

Assessment Of Physico Chemical Parameters Of Water And Their Seasonal Variation In Vikram Tearth Sarovar, Ujjain (M.P)

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Abstract

In freshwater ecosystems water quality plays an important role in determining the status and condition of that freshwater ecosystem. The present limnological investigations include analysis of various physico chemical parameters at the selected sites of Vikram Tearth Sarovar Ujjain (M.P) from Jan 2019 to Dec 2019. The aim of the current study was to evaluate the pollution status of Vikram Tearth Sarovar on the basis of different physico chemical conditions. The mean air temperature ranged from 29.0 °C ± 3.1 to minimum 20.1°C ± 4.3. The pH of the selected water body was alkaline throughout the study period. The pond depicted the usual cation progression Ca>Mg. The pond was categorized as Calcium rich after Ohle (1934). The water in Vikram Tearth Sarovar was transparent during winters rest it was turbid throughout the study period during all the seasons. The Water in Vikram Tearth Sarovar was typically hard water type. The DO (3.8± 0.2) was minimum during summers. High mean values of Nitrate (7.289±1.86) and Phosphate (1.110±0.1) were recorded during summers. The mean BOD (12.9±0.1) in Vikram Tearth Sarovar was maximum during summer season. Stastical analysis was also carried out to find the degree of relationship between various abiotic factors. D.O showed Negative correlation with Temperature (-0.892), BOD(-0.961), Nitrate (-0.896) and Phosphate (-0.943). While as Temperature showed positive correlation with BOD (0.877), Total Hardness (0.752), Magnesium Hardness (0.912), Nitrate(0.902) and Phosphate (0.889). The high values of the physico chemical properties of water were recorded in the present study in Vikram Tearth Sarovar Ujjain indicating the eutrophic nature of the pond due to increased anthropogenic activities. Thus measures need to be enforced to reduce the rate of pollution of the selected water body arising from the anthropogenic activities in the catchment of the reservoir.

Keywords; Vikram Tearth Sarovar; Pollution; Eutrophication; Anthropogenic pressures.

INTRODUCTION

Access to clean and safe water for human consumption was declared a human right by the United Nations General Assembly in July 2016 (UN, 2016). Given that climate change and anthropogenic activities are causing to major changes in the hydrological cycle. Water quality degradation has emerged as a crucial global concern for the sustainable development of human beings. Water, they say, is life, and indeed they were right; with water covers 70% of the earth's surface, it unquestionably becomes one of our most valuable resources. But a closer look at the water gives us a terrible shock. Water pollution has become a major global issue that is becoming critical in developing countries due to insufficient or non-existent surface water quality, conservation measures, and sanitation (Gupta et al., 2009). According to Adebisi (1981), knowledge of water's physico-chemical regime is immensely valuable in determining its productivity, usefulness, and other characteristics that influence the vertical and horizontal migration of species, as well as their distribution, diversity, and feeding pattern. The physicochemical characteristics of an aquatic body not only reveal the type and diversity of aquatic biota, but also the water quality and pollution (Mir *et al.*, 2004). The degree of eutrophication varies widely between lakes and ponds in general and wetlands in particular, progressing from oligotrophic to mesotrophic and eventually to eutrophic stages. High altitude lakes operating more or less solely under natural forces are oligotrophic, whereas low altitude lakes and ponds, which are subjected to a variety of anthropogenic pressures, are evolving at a far faster rate, with the majority of them being already classified as eutrophic ones (Zutshi *et al.*, 1980; Pandit, 1999).

The current study was conducted on one of the water body of Ujjain in Madhya Pradesh (India). Vikram Tearth Sarovar, being located on the Malwa Plateau of Ujjain district. The site being located at the end of the drainage system, the rigorous biotic intrusion, and cultural activities along the drainage basins are the contributory factors for their deteriorating conditions. As a result, it is important to thoroughly investigate the various physico-chemical parameters of water in this shallow water body. Therefore, this study aimed at evaluating the temporal (mainly seasonal) variation of physicochemical properties of the Vikram Tearth Sarovar.

MATERIALS AND METHODS

Vikram Tearth sarovar also known as Vikram Man sarovar is placed in Vikram University campus, Ujjain. It is also fed by seasonal rains. Vikram Tearth sarovar is located at Latitude 23°16'43"N and Longitude 75°80'53" E, with an average elevation of 489 m. The depth of the pond is 3.50 meter 0.45 m. The average length and width of the pond is 140 and 62 meters respectively. The pond receives huge amount of domestic sewage from government quarters located nearby to the pond.



Google Map of Ujjain (M.P)



Google Map of Vikram Tearth Sarovar

Study period: -The survey was conducted for a year (Jan- Dec 2019) in the following seasons:-

- Winter - December to February,
- Summer - March to June,
- Monsoon - July to September,
- Post Monsoon- October to November.

SELECTION OF SAMPLING POINTS

The sampling points were selected so as the water samples represent the entire ponds. The parameters such as pH, Conductivity, Dissolved Oxygen were analyzed at the sampling spots. The water for physico chemical analysis was collected in 1 litre plastic cans.

Physico-chemical analysis of water

The water quality analysis of the ponds gives the exact nature, cause and levels of the pollutants, if any. The physical parameters such as temperature and turbidity play an important role in pond productivity. The levels of chemical parameters including the pH, dissolved gases, dissolved minerals and nutrients decide the quality of the water. Physico-chemical characteristics of water were investigated on monthly basis. Immediately temperature was recorded on the sampling spot. For the remaining parameters, surface water samples were procured from each study site by dipping one litre polyethylene bottle for laboratory analysis. The analysis of water samples was carried out by standard methods of APHA (1998).

The methods employed for the determination of different physico-chemical parameters of water in Vikram TearthSarovar (Ujjain) for the year 2019 (Jan- Dec) are enumerated as follows:

Table I: Methods for physicochemical analysis	
Air Temperature °C	Mercury thermometer
pH	pH meter(APHA,1998)
Turbidity (NTU)	Turbidimetricmethod
Total Alkalinity(mg/l)	Titrimetric method
Total Hardness (mg/l)	EDTA Titrimetric method
Calcium Hardness(mg/l)	Titrimetric method
Magnesium Hardness (mg/l)	Titrimetric method
D.O (mg/l)	Winkler's Iodometric method (APHA,1998)
B.O.D (mg/l)	3 days 27°C method
Phosphorous (mg/l)	Stannous chloride method (APHA,1998)
Nitrates (mg/l)	Spectrophotometric method (APHA,1998)

STATISTICAL ANALYSES

Statistical analyses were performed by various softwares like SPSS (Version 22).

RESULTS AND DISCUSSION

Air temperature

Air temperature depicted a distinct seasonal trend during the entire study period in Vikram Tearth Sarovar for the year 2019. The maximum mean atmospheric temperature (29.0 ± 3.1) was recorded in summer season, while as the minimum mean air temperature (20.1 ± 4.3) was recorded in the winter season. According to Jhingran (1982) the degree and annual variations in temperature of a water body, have a great impact on its productivity, physiological, metabolic activities, and life processes. Chacko and Krishnamoorthy (1954), and Ganapati (1960) were of the opinion that Temperature aid in the formation of algal blooms. Fall in air temperature during winter in present in Vikram Tearth Sarovar for the year 2019 study may be attributed to shorter photoperiod/ day length, oblique incident rays and increased condensation due to higher percentage of water vapors in air. The observations are in agreement with the findings of Kour, (2002) and Zuber (2007). Higher air temperature during summer at Vikram Tearth Sarovar months may be attributed to vertical incident rays and heating up of atmosphere as a result of absorption of heat by suspended particles (Welch, 1952; Munawar, 1970). The Air temperature showed significant positive correlation with Turbidity ($r = 0.886$), Magnesium Hardness ($r = 0.912$), Phosphate ($r = 0.889$) and Nitrate ($r = 0.902$). While it showed significant negative correlation with D.O ($r = -0.892$).

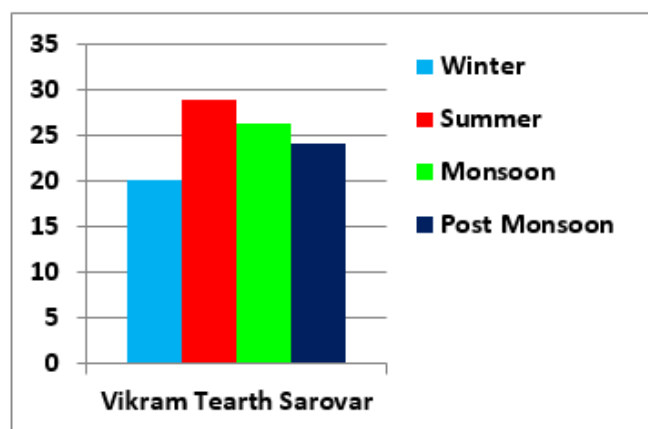


Fig I: Seasonal Variations in Air temperature ($^{\circ}\text{C}$) of Vikram Tearth Sarovar during the year Jan-Dec 2019.

pH

The water in the selected biotope was generally on alkaline side ($\text{pH} > 7$) during the investigation period. The maximum mean pH in Vikram Tearth Sarovar (8.7 ± 0.1) for the year 2019 was recorded during summer season and minimum 8.4 ± 0.1 during monsoon season. When it came to pH concentration, there were only minor differences in terms of spatial and temporal variation. However, a gradual increase in pH was observed from winter to summer, which can be attributed to the removal of carbon dioxide from the water column via photosynthesis by phytoplankton and macrophytes, shifting the equilibrium between carbonic acid and less soluble carbonates and monocarbonates with proton consumption, and thus increasing pH in summer. Our Statement agrees with (Wetzel, 1973). The decrease in pH values during the monsoon season (Rainy season) is caused by the presence of carbon dioxide at the surface and its incomplete utilization by photosynthetic organisms. The statement agrees Sreenivasan (1964).

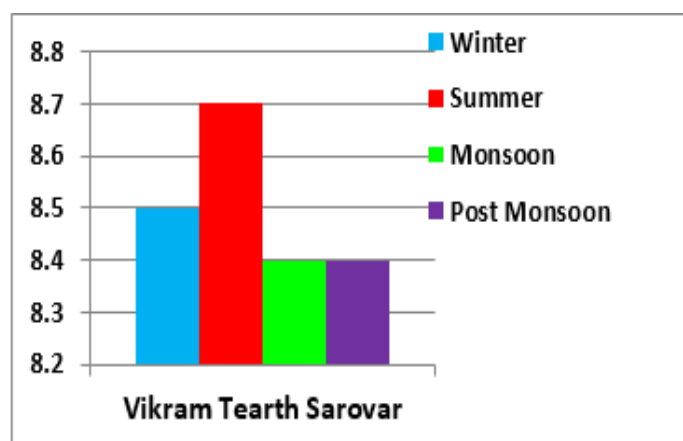


Fig II: Seasonal Variations in pH of Vikram Tearth Sarovar during the year Jan-Dec 2019

Turbidity

Turbidity, which is primarily caused by microorganisms, dissolved and suspended organic and inorganic matter in the water medium, showed significant seasonal variations in Vikram Tearth Sarovar. For the year (2019) in Vikram Tearth Sarovar, the average Turbidity ranged between the maximum of 71.8 ± 4.5 NTU (monsoon season) to the minimum of 21.4 ± 8.7 NTU (winter season). High algal bloom in summer and macrophytic growth increases the turbidity of the selected water body in summer season. While in monsoon season influx of runoff water and sewage are the main cause for the increased turbidity. Similar reasons were opined by (Haque, 1991). Turbidity showed significant positive correlation with Nitrate ($r = 0.847$), Phosphate ($r = 0.842$), Temperature ($r = 0.886$) and significant negative correlation with Dissolved Oxygen ($r = -0.768$).

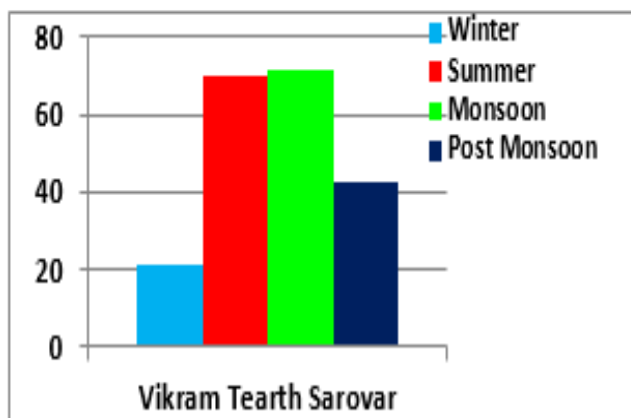


Fig III: Seasonal Variations in Turbidity of Vikram Tearth Sarovar during the year Jan-Dec 2019

Total Alkalinity

Total Alkalinity revealed a general trend registering higher values in winter and lower in summer in Vikram Tearth Sarovar for the year 2019. The seasonal mean values fluctuated from a low of 275.5 ± 8.0 mg/L (winter season) to a high of 307.7 ± 6.2 mg/L (summer season). Alikunhi (1957) proposed that Alkalinity higher than 100 mg/l indicates highly productive waters. High values of alkalinity were recorded throughout the study period during 2019 in Vikram Tearth Sarovar in all the seasons, though peak values were recorded in summer, monsoon and post monsoon. The high values of alkalinity in these seasons could be attributed to: Excessive release of soap and detergents, Decay and decomposition of organic matter, Entry of sewage from colonies and Leaching of carbonates and bicarbonates from catchment area. Similar trend was observed by Wurts and Durborow, 1992. Total Alkalinity showed significant positive correlation with BOD ($r = 0.974$), Phosphate ($r = 0.934$), Nitrate ($r = 0.971$) and significant negative correlation with DO ($r = -0.958$).

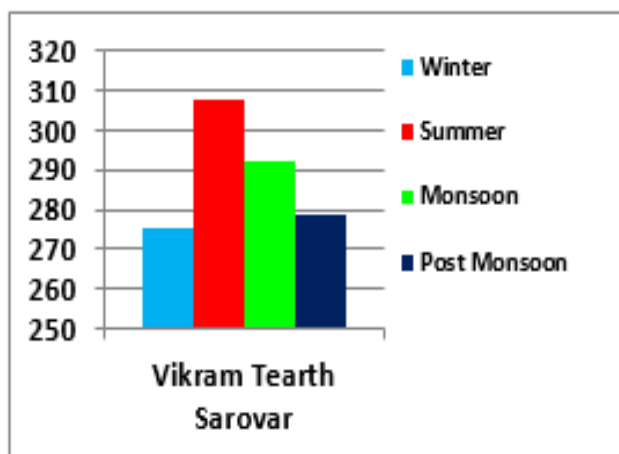


Fig IV: Seasonal Variations in Total Alkalinity of Vikram Tearth Sarovar during the year Jan-Dec 2019

Total Hardness

A perusal of data during the present study for Total Hardness in (2019) in Vikram Tearth Sarovar indicated that, the average seasonal Total Hardness ranged between the maximum of 424.0 ± 18.19 mg/L (summer season) to the minimum of 324.5 ± 2.1 mg/L (Post Monsoon season). High values of hardness in Vikram Tearth Sarovar could be attributed to high temperature, high anthropogenic activities in and around this pond and addition of sewage water from surrounding areas and use of detergents. The lower values of Total hardness in Vikram Tearth Sarovar recorded during post monsoon season were due to dilution of rainwater. Our observation is in agreement with Park and Shin (2007), and Rajagopal *et*

al., (2010). Total Hardness showed significant Positive correlation with Calcium Hardness with ($r = 0.970$), Magnesium Hardness ($r = 0.765$) and Phosphate ($r = 0.817$), and negative correlation with D.O ($r = - 0.887$).

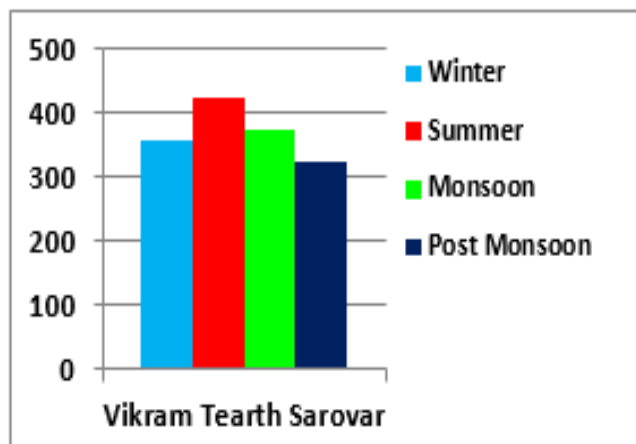


Fig V: Seasonal Variations in Total Hardness of Vikram Tearth Sarovar during the year Jan-Dec 2019

Calcium Hardness

Calcium tends to occur naturally in water. The natural occurrence of calcium in the earth's crust is one of the primary reasons for its abundance in water. Seasonal mean values of Calcium Hardness for the year 2019 (Jan-Dec) in Vikram Tearth Sarovar ranged between the maximum of 319.1 ± 11.7 mg/L (summer season) to the minimum of 241.0 ± 4.2 mg/L (Post Monsoon season). In the present study high values of Calcium during summer season in Vikram Tearth Sarovar were mainly due to evaporation of water resulting in the concentration of this cation in the selected biotope. Further, it is released during decomposition of dead plants and animals. While as low values of calcium in Vikram Tearth Sarovar during Post monsoon season were due to dilution. Similar observation was noticed by (Khan and Siddiqui, 1974; Gaur *et al.*, 2001 and Khan *et al.*, 2002).

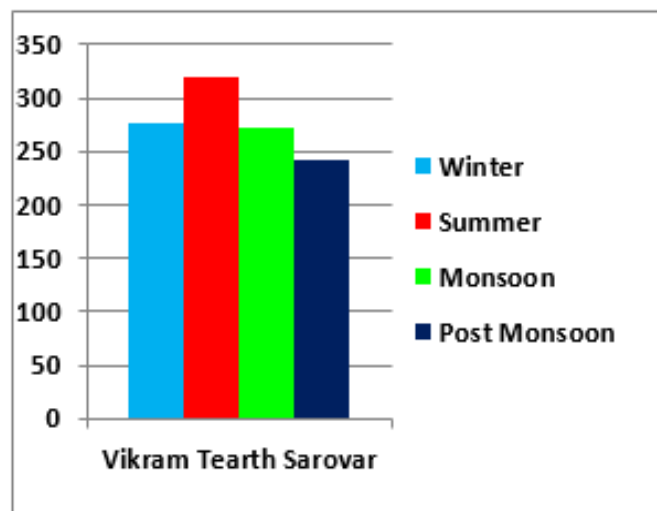


Fig VI: Seasonal Variations in Calcium Hardness of Vikram Tearth Sarovar during the year Jan-Dec 2019

Magnesium Hardness

Magnesium occurs in all kinds of natural water with calcium but its concentration remains generally lower than the calcium. It is required universally by chlorophyllous plants. The magnesium content depicted relatively lower values as compared to Ca content; The maximum Magnesium in Vikram Tearth Sarovar for the year 2019 ranged between (25.3 ± 32.8) mg/L during summer season to the minimum values 19.4 ± 2.0 mg/L during winter season. Higher magnesium content was observed during the summer in Vikram Tearth Sarovar, which could be attributed to the decomposition of leaves and algae, which released magnesium into the water. Similar observations were made by, Choudhary and Mamun (2006), and Tambekar *et al.*, (2010) during their studies. Lower value of magnesium in Vikram Tearth Sarovar were recorded in winter which could be attributed higher sedimentation rate leading to their settlement in the bottom, utilization by plankton organisms and its incorporation into chlorophyll. The findings are in conformity with the findings of Tripathi and Pandey (1990). Magnesium Hardness showed significant Positive correlation with Air Temperature ($r = 0.912$), Total Alkalinity ($r = 0.882$), Nitrate ($r = 0.892$) and Phosphate ($r = 0.887$).

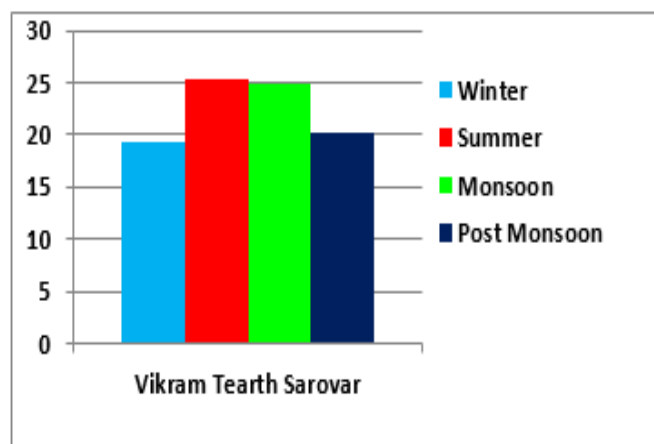


Fig VII: Seasonal Variations in Magnesium Hardness of Vikram Tearth Sarovar during the year Jan-Dec 2019

Dissolved Oxygen

One of the most important factors in determining water quality is Dissolved oxygen, which reflects the biological and physical processes occurring in the water. During the entire study, Dissolved oxygen concentration recorded in Vikram Tearth Sarovar for the year 2019 was recorded higher in winter (5.1 ± 0.2) mg/L and lower in summer season (3.8 ± 0.2) mg/L. The low values in the summer season in Vikram Tearth Sarovar may be correlated to bacterial oxygen uptake, a faster decomposition of organic matter, and rapid rate of microorganism. The high values of DO in Vikram Tearth Sarovar during winter season may be attributed to Low biological activity and low photosynthetic activity. The findings are in conformity with the findings of Goltermann, 1966; Karne and Kulkarni (2009). Dissolved Oxygen showed significant Negative correlation with Air Temperature ($r = -0.892$), BOD ($r = -0.961$), Phosphate ($r = -0.943$), Nitrate ($r = -0.896$) and Total Alkalinity ($r = -0.958$). It means whenever there was decrease in Dissolved oxygen in Vikram Tearth Sarovar the above mentioned parameters always increased and *vice versa*.

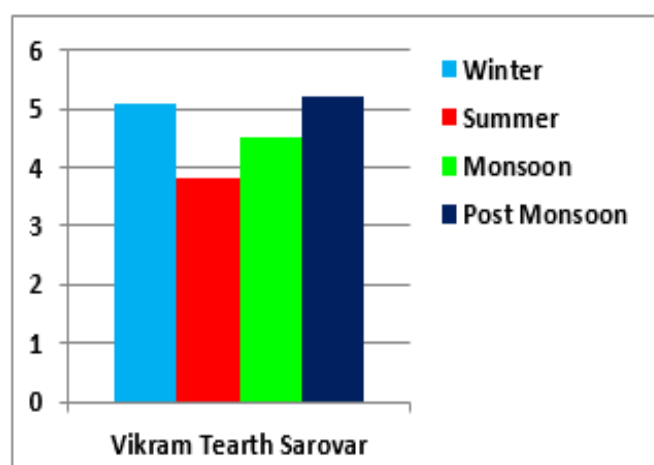


Fig VIII: Seasonal Variations in DO of Vikram Tearth Sarovar during the year Jan-Dec 2019

BOD

Biochemical oxygen demand determination (BOD) is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds by microorganisms and oxidation of certain inorganic materials. The average B.O.D in Vikram Tearth Sarovar for the year 2019 ranged between the maximum of 12.9 ± 1.6 mg/L (summer season) to the minimum of 6.5 ± 1.3 mg/L (winter season). Higher of BOD in summer season in Vikram Tearth Sarovar Ujjain for the year 2019 were due to high rate of organic decomposition and low values of BOD during the winter may be due to a decrease or slow down in microbial activity. Our study is in consonance with the Bhatt *et al.*, 1999; Sachidanandamurthy and Yajurvedi 2006). BOD showed significant Positive correlation with Nitrate ($r = 0.949$), Phosphate ($r = 0.940$) and Air temperature ($r = 0.877$) and showed significant negative correlation with D.O ($r = -0.961$).

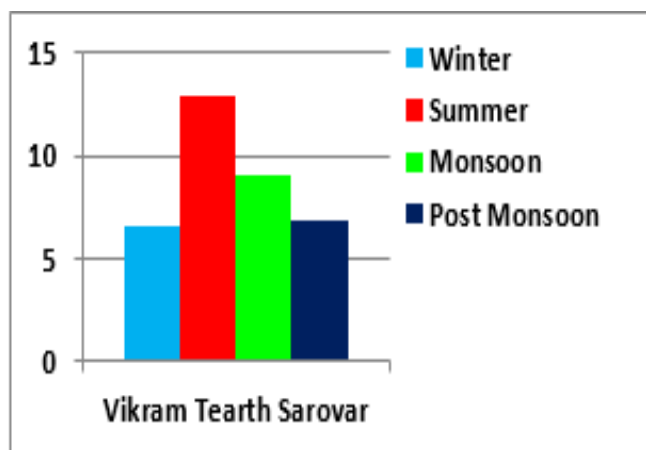


Fig IX: Seasonal Variations in BOD of Vikram Tearth Sarovar during the year Jan-Dec 2019

Phosphate

Eutrophication of most freshwater including wetlands, lakes and ponds is reliant on nutrient supplies such as nitrogen and phosphorus (Vollenweider, 1968). Phosphate is a major nutrient that contributes to biological productivity. A perusal of data during the year 2019 of the study in Vikram Tearth Sarovar indicated that, the average seasonal Phosphorous ranged between the maximum of $1.110 \pm 0.1 \text{ mg/L}$ (summer season) to minimum $0.672 \pm 0.1 \text{ mg/L}$. Increased values of Phosphorous during the summer in Vikram Tearth Sarovar in 2019 were mainly due to the regeneration of inorganic phosphorus from the organic form during decomposition and also due to increase in temperature during the summer enhance microbial activity, which consequently leads to an increase in the diffusion process of Phosphorous from the sediment to the upper layers of water. Lower phosphate levels during the winter season in the present study may be due to its utilization in macrophytic growth and sedimentation in the form of ferric complexes in soil, as well as low calcium levels in the water and low water temperature. Our observation is in agreement with (Maassen *et al.*, 2005; Khan and Siddiqui, 1974). Phosphate showed significant Positive correlation with Total Alkalinity ($r = 0.934$), Air temperature ($r = 0.889$) and significant negative correlation with DO ($r = -0.943$).

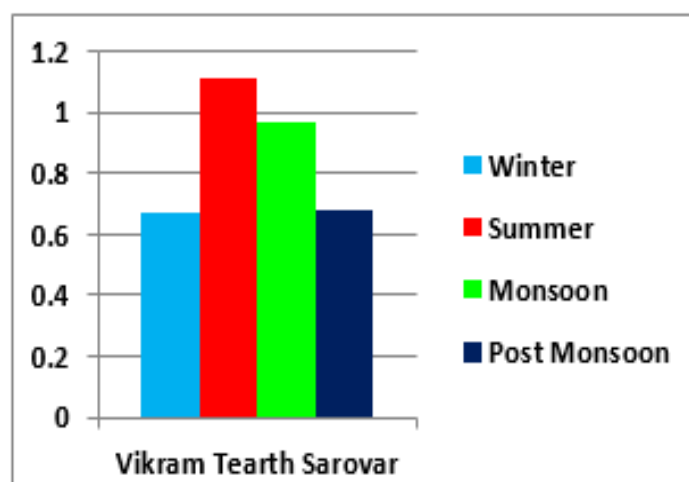


Fig X: Seasonal Variations in Phosphate of Vikram Tearth Sarovar during the year Jan-Dec 2019

Nitrate

The average Nitrates in Vikram Tearth Sarovar for the year 2019 ranged between the maximum of $7.289 \pm 1.86 \text{ mg/L}$ (summer season) to the minimum of $1.355 \pm 0.571 \text{ mg/L}$ (winter season). Ganpati (1960) observed that tropical waters, particularly non-polluted ones, are deficient in nitrate. The higher concentration of $\text{NO}_3\text{-N}$ in summer season in Vikram Tearth Sarovar indicates that this water body receives their nitrogen supply through drainage, catchment area and surface runoff and due to increased rate of decomposition of organic matter at higher temperature and formation of algal mats on the surface. Decline in nitrate values in present study during winter in Vikram Tearth Sarovar might be due to reduced rate of decomposition at low temperature and active uptake and utilization of nitrates by macrophytes. Our study is in consonance with the (Lee *et al.*, 1975; Nawange, 1993 and Ganai *et al.*, 2010 Sunderraj and Krishnamurthy, 1981). Nitrate showed significant Positive correlation with Total Alkalinity ($r = 0.971$), Air temperature ($r = 0.902$) and Phosphate ($r = 0.900$) and significant Negative Correlation with D.O ($r = -0.896$).

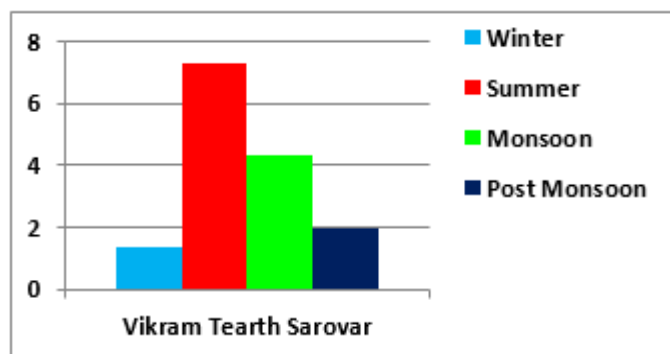


Fig VII: Seasonal Variations in Nitrate of Vikram Tearth Sarovar during the year Jan-Dec 2019

CONCLUSION

This study was conducted to assess the physicochemical properties of surface water for the year 2019 (Jan- Dec) in Vikram Tearth Sarovar Ujjain (M.P). The research confirmed that most of the physicochemical parameters like BOD, DO, Nitrate, Phosphate, Total Alkalinity and Total Hardness were very high in concentration compared to the national and international standards. On the basis of the above set criteria used for the selected site under study, it can be inferred that Vikram Tearth Sarovar is facing accelerated eutrophication. In order to arrest the accelerated eutrophication in Vikram Tearth Sarovar (Ujjain), it is imperative to restore the health of this deteriorating ecosystems based on sound management tools. For this purpose active but hard management tools involving the treatment of catchment of the water body is required

ACKNOWLEDGMENTS

Thanks are due to the Pollution control Board Indore (M.P) and Govt. Holkar Science College, Indore (M.P) for providing necessary laboratory facilities and also support to our research.

Table II; showing; Spatial and temporal variations of Physico Chemical Parameters at Vikram Tearth Sarovar Jan 2019- Dec 2019

Parameters	Jan 2019-Dec 2019																			
	Winter					Summer					Monsoon					Post Monsoon				
	Dec	Jan	Feb	MEAN	SD	Mar	Apr	May	Jun	MEAN	SD	Jul	Aug	Sep	MEAN	SD	Oct	Nov	Mean	SD
AT	15.5	21.00	24.00	20.1	4.3	26.00	29.00	32.2	30.5	29.0	3.1	28.5	26.00	24.5	26.3	2.0	25.00	23.5	24.2	1.0
pH	8.6	8.5	8.6	8.5	0.1	8.7	8.8	8.9	8.7	8.7	0.1	8.6	8.5	8.2	8.4	0.2	8.4	8.5	8.4	0.1
TU	14.0	19.3	31.1	21.4	8.7	48.5	62.3	88.0	80.0	69.7	17.7	77.0	70.1	68.5	71.8	4.5	55.1	30.3	42.7	17.5
TA	269.0	273.2	284.5	275.5	8.0	301.0	306.4	316.0	307.6	307.7	6.2	298.0	291.2	286.5	291.9	5.7	281.0	277.0	279	2.8
TH	335.0	349.0	389.0	357.6	28.0	407.0	421.0	451.0	417.0	424	18.9	409.0	396.0	318.0	374.3	49.2	323.0	326.0	324.5	2.1
CH	264.0	266.0	302.0	277.3	21.3	316.0	323.0	334.0	306.0	319.7	11.7	302.0	291.0	222.0	271.6	43.3	238.0	244.0	241.0	4.2
MH	17.2	20.1	21.1	19.4	2.0	22.1	23.8	28.4	26.9	25.3	2.8	26.0	25.5	23.3	24.9	1.4	20.6	19.9	20.2	0.4
DO	5.8	5.00	4.6	5.1	0.6	4.00	3.7	3.5	4.00	3.8	0.2	4.3	4.5	4.7	4.5	0.2	5.00	5.5	5.2	0.3
BOD	5.3	6.4	8.00	6.5	1.3	11.2	14.00	14.7	11.8	12.9	1.6	9.8	9.00	8.3	9.0	0.7	7.6	6.2	6.9	0.9
P	0.526	0.700	0.792	0.672	0.1	0.910	1.236	1.288	1.009	1.110	0.1	1.00	0.990	0.923	0.971	0.1	0.722	0.644	0.683	0.1
N	0.914	1.140	2.011	1.355	0.57	4.812	7.00	9.120	8.225	7.289	1.86	6.213	3.921	2.811	4.315	1.73	2.461	1.521	1.991	0.66

*AT; Air Temperature (°C), TU; Turbidity (NTU), TA; Total Alkalinity (mg/l), TH; Total Hardness (mg/l), CH; Calcium Hardness (mg/l), MH; Magnesium Harness (mg/l,) DO; Dissolved Oxygen (mg/l), BOD; Biological Oxygen Demand (mg/l), P; Phosphorous (mg/l), N; Nitrate, (mg/l).

Table III; Inter Correlation between the various physico chemical analyses of Water at Vikram Tearth Sarovar Ujjain (M.P)

	AT	pH	TU	TA	TH	CH	MH	DO	BOD	P	N
AT	1										
pH	.479	1									
TU	.886	.238	1								
TA	.925	.665	.837	1							
TH	.752	.846	.597	.879	1						
CH	.602	.910	.398	.773	.970	1					
MH	.912	.409	.939	.882	.765	.586	1				
DO	-.892	-.618	-.768	-.958	-.887	-.788	-.838	1			
BOD	.877	.710	.761	.974	.864	.784	.804	-.961	1		
P	.889	.550	.842	.934	.817	.694	.887	-.943	.949	1	
N	.902	.668	.847	.971	.861	.747	.892	-.896	.940	.900	1

Where, A.T= Air Temperature; TU= Turbidity; TA= Total Alkalinity; TH=Total Hardness;. CH= Calcium Hardness; MH= Magnesium Hardness; DO= Dissolved Oxygen; BOD= Biological Oxygen Demand; P= Phosphorous; N= Nitrate.
*Correlation is significant at the 0.01 level (2 tailed).

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