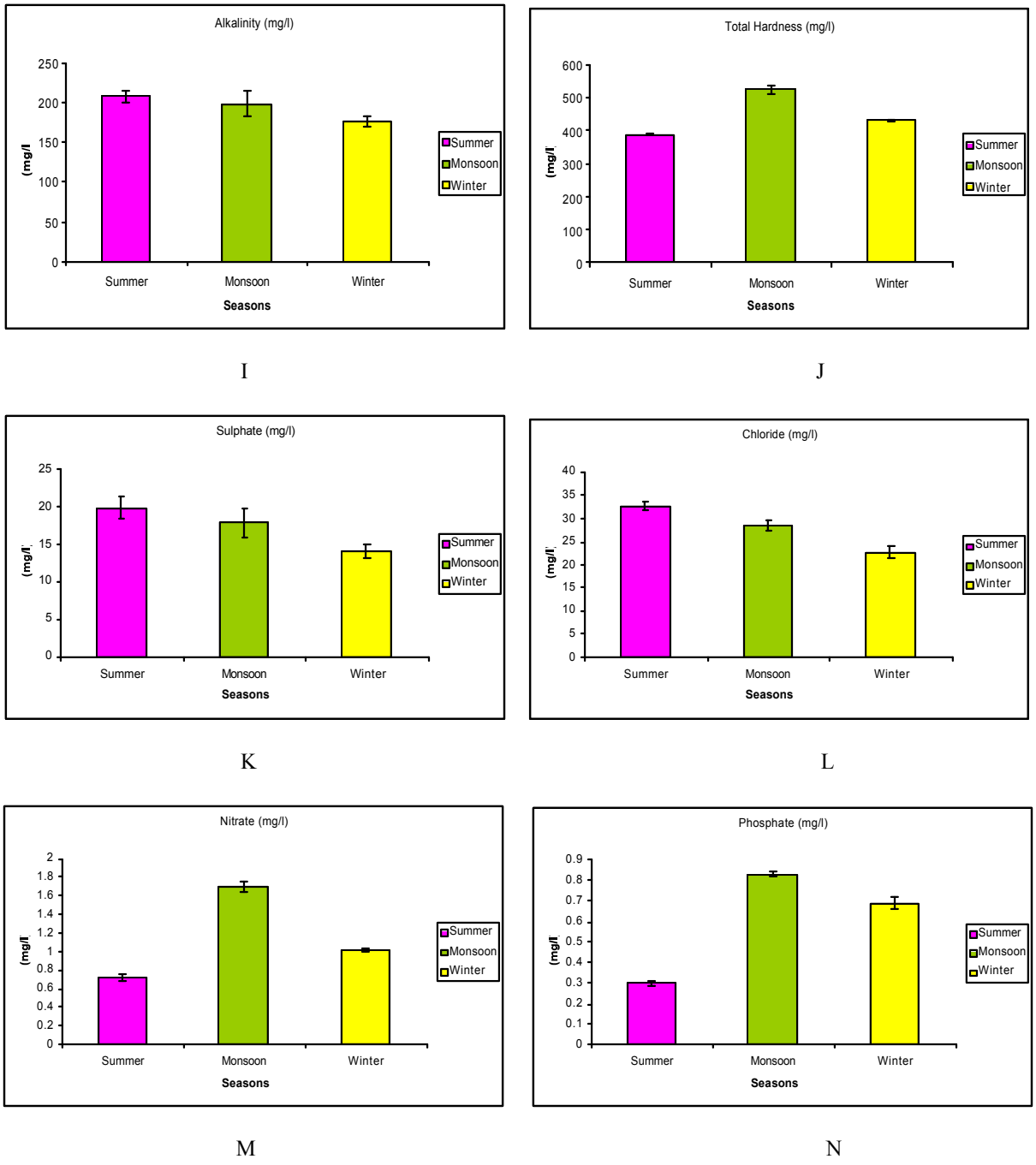

Fig. 1: Graphs showing average seasonal variations of four sties in Water temperature, Turbidity, Transparence, pH, Electric conductivity, Total Solids, Total Dissolve Solids, Total Suspended Solids, Alkalinity, Total hardness, Sulphate, Chloride Nitrate and phosphate (A to N) at different seasons of Harsool-Savangi dam, [M.S] India. (During January - December 2009).

Table 2: Correlation matrix among the physico-chemical properties, phytoplanktons, zooplanktons and fishes density of Harsool-Savangi dam from January-December 2009

Parameter	W.T (0°C)	Turbidity (NTU)	Tra. (cm)	pH	E. C (µmhos /cm)	T.S (mg/l)	TDS (mg/l)	TSS (mg/l)	Alkalinity (mg/l)	T.H (mg/l)	Sulphate (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)
W.T (0°C)	1													
Turbidity (NTU)	-0.38	1												
Tra. (cm)	0.64*	-0.95**	1											
pH	0.98**	-0.52	0.76**	1										
E.C (µmhos /cm)	-0.65*	0.94**	-0.99**	-0.77**	1									
TS(mg/l)	-0.81**	0.84**	-0.96**	-0.89**	0.97**	1								
TDS (mg/l)	-0.82**	0.83**	-0.96**	-0.90**	0.96**	0.99**	1							
TSS (mg/l)	-0.56	0.97**	-0.99**	-0.68*	0.99**	0.93**	0.93**	1						
Alkalinity (mg/l)	0.97**	-0.16	0.45	0.92**	-0.46	-0.65*	-0.67*	-0.35	1					
T.H (mg/l)	-0.32	0.99**	-0.93**	-0.47	0.92**	0.81**	0.80**	0.96**	-0.10	1				
Sulphate (mg/l)	0.98**	-0.19	0.48	0.93**	-0.50	-0.68*	-0.69*	-0.39	0.99**	-0.13	1			
Chloride(mg/l)	0.99**	-0.28	0.55	0.96**	-0.57	-0.74**	-0.75**	-0.46	0.99**	-0.22	0.99**	1		
Nitrate(mg/l)	-0.31	0.99**	-0.92**	-0.46	0.92**	0.80**	0.79**	0.96**	-0.08	0.99**	-0.12	-0.20	1	
Phosphate (mg/l)	-0.72**	0.91**	-0.99**	-0.83**	0.99**	0.99**	0.98**	0.97**	-0.55	0.88**	-0.58	-0.65*	0.87**	1

** = Correlation is high significant at $p < 0.01$ level, '-' indicate negative correlation, * = Correlation is significant at $p < 0.05$ level, W.T = Water temperature, Tra. = Transparency, E.C = Electrical conductivity, T.S = Total solids, T.D.S = Total Dissolved Solids, T.S.S. = Total Suspended Solids, DO= Dissolved Oxygen, BOD= Biochemical Oxygen Demand, COD= Chemical Oxygen Demand, T.H = Total Hardness, PHY = Phytoplanktons and ZOO = Zooplanktons.

In the present investigation, the turbidity values were maximum during monsoon and minimum during summer. High values of turbidity in monsoon may be due to influx of rain water from catchments area, cloudiness, less penetration of light, washes silts, sand, high organic matter and low transparency due to suspended inert particulate matter. However, low values of turbidity in summer may be due to clear atmosphere, evaporation of water and high light penetration. Particularly north site showed high values of transparency due to exclusive addition of River entry point results increased transparency, adversely affecting the turbidity.

Similarly, results have been reported [19,21-23] recorded the highest turbidity in monsoon

Transparency: The transparency of natural waters is an indicator of productivity. The extent to which light can penetrate depends on the transparency of standing water column. Further, transparency of water is inversely proportional to turbidity, created by suspended inorganic and organic matter [24]. The transparency of water body is affected by the factors like planktonic growth, rainfall, sun's position in the sky, angle of incidence of rays, cloudiness, visibility and turbidity due to suspended inert particulate matter.

In study period i.e. January-December 2009 transparency showed high significant negative relationship with turbidity; it showed significant positive relationship with water temperature (Table 2). The maximum value was recorded 20.82 ± 1.35 (cm) and coefficient variation was 6.48 % recorded during summer; minimum value was recorded 9.03 ± 1.48 (cm) and coefficient variation was 16.38 % recorded during monsoon. The overall mean was 14.40 ± 5.96 (cm) and coefficient variation was 41.38 % (Table 1 and Fig. 1C).

In the present investigation, the transparency values were maximum during summer and minimum during monsoon. Low values of transparency in monsoon may be due to influx of rain water from catchments area, cloudiness, less penetration of light and high turbidity due to suspended inert particulate matter. However, high values of transparency in summer may be due to clear atmosphere and high light penetration. Particularly north site showed low values of transparency due to exclusive addition of sewage results increased turbidity, adversely affecting the transparency.

Similarly, results have been reported [9,25-27] recorded low values of transparency during monsoon as compared to summer and winter.

pH: P^H is defined as the intensity of the acidic or basic character of a solution at a given temperature. P^H is the negative logarithm of hydrogen ion concentration ($P^H = -\log [H^+]$). P^H values from 0 to 7 are diminishingly acidic, whereas values of 7 to 14 are increasingly alkaline. At 25°C, P^H 7.0 is neutral, where the activities of the hydrogen and hydroxyl ions are equal and it corresponds to 10-7 moles/L. The neutral point is temperature dependant and is P^H 7.5 at 0°C and pH 6.5 at 60°C.

In study period i.e. January-December 2009 P^H showed high significant positive relationship with water temperature and transparency (Table 2). The maximum value was recorded 8.40 ± 0.04 and coefficient variation was 0.47 % recorded during summer; minimum value was recorded 8.07 ± 0.08 and coefficient variation was 0.99 % recorded during winter. The overall mean was 8.21 ± 0.16 and coefficient variation was 1.94 % (Table 1 and Fig. 1D).

In the present investigation, the pH values were maximum during summer and minimum during monsoon.

In the present investigation, the pH range showed that the water of all the sampling sites of the Lake was alkaline in nature high in summer. High values of P^H during summer might be low water levels and concentration of nutrients in water. The decrease P^H values were due to dilution caused by the rainwater during monsoon.

Similar trend was also reported [19,21,26,28-31]. Pawar and Pulle [32] observed the pH in range of 7.0 to 7.85 and stated that the pH of water is important for the biotic Communities because most of the plant and animal species can survive in narrow range of pH from slightly acidic to slightly alkaline condition.

Electric Conductivity: Electrical conductivity is a numerical expression ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. Electrical conductivity measurements can be used to calculate total dissolved solids by multiplying electrical conductivity (in LS/cm) by an empirical factor, which vary between 0.55 to 0.9, depending on the soluble components of the water and the temperature of measurement.

In study period i.e. January-December 2009 electric conductivity showed high significant positive relationship with turbidity, it showed high significant negative relationship with transparency and pH, it showed significant negative relationship with water temperature (Table 2). The maximum value was recorded 506.03 ± 17.88 (µmhos /cm) and coefficient variation was 3.53 % recorded during monsoon; minimum value was recorded 263.05 ± 13.91 (µmhos /cm) and coefficient variation was 5.28 % recorded during summer. The overall mean was 394.48 ± 123.23 (µmhos /cm) and coefficient variation was 7.40 % (Table 1 and Fig. 1E). Electric conductivity increases with increase in total dissolve solid.

In the present investigation, the electrical conductivity values were maximum during monsoon and minimum during summer. High value of electrical conductivity in monsoon could be due to inflow of high quantum of domestic sewage in rainy season and low values in summer might be due to higher temperature and stabilization of water due to sedimentation and increased concentration of slats because of discharged domestic sewage and organic matter in the river join the Harsool-Savangi Dam, Aurangabad [M.S] India.

Similarly, results have been reported by Narayana *et al*. [19] reported that high electrical conductivity in monsoon.

Total Solids, Total Suspended Solids and Total Dissolve Solids (T.S, T.D.S and T.S.S): Solids refer to suspended and dissolved matter in water. They are very useful parameters describing the Chemical constituents of the water and can be considered as general of edaphically relation that contributes to productivity within the water body [33].

In study period i.e. January-December 2009 total solids showed high significant positive relationship with turbidity and electric conductivity; it showed high significant negative relationship with water temperature, transparency and pH (Table 2). The maximum value of T.S was recorded 459.13 ± 3.74 (mg/l) and coefficient variation was 0.81 % recorded during monsoon; minimum value of T.S was recorded 399.54 ± 2.70 (mg/l) and coefficient variation was 0.67 % recorded during summer. The overall mean was 436.6 ± 32.34 (mg/l) and coefficient variation was 7.40 % (Table 1 and Fig. 1F).

In study period i.e. January-December 2009 total dissolved solids showed high significant positive relationship with turbidity, electric conductivity and total solids, it showed high significant negative relationship with water temperature, transparency and pH (Table 2). The maximum value of T.D.S was recorded 446.87 ± 4.19 (mg/l) and coefficient variation was 0.93 % recorded during monsoon; minimum value of T.D.S was recorded 390.46 ± 1.96 (mg/l) and coefficient variation was 0.50 % recorded during summer. The overall mean was 425.88 ± 30.85 (mg/l) and coefficient variation was 7.24 % (Table 1 and Fig. 1G).

In study period i.e. January-December 2009 total suspended solids showed high significant positive relationship with turbidity, electric conductivity, total solid and total dissolved solids, it showed high significant negative relationship with transparency, it showed

significant negative relationship with pH (Table 2). The maximum value of T.S.S was recorded 12.26 ± 0.56 (mg/l) and coefficient variation was 4.56 % recorded during monsoon; minimum value of T.S.S was recorded 9.07 ± 0.79 (mg/l) and coefficient variation was 8.71 % recorded during summer. The overall mean was 10.70 ± 1.59 (mg/l) and coefficient variation was 14.85 % (Table 1 and Fig. 1H).

In the present investigation, the T.S, T.D.S and T.S.S values were maximum during monsoon and minimum during summer. High values of total suspended solids during monsoon may be due to siltation, deterioration, heavy precipitation and mixing run off rain water which carried mud, sand etc mixed in the dam water.

Similarly, results have been reported by Jawale and Patil[18] and Salve and Hiware, [35] reported seasonal analysis and stated that low total dissolved solids recorded in winter season while maximum value in monsoon due to addition of solids from surface run off in Wanparakalpa reservoir, Nagapur near Parali Vaijanath Dist. Beed, Maharashtra.

Alkalinity: Alkalinity of surface water is primarily a function of carbonate, hydroxide content and also includes the contributions from borates, phosphates, silicates and other bases. Alkalinity is a measure amount of strong acid needed to lower the P^H of a sample to 8.3, which gives free alkalinity (phenolphthalein alkalinity) and to a P^H 4.5 gives total alkalinity. Total alkalinity is the sum of hydroxides, carbonates and bicarbonates.Total Alkalinity is a measure of capacity of water to neutralize a strong acid.

In study period i.e. January-December 2009 alkalinity showed high significant positive relationship with water temperature and pH, it showed significant negative relationship with total solid and total dissolved solids (Table 2). The maximum value was recorded 208.19 ± 7.34 (mg/l) and coefficient variation was 3.52 % recorded during summer; minimum value was recorded 175.77 ± 6.23 (mg/l) and coefficient variation was 3.54 % recorded during winter. The overall mean was 193.91 ± 16.55 (mg/l) and coefficient variation was 8.53 % (Table 1 and Fig. 1I).

In the present investigation, the alkalinity values were maximum during summer and minimum during monsoon. This may be attributed to increase the rate of organic decomposition during which CO_2 is liberated, which reacts with water to form HCO_3, thereby increasing the total alkalinity in summer. The increased alkalinity during summer and winter was due to the concentration of nutrients in water. The decrease was due to dilution caused by the rainwater during monsoon.

Similarly, it was observed that the higher values of total alkalinity with high bicarbonate contents in the dam. This further supported by the observations made by [35-36], that the dam is highly productive from the viewpoint of alkalinity of its water

Total Hardness: Hardness is due to concentration of alkaline earth metals. Ca^{++} and Mg^{++} ions are the principal cations imparting hardness, it prevents leather forming. Ca^{++} and Mg^{++} are the most abundant elements in natural surface and ground water and exist mainly as carbonates, bicarbonates and carbon dioxide constituted major source of inorganic carbon to producers in an aquatic ecosystem. They also act as buffers regulating the pH of the medium.

In study period i.e. January-December 2009 total hardness showed high significant positive relationship with turbidity, electric conductivity, total solid, total dissolved solids and total suspended solids, it showed high significant negative relationship with transparency (Table 2). The maximum value was recorded 524.61 ± 13.98 (mg/l) and coefficient variation was 2.66 % recorded during monsoon; minimum value was recorded 389.76 ± 0.88 (mg/l) and coefficient variation was 0.22 % recorded during summer. The overall mean was 448.60 ± 69.04 (mg/l) and coefficient variation was 15.39 % (Table 1 and Fig. 1J).

In the present investigation, the maximum hardness recorded in monsoon and minimum in summer season. Maximum total hardness value recorded during the monsoon may be due leaching of rocks in catchments area. Hardness is mainly due to calcium and magnesium, the major cation present in natural waters as calcium and magnesium, its main source being leaching of rocks in the catchments. Its concentration restricts water use, while it is an important component in the exoskeleton of arthropods and shells in mollusca [37].

Similarly, results have been reported by Pawar and Pulley [32] studied on Pethwadaj Dam, Nanded, Maharashtra, the maximum values were recorded during monsoon while minimum during winter. Salve and Hiware[34] reported that the Total Hardness was higher in winter, moderate in monsoon and lower in summer.

Sulphate: Sulphate is present in fertilizers they contribute to water pollution and increase sulphate concentration in water body. They also come from runoff water, which contains relatively large quantities of organic and mineral sulphur compounds. The supply of

sulphate ions in surface water under natural conditions are due to the reactions of water with sulphate containing rock and with the biochemical and partly chemical oxidation of sulphides and other compounds of sulphur. The most stable from of sulphur in water at 25 °C and atmospheric pressure are SO_4, H_2SO_4, free sulphur and HS-H_2S [38].

In study period i.e. January-December 2009 sulphate showed high significant positive relationship with water temperature, pH and alkalinity, it showed high significant negative relationship with, it showed significant negative relationship with total solid and total dissolved solids (Table 2). The maximum value was recorded 19.83 ± 1.49 (mg/l) and coefficient variation was 7.51 % recorded during summer; minimum value was recorded 14.08 ± 1.03 (mg/l) and coefficient variation was 7.31 % recorded during winter. The overall mean was 17.23 ± 2.91 (mg/l) and coefficient variation was 16.88 % (Table 1 and Fig. 1K).

In the present investigation, the Sulphate values were maximum during monsoon and minimum during winter. Maximum Sulphate concentration during monsoon may be due to the dilution and utilization of Sulphate by aquatic plants. However, the low Sulphate concentration was noted during winter may be due to biodegradation and low water level.

Similarly, results have been reported Reddy *et al*. [21], Telkhade *et al*. [39] and Shanthi *et al*. [40] observed high value in monsoon.

Chlorides: Chloride anion is generally present in natural waters. Chlorides as chloride anions (Cl-) are major anions in wastewater. The chloride concentration is higher in organic wastes and its higher level in natural water is definite indication of pollution from domestic sewage. The ecological significance of chloride lies in its potential to regulate salinity of water and exert consequent osmotic stress on biotic communities. The increase in chloride concentration in Lakes, Rivers and dams is due to the discharge of municipal and industrial wastes reported by Kant and Raina [41].

In study period i.e. January-December 2009 chloride showed high significant positive relationship with water temperature, pH, alkalinity and sulphate, it showed high significant negative relationship with total solid and total dissolved solids (Table 2). The maximum value was recorded 32.65 ± 0.93 (mg/l) and coefficient variation was 2.84 % recorded during summer; minimum value was recorded 22.66 ± 1.18 (mg/l) and coefficient variation was 5.20 % recorded during winter. The overall mean was 27.89 ± 5.01 (mg/l) and coefficient variation was 17.96 % (Table 1 and Fig. 1L).

In the present investigation, the Chloride values were maximum during summer and minimum during winter. Maximum value recorded during summer and minimum during winter. It can be concluded that there was no definite pattern of Chloride fluctuation, lower value during winter could be attributed to dilution effect and renewal of water mass alter summer stagnation and also may be due to high sedimentation rate on relatively stable environmental condition. Maximum value during summer could be due to higher concentration of Chloride resulted from evaporation.

Similarly, results have been reported [19.21,42,43] reported that the Chloride maximum value recorded in May while minimum recorded in August.

Nitrate: Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters, because it is a product of aerobic decomposition of organic nitrogenous matter. Significant sources of nitrates are fertilizers, decayed vegetable and animal matter, domestic and industrial effluents and atmospheric washouts. Unpolluted natural water contain usually only minute amount of nitrate.

In study period i.e. January-December 2009 nitrate showed high significant positive relationship with turbidity, electric conductivity, total solid, total dissolved solids, total suspended solids and total hardness, it showed high significant negative relationship with transparency (Table 2). The maximum value was recorded 1.70 ± 0.06 (mg/l) and coefficient variation was 3.52 % recorded during monsoon; minimum value was recorded 0.72 ± 0.04 (mg/l) and coefficient variation was 5.55 % recorded during summer. The overall mean was 1.14 ± 0.50 (mg/l) and coefficient variation was 43.85 % (Table 1 and Fig. 1M).

In the present investigation, values of Nitrate were maximum during monsoon and minimum during summer season. Nitrate levels in surface water often show marked seasonal fluctuations with higher concentrations being found during monsoon months compared to summer and winter months. During summer months the reduction in nitrates could be due to algal assimilation and other biochemical mechanism and Nitrate value higher during monsoon may be due to surface run off and domestic sewage and specially washing activities.

Similarly, results have been reported [44-45].

Phosphate: Phosphorus is a nutrient for plant growth and a fundamental element in the metabolic reaction of plants and animals. It controls algal growth and primary productivity. In most natural waters, phosphorus ranges from 0.005 to 0.020 mg/L. Algae require only small amounts of phosphorus. Excess amounts of phosphorus can cause eutrophication leading to excessive algal growth called algal blooms.

In study period i.e. January-December 2009 phosphate showed high significant positive relationship with turbidity, electric conductivity, total solid, total dissolved solids, total suspended solids, total hardness and nitrate, it showed high significant negative relationship with water temperature, transparency and pH, it showed significant negative relationship with chloride (Table 2). The maximum value was recorded 0.83 ± 0.01 (mg/l) and coefficient variation was 1.20 % recorded during monsoon; minimum value was recorded 0.30 ± 0.01 (mg/l) and coefficient variation was 3.33 % recorded during summer. The overall mean was 0.60 ± 0.27 (mg/l) and coefficient variation was 45.00 % (Table 1 and Fig. 1N).

In the present investigation, the Chloride values were maximum during monsoon and minimum during summer. Maximum during monsoon might be due to the washing activities, there is an entry of detergents in the water body and less water quantity and during summer season the relatively low level of Phosphate have been reported which may be attributed to abundance of Phytoplanktons.

Similarly, results have been reported [46-47].

CONCLUSIONS

The present study show detailed physico-chemical characteristics and quality of water in Harsool-Savangi dam, Aurangabad (M.S) India.

- The summer, monsoon and winter seasons shows different seasonal fluctuations in various physico-chemical parameters.
- The water of present reservoir is useful for irrigation as well as fish culture.
- The water parameters indicate that the reservoir is rich in nutrients.
- Total hardness in this region was beyond the permissible limit in monsoon season only according to WHO and ISI standards for drinking purpose in the year.
- The correlation coefficient indicates positive and negative significant correlation of physico-chemical parameters with each other. Positive correlation mean one parameter increase with other parameters also increase and negative correlation mean one parameter increase with other parameters decrease.
- To improve quality of water there should be continuous monitoring of pollution level and maintain the favorable conditions essential for fish survival, growth and reproduction in Harsool-Savangi dam Aurangabad (M.S) India.

ACKNOWLEDGEMENTS

The authors are thankful to Head, Dept of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad-431004 (M.S) India for providing laboratory and library Facilities. We are grateful to UGC for providing financial assistance under SRF during the course of study.

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