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Application of water quality index (WQI) for the assessment of surface water quality (Ambazari Lake)

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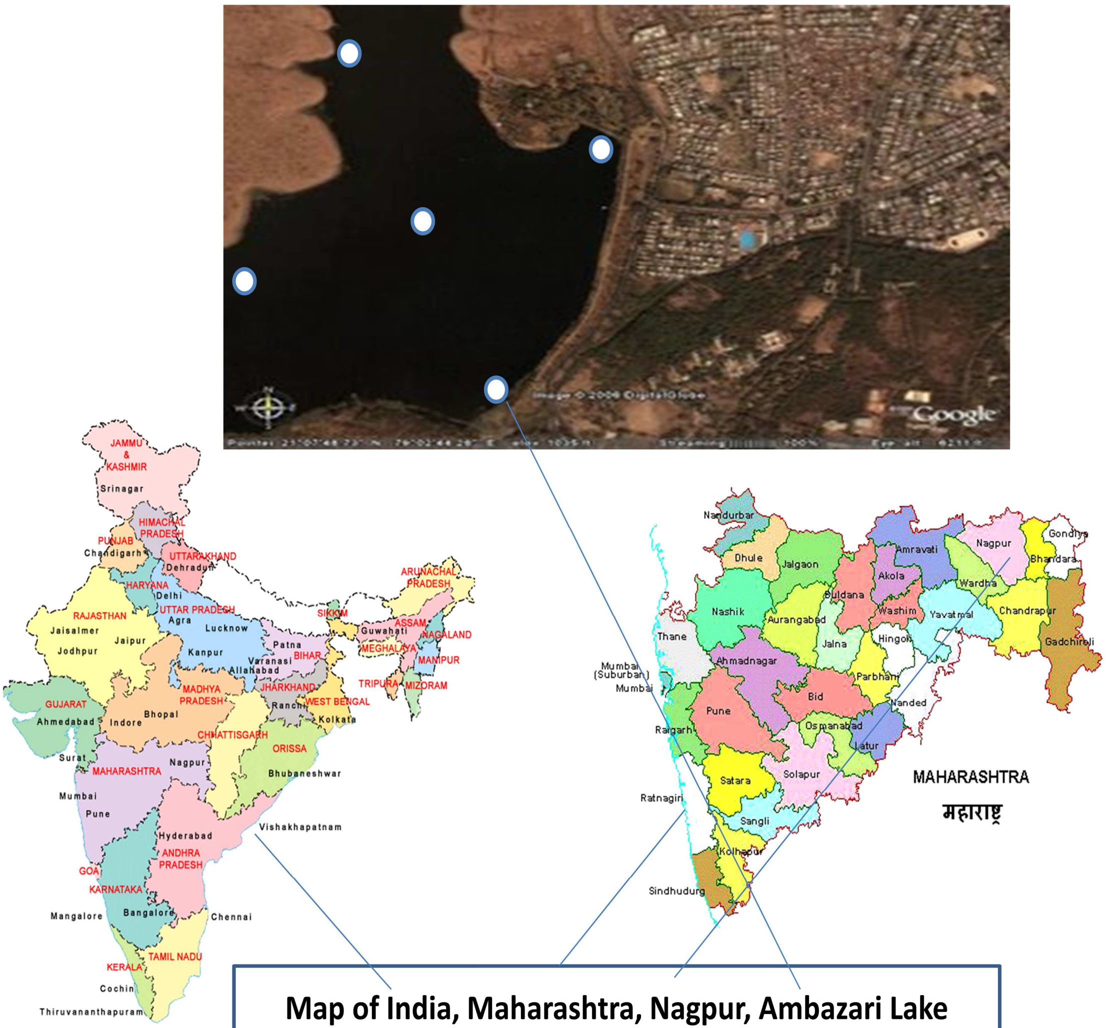
ABSTRACT

The present work aims at assessing the water quality index (WQI) in the surface water (Ambazari lake) situated in Nagpur city, Maharashtra India, by monitoring five sampling locations within Ambazari lake (viz., inlet1, inlet2, centre, corner and outlet) for a period of 3 months from August to October-2013. For calculating the WQI, 14 parameters, namely, pH, electrical conductivity, total dissolved solids, total hardness, alkalinity, calcium, magnesium, sodium, potassium, chloride, sulphate, nitrate, fluorides and iron were considered. It is apparent from WQI values that Ambazari Lake water with WQI values ranging from 42.28 to 49.84(pre-immersion period), 58.57 to 109.66(immersion period) and 55.19 to 62.74 (post-immersion period falls under simply good to poor water category. It was observed that the values of physicochemical parameters significantly increased during the immersion period and then declined in the post-immersion period, however the general trend observed was: immersion > post-immersion > pre-immersion values. The present study revealed that Ambazari lake water is polluted (due to surface run-off, bathing activities, agriculture run-off, effluents from upstream from surrounding industrial and garden area, immersion of idols of God and Goddess during festival season), and is unsuitable for human consumption, industrial purpose also for the survival of life forms unless treated properly.

Keywords: Physicochemical analysis, WQI, lake, water pollution, festivals.

INTRODUCTION

Water is considered to be one of the most abundant commodities in nature but also misuse one. Today surface water is most vulnerable to pollution due to its easy accessibility for disposal of pollutants and wastewater. Worldwide surface water quality is governed by complex anthropogenic activities and natural processes [1,2] including weathering erosion, hydrological features, climate change, precipitation, industrial activities, agricultural land use, sewage discharge, and the human exploitation of water resources[3]. During the last decade, widespread deterioration in water quality of inland aquatic systems has been reported due to rapid development of industries, agriculture, and urban sprawl [4]. The need (essentiality and importance) of water in the lives of living organisms can never be undermined for its supportive role; it is one of the most important compounds that profoundly influence life. In spite of its enormousness, increasing the population of any country increases the demand for water supply and everything needed by man for survival. Satisfying these anthropogenic needs tend to change the originality of some of these existing natural resources of which water is of no exception.



Map of India, Maharashtra, Nagpur, Ambazari Lake

STUDY AREA

Nagpur city is one of India's fastest growing cosmopolitan cities. The city is spread in an area of about 220 Km^2. The road length of city under the Nagpur Municipal Corporation (NMC) is 1200 meters towards NW, W and SW of the city [5]. In many areas of Nagpur city tap water supply is not available and people are dependent mainly on the ground water sources. In and around Nagpur city (M.S.) there are large numbers of water bodies. Nag River which is a tributary of Kanhan takes it origin from Ambazari and flows towards east through Nagpur city. The Nag river water is completely polluted on account of draining of sewage into river [6]. Lakes are significant resource base of Nagpur city. Some of these are used to supply water for drinking purpose like Gorewada lake and Wena tank. The water from Futala Lake is used for irrigation and water from Ambazari lake is used for industrial purpose. Ambazari lake is situated near the western border of Nagpur. Nag River of Nagpur city originates from this lake. This was built in the year 1870 under Bhonsle ruler for supplying water to the city. Government officials and eminent people were supplied water through clay pipes. This lake was surrounded by mango trees, gaining the name Ambazari as Amba means Mango in Marathi. The Ambazari, which is 6.4 km from the city, is about 330 meters above sea level and has a catchment area of 15.5 km^2 and a water-spread area of about 2.56km^2. The water supply from this source is about 440 m^3/day. The shoreline of the lake is wavy, and the side in which the raw-water intake point is situated has an embankment of cut stones and hard rock. The reservoir has a depth of about 8 meters in the middle and 5-8 meters at the intake point. The wave action in this water body is rather poor.The Ambazari Lake falls under the toposheet number 55 O/4 and lies between latitude 20º35'-21º44'N and longitude 78º15'-79º40'E, covering over 15.4 sq. km. Few small streams adjoining the Ambazari Lake bring waste water from the surrounding area, especially drainage from adjacent industrial area [7]. The Nagpur area is geologically comprised of the Archeans, the

Gondwana, the Deccan Traps with the inter-trappeans, soil and alluvium. The Ambazari area is geologically comprised of the Deccan Traps anging in age from the Upper Cretaceous to Lower Eocene. The Ambazari Lake is having its water supply from strom run-off and streams. To the north-west side hill top on the city is a small plateau from where originates the main streams of Nag river adding water to Ambazari reservoir. The overflow point is responsible for shedding water during heavy rains. The lake water is sustained due to bund wall, built with the purpose to provide potable water to city. Due to rapid urbanization and industrial growth, the purpose merely exists up to commercial uptake of water, fishery and recreational purpose. The lake was used to supply water to Nagpur for over 30 years. Due to pollution it is not currently used as a water supply. The Ambazari Lake water overflows for maximum 15 days during most of time in monsoon. MIDC is lifting 11 million liters per day (MLD) water from the Ambazari lake for supplying to around 1,500 industries and two villages. Three types of structures are evidence of a reservoir. One is waste water weir (overflow point), second is outlet and lack of hillocks. The lake has systematic waste water weir and can be seen clearly. It also has an outlet and was utilized once for drinking water supply. Ambazari lake has a defined shape and is undoubtedly a reservoir constructed on Nag river. Besides, the Nag river joins the lake from behind the lake and overflow point is on the opposite direction.

PROBLEM ON HAND

Nagpur city has got nine major water bodies, at least six ponds, two rivers, and several streams. This is not a finding based on historic records. This is what the latest map of Nagpur Municipal Corporation (NMC) shows. The map, prepared as part of disaster management initiative, is an admission that the city has so many water sources. Then, a common Nagpurian is left perplexed as to why the city has to depend upon Pench irrigation project for water supply. As a result, many parts of the city face water scarcity every summer. Many areas of the city get inundates in the event of heavy rainfall. Despite horizontal growth of the city, the civic body is unable to lay pipelines to supply water to newly developed areas. The Nagpur city is an upcoming metro and preparing maps with so many water bodies, the civic authorities need to plan for utilization of water from the system available within city, instead of spending crores of rupees on ‘projects’ like Pench-I, Pench-II, Pench-III, Pench-IV. Countless many residing in the areas near these water bodies and streams also remember that wells in the courtyard of their houses had healthy level. Even the records tell how water from this very currently deteriorating system was put in place with a vision to satiate thirst and suffice the need of population of Nagpur city. From Ambazari lake, water was supplied to the city areas. Later, water from it was diverted to industrial units in MIDC area. As far as present condition of smaller water bodies is concerned, the city’s population, including its leadership, is to be blamed. How can one explain green weeds covering Naik Talao almost fully? How can one explain shrinking of Lendi Talao to an extent that can be termed as ‘verge of extinction? How can one explain Sakkardara, Sonegaon, Gandhisagar lakes getting polluted and being used as places to dump garbage? These lakes can be rejuvenated as one of these areas that require deeper thought and understanding of lake structure, location, streams charging them, drainage, elevation, biological growth, silt etc. The MIDC water supply scheme, Hingna industrial area, Nagpur uses Ambazari lake water as a raw water source for their water treatment plant. The treated water is supplied to various industrial units and their residential colonies located at Hingna industrial area, Nagpur. Ambazari lake in Nagpur city is very close to the Hingna-Wadi MIDC area and has very large catchment area covering various industries. This difference is due to the fact that many industries and University laboratories lie in the catchment area of Ambazari Lake. MIDC Division, Hingna industrial area, Nagpur, informed that they have been experiencing presence of pungent odor and yellowish color in the raw water at Ambazari lake since last few years. Now a days, the major lakes in Nagpur city which once use to be eco-friendly and useful purpose, have lost their grandeur and have rather becomes a source of nuisance due to various sort of pollution. Thus it is quite imperative to know the quality states of these lakes water with a view to renovate them so that these serve for a useful purpose to the society.

MATERIALS AND METHODS

To characterize water quality throughout the main basin of the lakes, five permanent stations for monthly sampling g were established and marked within inlet1 S_1, inlet2 S_2, centre S_3, corner S_4, and outlet S_5, regions. Regular samples were collected in sterilized glass bottles for various physicochemical analysis of sample; the pre-cleaned plastic polyethylene bottles were used. Prior to sampling, the entire sampling container’s were washed and rinsed thoroughly with lake water to be taken for analysis. The collected surface water samples were collected from these six locations in a 2 L pre-cleaned polyethylene bottles for a period of 3 months from August 2013 to October 2013. Three months continuous monitoring involved comprehensive physico-chemical analyses encompassing estimation of major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Fe^{2+}), anions (Cl^{-}, SO_4^{2-}, NO_3^{-}, F^{-}, PO_4^{3-}) besides general parameters (pH, EC, TDS, alkalinity, total hardness, DO, BOD, COD and temperature). In situ parameters like pH, EC, TDS, dissolved oxygen, etc. was measured immediately in the field immediately after sampling. The standard analytical procedures as recommended by the American Public Health Association [8] were employed in the present study (Table 1). The suitability of the surface water from these Ambazari Lake for drinking, domestic, and irrigation purposes was evaluated by comparing the values of different water quality parameters with those of the Bureau of Indian standards [9] guideline values for drinking water.

Water quality index (WQI) [10]

Water quality index (WQI) is of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. The WQI provides a comprehensive picture of the quality of surface/ground water for most domestic uses. WQI is defined as a rating that reflects the composite influence of different water quality parameters. Hence, for calculating the WQI in the present study, 14 parameters namely, pH, electrical conductivity, total dissolved solids, total hardness, alkalinity, calcium, magnesium, sodium, potassium, chloride, sulphate, nitrate, fluorides and iron have been considered (Table 2). There were three steps for computing WQI of a water sample.

a. Each of the chemical parameters was assigned a weight (w_i) based on their perceived effects on primary health and their relative importance in the overall quality of water for drinking purposes (Table 2). The highest weight of 5 was assigned to parameters which have the major effects on water quality and their importance in quality (viz, NO_3^-, F^- and TDS) and a minimum of 2 was assigned to parameters which are considered as not harmful (Ca^{2+}, Mg^{2+}, K^+).

b. Computing the relative weight (W_i) of each parameter using Eq. 1. Table 2 present the weight (w_i) and calculated relative weight (W_i) values for each parameter.

c. A quality rating scale (q_i) for each parameter is computed by dividing its concentration in each water sample by its respective standard according to the guidelines laid down by BIS (1998) and then, the result was multiplied by 100 using Eq. 2. Finally, for computing the WQL, the water quality sub-index (SI_i) for each chemical parameter is first determined, which is then used to determine the WQI as per the Eqs. 3 and 4.

$$W_i = \frac{w_i}{\sum_{n=1}^{n} w_i} \qquad (1)$$

Where Wi is the relative weight, w_i is the weight of each parameter and n is the number of parameters.

$$q_i = \left(\frac{C_i}{S_i}\right) x100 \qquad (2)$$

where q_i = quality rating, C_i = concentration of each chemical parameter in each water sample in mg/L, S_i = Indian drinking water standard (BIS 1998) for each chemical parameter in mg/L except for conductivity (μS/cm) and pH.

$$SI = Wiqi \qquad (3)$$

$$\text{WQI} = \sum_{i=1}^{n} SI_i \qquad (4)$$

where SI_i is the sub-index of ith parameter; qi is the rating based on concentration of ith parameter and n is the number of parameters.

Table A: Analytical methods adopted with the BIS desirable and Permissible limits [10]

Sl. No.	Characteristics	Analytical method	Unit	BIS limits (1998)	
				Desirable	Permissible
1.	pH	Electrode	-	6.5-8.5	6.5-8.5
2.	Electrical conductivity (EC)	Conductivity meter	μS/cm	2,000	3,000
3.	Total dissolved solids (TDS)	Conductivity-TDS meter	mg/L	1,000	2,000
4.	Total Alkalinity (TA)	Titrimetric	mg/L	200	600
5.	Total hardness (TH)	EDTA titrimetric	mg/L	300	600
6.	Dissolved Oxygen (DO)	Modified Winder's method	mg/L	6.0	NA
7.	Biochemical oxygen demand (BOD)	Modified Winder's method	mg/L	3.0	6.0
8.	Chemical oxygen demand (COD)	Closed reflux method	mg/L	NA	NA
9.	Calcium (as Ca^{2+})	EDTA titrimetric	mg/L	75	200
10.	Magnesium (as Mg^{2+})	EDTA Titrimetric	mg/L	20	100
11.	Potassium (as K^+)	Flame photometric	mg/L	10	10
12.	Chlorides (Cl^-)	Argentometric titration	mg/L	250	1,000
13.	Nitrates (as NO_3^-)	Ion selective electrode (ISE)	mg/L	45	45
14.	Fluoride (as F^-)	Ion selective electrode (ISE)	mg/L	1.0	1.5
15.	Phosphates (as PO_4^{3-})	Stannous chloride	mg/L	0.3	0.3
16.	Sulphates (as SO_4^{2-})	Barium chloride	mg/L	200	400

Table B: The weight and relative weight of each of the physico-chemical parameters used for WQI determination [10]

Parameters	BIS desirable limit (1998)	Weight (w_i)	Relative weight (W_i)
pH	8.5	3	0.0698
Electrical conductivity	2,000	3	0.0698
Total dissolved solids	1,000	5	0.1163
Total alkalinity	200	2	0.0465
Total harness	300	3	0.0698
Calcium	75	2	0.0465
Magnesium	30	2	0.0465
Sodium	100	3	0.0698
Potassium	10	2	0.0465
Chloride	250	3	0.0698
Sulphate	200	3	0.0698
Nitrate	45	5	0.1163
Fluoride	1	5	0.1163
Iron	0.3	2	0.0465
	-	$\Sigma w_i = 43$	$\Sigma W_i = 1.000$

RESULTS AND DISCUSSION

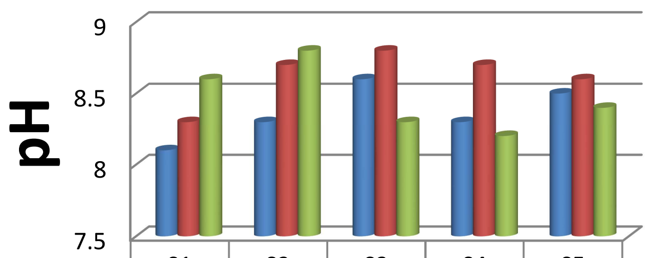
Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. WQI has been calculated for five sites for Ambazari lake in Nagpur city in the pre-immersion period, immersion and post-immersion period. WQI depicts the composite influence of different water quality parameters and communicates water quality information to the public and legislative decision makers. Festivals are an integral part of rich and diverse cultural heritage of India. Idol worship has been in the practice in India since ancient time. The religious scripts, mythology and rituals have attempted to drive the importance of preserving nature by adoring it through the centuries. To worship god and goddess only natural things like milk, curd, ghee, coconut, beetle, and river water were usually used. In India idol immersion is another anthropogenic activity. The idols of Lord Viswakarma, Lord Ganesh, Lord Krishna, Goddess Durga etc. are worshipped with all rituals by Hindu are immersed in water bodies between the months of August to October respectively every year. Similarly during the Mohrum festival, tazias are being immersed by Muslims in the month of May every year. However in present day scenario, metals, ornaments, oily substances, synthetic colors, chemical are used to make polish and decorate these idols for worship followed by immersion of these idols in our surrounding aquatic environment which gets severally affected. When the idols are immersed in water bodies, their colors, chemicals, and other components that are used for idol preparation get dissolved and lead to significant changes in the water quality [11]. When immersed, these colors and chemicals dissolve slowly leading to significant alternation in the water quality. The input of biodegradable and non biodegradable substances deteriorates the water quality and enhances silt loaded in the water bodies. The floating materials released through idol in the river and lake after decomposition result in eutrophication of the lakes.

Thus too many religious activities and religious fanatics have now become a major threat to the ecosystem. The under mentioned research work is mainly concerned about the water quality assessment to evaluate the qualitative nature and quantitative extent of pollution in water body during pre-immersion, immersion, and post-immersion of idols in festivals season. It was observed that the values of these parameters significantly increased during the immersion period and then declined slowly in the post-immersion period due to self purification mechanism of water body.

pH

Hydrogen ion concentration of lake water is quite variable throughout the seasons and pH>7 indicate that alkaline conditions are dominant in the lake [12]. Hydrogen ion concentration plays an important role in the biological processes of almost all aquatic organisms. Relatively low pH values may reflect the decreased productivity of the lake as a result of the polluted water discharged into the Lake. Variation in pH in collected water sample were 8.1 to 8.6 (August, pre-immersion period); 8.3 to 8.6 (September, immersion period) and 8.2 to 8.8 (October, post-immersion period) respectively.

Table and Chart 1 : pH Measurment



	S1	S2	S3	S4	S5
August (Pre-immersion)	8.1	8.3	8.6	8.3	8.5
September (immersion)	8.3	8.7	8.8	8.7	8.6
October (post-immersion)	8.6	8.8	8.3	8.2	8.4

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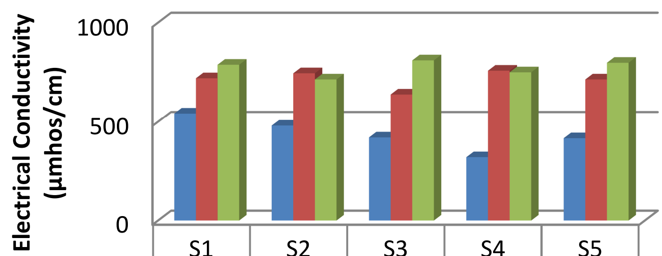
Electrical conductivity

Measurement of electrical conductivity [EC] in lake water provides rather sufficient information about the quantity of dissolved material found in water. Water bodies that have an EC value of 50-200 μScm^{-1}, 200-500 μScm^{-1} and 500-2000μScm^{-1} are classified as very soft, soft and hard, respectively [13]. Variation in Electrical conductivity in collected water sample were 320 to 542 µmhos/cm (August, pre-immersion period); 638 to 758 µmhos/cm (September, immersion period) and 714 to 810 µmhos/cm (October, post-immersion period) respectively.

Table and Chart 2



	S1	S2	S3	S4	S5
August (Pre-immersion)	542	480	420	320	416
September (Immersion)	720	745	638	758	714
October (Post-immersion)	788	714	810	750	798

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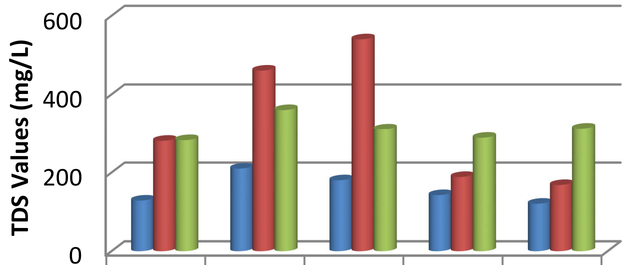
Total Dissolved Solid

The amount of total dissolve solids (TDS) in water indicates salinity of water and may also be used as an indicator for rapid plankton growth and sewage contamination. The total dissolved solids in water comprise mainly of inorganic salts and small amount of organic matter such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium. The total dissolved solids in water originate from natural sources and depend upon location, geological nature of the Lake Basin, drainage, rainfall, bottom deposit and inflowing water [14]. TDS was found to be higher during immersion of idols (period). The high values of TDS in pre-monsoon may be due to deposition of inorganic salts and organic matter and idol immersion activities in Ambazari Lake. Variation in total dissolved solid in collected water sample were 120.72 to 210.14 mg/L (August, pre-immersion period); 188.82 to 540.26 mg/L (September, immersion period) and 282.62 to 360.18 mg/L (October, post-immersion period) respectively.

Table and Chart 3

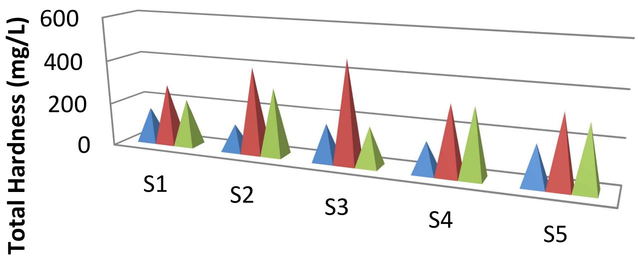


	S1	S2	S3	S4	S5
August (Pre-immersion)	128.72	210.14	180.36	142.66	120.72
September (Immersion)	280.86	460.62	540.26	188.82	168.32
October (Post-immersion)	282.62	360.18	310.72	288.72	312.74

Total Hardness

Hardness is the result of positive ions dissolved in water such as Ca^{++}, Mg^{++}, Sr^{++}, Fe^{++}, Mn^{++}. In addition to these cations, some anions (mainly SO_4^{2-}, Cl^-, NO_3^- and SiO_3^-) naturally exist in water. Inland lakes are generally dominated by calcium and bicarbonate. Variation in total hardness in collected water sample were 122.32 to 170.32 mg/L (August, pre-immersion period); 280.12 to 468.16 mg/L (September, immersion period) and 178.24 to 312.31 mg/L (October, post-immersion period) respectively.

Chart and Table 4

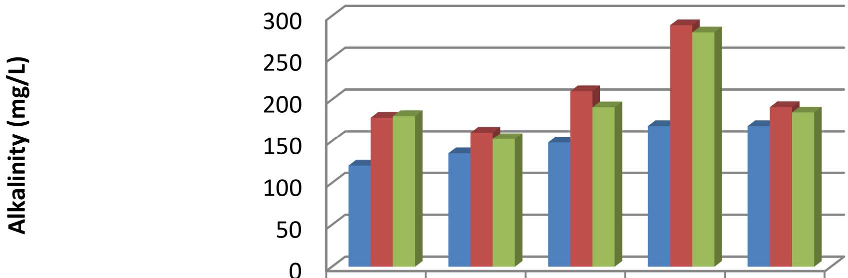


	S1	S2	S3	S4	S5
August (Pre-immersion)	160.54	122.32	170.32	140.48	180.24
September (Immersion)	280.12	396.36	468.16	314.32	320.44
October (Post-immersion)	218.22	310	178.24	312.31	288.72

Total Alkalinity

The lower values of total alkalinity during August month may be due to the utilization of CO_2 during phytoplankton growth as well as the effect of drainage water discharged into the Ambazari lake. On the other hand, the lower values during October month are mostly due to its assimilation by phytoplankton and aquatic plants during the spring bloom. Some organic matter containing nitrogen usually resists bacterial change and remains in the water or sinks to the sediments as bottom humus [18]. Variation in total alkalinity in collected water sample were 120.66 to 168.32 mg/L (August, pre-immersion period); 178.34 to 288.82 mg/L (September, immersion period) and 152.62 to 280.32 mg/L (October, post-immersion period) respectively.

Chart and Table 5

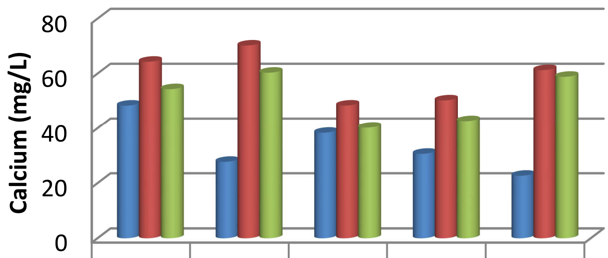


	S1	S2	S3	S4	S5
August (Pre-immersion)	120.66	135.34	148.36	168.32	168.32
September (Immersion)	178.34	160.22	210	288.82	190.94
October (Post-immersion)	180.24	152.62	190.74	280.32	184.64

Major Ion Chemistry (calcium, magnesium, sodium and potassium)

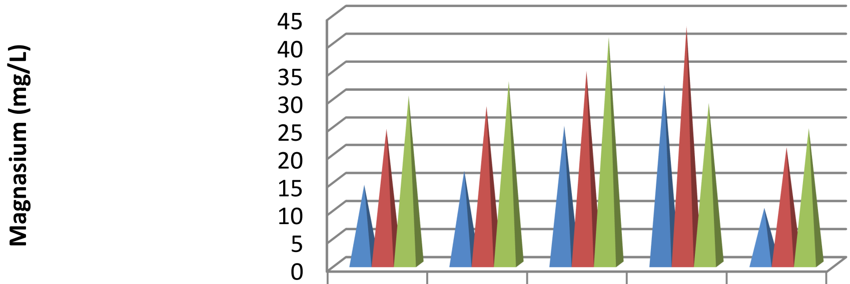
In Ambazari lake water, the predominant cation trend was in the order of $Ca^{2+} > Na^{+} > Mg^{2+} > K^{+}$ with calcium being dominant cation and the predominant anion trend was in the order of $SO_4^{2-}>Cl^{-}>HCO_3^{-}$, with sulphate being the dominant anion. The distributions of calcium and magnesium concentrations in the water of Ambazari lake were highly fluctuations during different periods. Variation in calcium in collected water sample were 22.68 to 48.34 mg/L (August, pre-immersion period); 46.36 to 70.22 mg/L (September, immersion period) and 40.24 to 60.32 mg/L (October, post-immersion period) respectively. Variation in potassium in collected water sample were 1.12 to 3.42 mg/L (August, pre-immersion period); 4.67 to 6.68 mg/L (September, immersion period) and 3.88 to 6.32 mg/L (October, post-immersion period) respectively. Calcium and magnesium exists in surface and ground water mainly as carbonates and bicarbonates. Lake water contributed calcium due to higher proportion of calcium in the surrounding rocks and soils which is essential for plant precipitation of lime, bone building etc. The main source of magnesium is sewage inflows and minerals generate from soil erosion and are important for enzyme activation, growth of chlorophyll and phytoplankton [15]. Variation in magnesium in collected water sample were 14.20 to 32.12 mg/L (August, pre-immersion period); 24.24 to 42.64 mg/L (September, immersion period) and 24.36 to 40.72 mg/L (October, post-immersion period) respectively According to the result obtained in the present study calcium and magnesium content is found with the permissible limit given by BIS. When agricultural lands are irrigated with water containing high concentration of Na, Na replaces Ca and Mg ions, which causes negativity in land structure. Source of Ca ion is calcium minerals with carbonate and sulphate. In this respect, different concentrations of calcium may exist in water. Higher concentrations of Ca and Mg restrict use of drinking, industrial and irrigation water [16]. Variation in sodium in collected water sample were 10.88 to 16.38 mg/L (August, pre-immersion period); 19.36 to 84.62 mg/L (September, immersion period) and 16.78 to 32.64 mg/L (October, post-immersion period) respectively.

Chart and Table 6



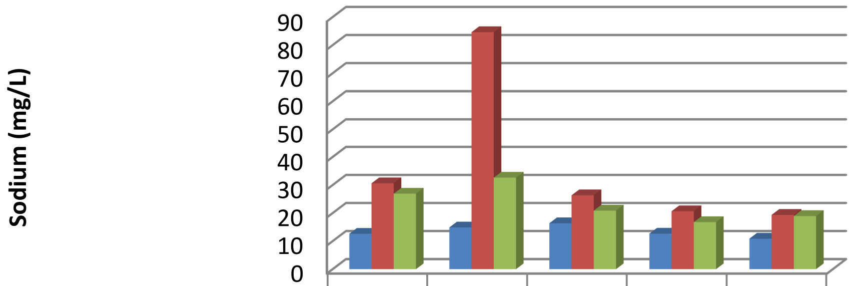
	S1	S2	S3	S4	S5
August (Pre-immersion)	48.34	27.74	38.32	30.66	22.68
September (Immersion)	64.32	70.22	48.36	50.24	61.26
October (Post-immersion)	54.34	60.33	40.24	42.66	58.84

Chart and Table 7

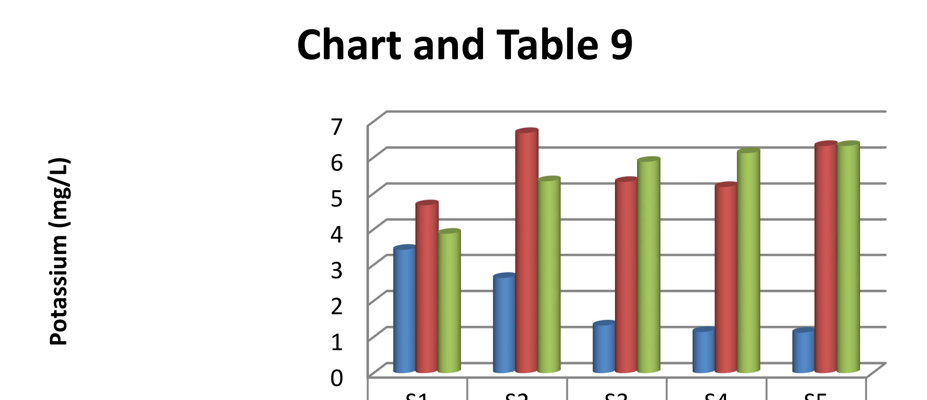


	S1	S2	S3	S4	S5
August (Pre-immersion)	14.2	16.72	24.82	32.12	10.07
September (Immersion)	24.24	28.32	34.64	42.64	20.87
October (Post-immersion)	30.21	32.76	40.72	28.88	24.36

Chart and Table 8



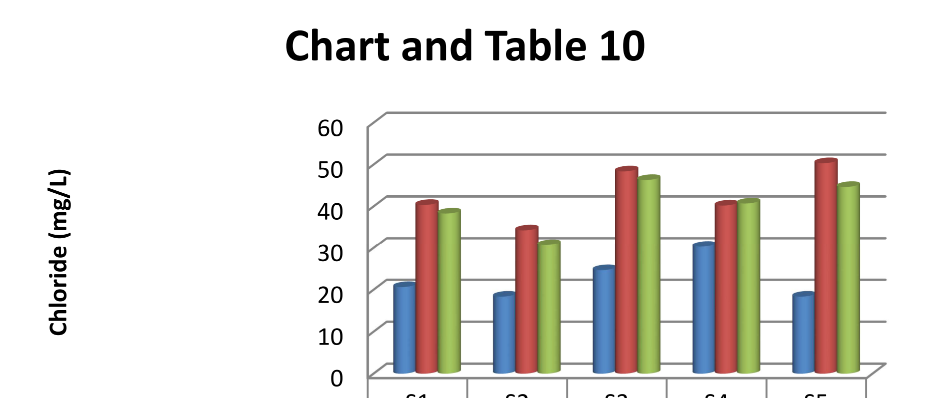
	S1	S2	S3	S4	S5
August (Pre-immersion)	12.62	14.88	16.38	12.66	10.88
September (Immersion)	30.62	84.62	26.34	20.66	19.36
October (Post-immersion)	26.92	32.64	20.88	16.78	18.94



	S1	S2	S3	S4	S5
August (Pre-immersion)	3.42	2.64	1.32	1.14	1.12
September (Immersion)	4.67	6.68	5.32	5.18	6.32
October (Post-immersion)	3.88	5.34	5.88	6.12	6.32

Chloride

The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin [17]. Variation in chloride in collected water sample were 18.36 to 30.33 mg/L (August, pre-immersion period); 34.28 to 50.34 mg/L (September, immersion period) and 30.72 to 46.32 mg/L (October, post-immersion period) respectively.

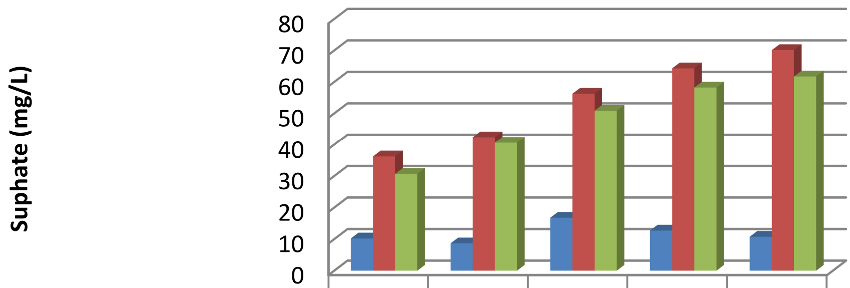


	S1	S2	S3	S4	S5
August (Pre-immersion)	20.64	18.36	24.68	30.33	18.36
September (Immersion)	40.36	34.28	48.38	40.22	50.34
October (Post-immersion)	38.32	30.72	46.32	40.72	44.66

Sulphate

Sulphate, the predominant form of sulphur in an aquatic ecosystem, is of immense importance as it affects ecosystem productivity, abundance and distribution of biota etc. Nearly all assimilation of sulphur takes place as sulphates but during decomposition of organic matter, sulphur is reduced to hydrogen sulphide which is oxidized rapidly [18]. In an aquatic environment, sulphate do not limit the growth and distribution of biota. Variation in sulphate in collected water sample were 8.66 to 16.78 mg/L (August, pre-immersion period); 36.22 to 70.12 mg/L (September, immersion period) and 30.68 to 61.74 mg/L (October, post-immersion period) respectively.

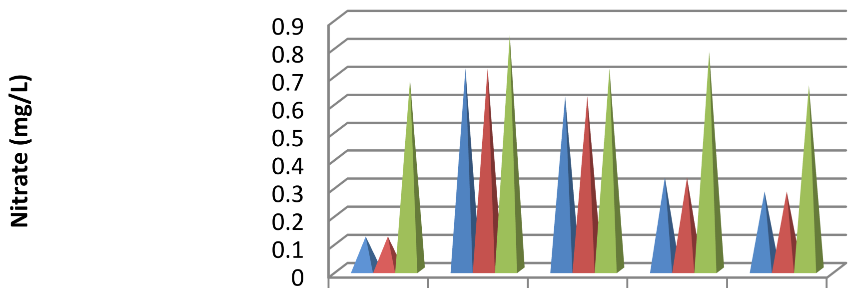
Chart and Table 11



	S1	S2	S3	S4	S5
August (Pre-immersion)	10.22	8.66	16.78	12.72	10.76
September (Immersion)	36.22	42.38	56.26	64.32	70.12
October (Post-immersion)	30.68	40.62	50.86	58.23	61.74

Nitrate (NO_3^-):
Nitrate occurs in water from various natural sources and due to human activities like food production, agriculture and manure disposal of domestic and industrial sewage. High level of nitrates is found in rural areas because of extensive application of nitrogenous fertilizers in agriculture. In urban areas sewage water rich in nitrates contaminate surface water thus increases the nitrate amount [19]. Nitrate stimulates the growth of hydrophytes and phytoplankton that consequently increase the nutrient in water body leading to eutrophication. Variation in nitrate in collected water sample were 0.12 to 0.72 mg/L (August, pre-immersion period); 0.72 to 0.99 mg/L (September, immersion period) and 0.66 to 0.84 mg/L (October, post-immersion period) respectively.

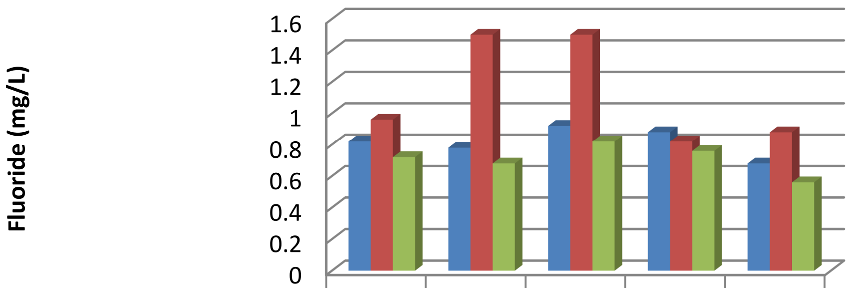
Chart and Table 12



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.12	0.72	0.62	0.33	0.28
September (Immersion)	0.12	0.72	0.62	0.33	0.28
October (Post-immersion)	0.68	0.84	0.72	0.78	0.66

Fluoride
Fluoride is a trace element typically present in water at levels from 0.1 to 1.5 mg/L. It may be added excess to water as a measure to prevent tooth decay in humans (0.7 to 1.2 mg/L). Levels at or above 3 mg/l are reported to cause losses of some fish species, depending upon complex water conditions. Variation in fluoride in collected water sample were 0.68 to 0.92 mg/L (August, pre-immersion period); 0.88 to 1.05 mg/L (September, immersion period) and 0.56 to 1.2 mg/L (October, post-immersion period) respectively

Chart and Table 13

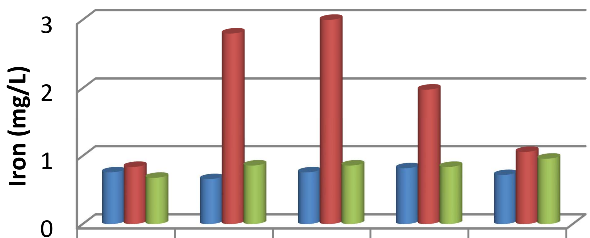


	S1	S2	S3	S4	S5
August (Pre-immersion)	0.82	0.78	0.92	0.88	0.68
September (Immersion)	0.96	1.5	1.5	0.82	0.88
October (Post-immersion)	0.72	0.68	0.82	0.76	0.56

Iron

The concentration of Fe was found to be very high in Ambazari Lake water samples collected from different sampling sites, mainly due to the inflow of surface run off from hill torrents and agricultural wastes (agricultural and rocks). Exchangeable Fe usually relates to the adsorbed metals on the sediment surface can be easily remobilized into the Lake water [20]. Variation in iron in collected water sample were 0.66 to 0.82 mg/L (August, pre-immersion period); 0.84 to 3.0 mg/L (September, immersion period) and 0.84 to 0.94 mg/L (October, post-immersion period) respectively.

Chart and Table 14

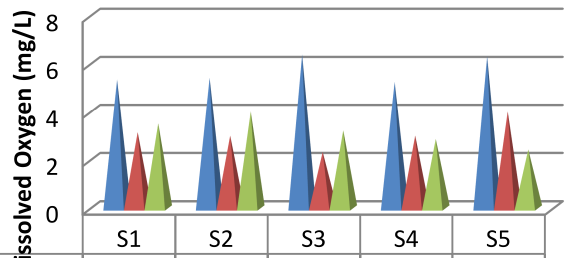


	S1	S2	S3	S4	S5
August (Pre-immersion)	0.76	0.66	0.76	0.82	0.72
September (Immersion)	0.84	2.8	3	1.98	1.06
October (Post-immersion)	0.68	0.86	0.86	0.84	0.96

Dissolved oxygen (DO)

Oxygen is the most important gas for most aquatic organisms and for self-purification processes [21]. It is an important parameter which is essential to the metabolism of all aquatic organisms that posses aerobic respiration. Variation in dissolved oxygen in collected water sample were 5.34 to 6.38 mg/L (August, pre-immersion period); 2.32 to 4 mg/L (September, immersion period) and 2.42 to 4.0 mg/L (October, post-immersion period) respectively.

Chart and Table 15

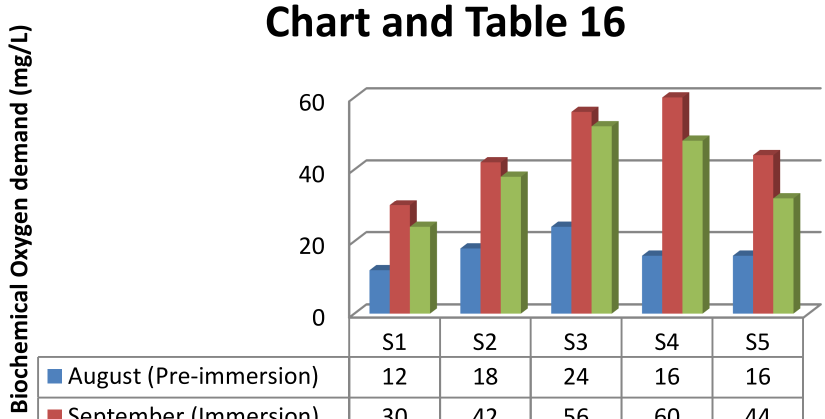


	S1	S2	S3	S4	S5
August (Pre-immersion)	5.34	5.41	6.38	5.24	6.31
September (Immersion)	3.14	3	2.32	3	4
October (Post-immersion)	3.51	4	3.22	2.86	2.42

Biochemical oxygen demand (BOD)

BOD and COD are important parameters that indicate contamination with organic wastes. Biochemical oxygen demand (BOD) is the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions [22]. It is required to assess the pollution of surface and ground water contamination occurred due to disposal of domestic and industrial effluents. According to WHO drinking water standard, BOD should not exceed 6 mg/L. Variation in biochemical oxygen demand in collected water sample were 12.0 6 to 24.0 mg/L (August, pre-immersion period); 30.0 to 60.0 mg/L (September, immersion period) and 24.0 to 52.0 mg/L (October, post-immersion period) respectively.

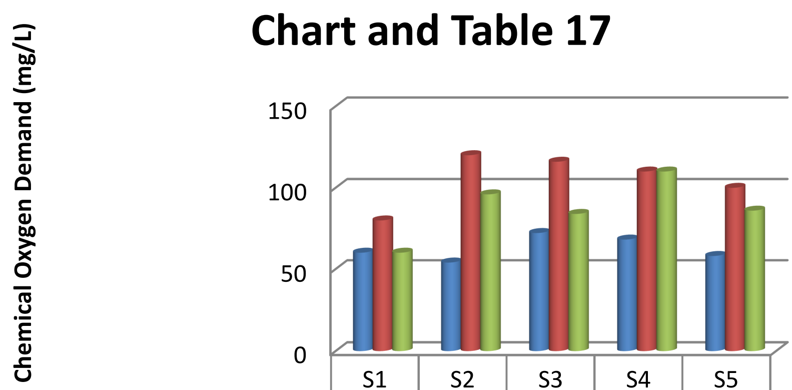
Chart and Table 16



	S1	S2	S3	S4	S5
August (Pre-immersion)	12	18	24	16	16
September (Immersion)	30	42	56	60	44
October (Post-immersion)	24	38	52	48	32

Chemical oxygen demand (COD)

Chemical oxygen demand (COD) determines the oxygen required for chemical oxidation of most organic matter and oxidizable inorganic substances with the help of strong chemical oxidant. In conjunction with the BOD, the COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. [23] Variation in chemical oxygen demand in collected water sample were 54.0 to 72.0 mg/L (August, pre-immersion period); 80.0 to 120.0 mg/L (September, immersion period) and 60.0 to 92.0 mg/L (October, post-immersion period) respectively.



	S1	S2	S3	S4	S5
August (Pre-immersion)	60	54	72	68	58
September (Immersion)	80	120	116	110	100
October (Post-immersion)	60	96	84	110	86

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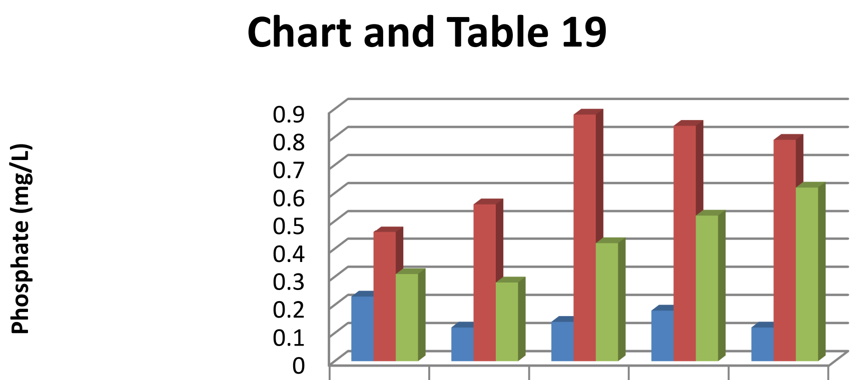
Phosphate (PO_4^{-3}):

Phosphate has a limited source in nature and also acts as a limiting factor for productivity of water body. Phosphate may occur in lake as result of domestic waste, detergent and agricultural runoff containing fertilizer [17] Variation in phosphate in collected water sample were 0.12 to 0.23 mg/L (August, pre-immersion period); 0.46 to 0.84 mg/L (September, immersion period) and 0.28 to 0.62 mg/L (October, post-immersion period) respectively.

Table C: The classification of lakes (trophic status)on the basis of total phosphate [24].

Sr. No.	Trophic status	Values of PO_4^{3-}in mg/L
1	Oligotrophic	< 0.005
2	Mesotrophic	0.005 to 0.01
3	Mesoeutrophic	0.01 to 0.03
4	Eutrophic	0.03 to 0.1
5	Hypereutrophic	>0.1 mg/L

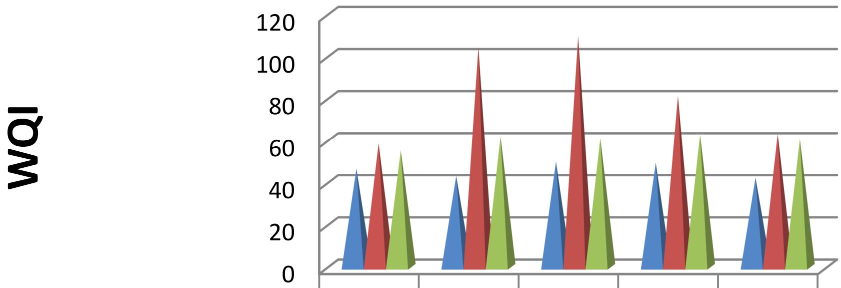
The trophics status of Ambazari lake as per the above classification and average values of WQI it varies from mesotrophic to hypereutrophic during different months.



	S1	S2	S3	S4	S5
August (Pre-immersion)	0.23	0.12	0.14	0.18	0.12
September (Immersion)	0.46	0.56	0.88	0.84	0.79
October (Post-immersion)	0.31	0.28	0.42	0.52	0.62

Water quality index (WQI)
A water quality index is a means to summarize large amounts of water quality data into simple terms for reporting to management and the public in a consistent manner. The Ambazari Lake water quality shows given lake water quality is simply poor to good.

Chart and Table 18



	S1	S2	S3	S4	S5
August (Pre-immersion)	46.47	43.09	49.84	49.3	42.28
September (Immersion)	58.57	104.39	109.66	81.28	63.06
October (Post-immersion)	55.19	61.84	60.88	62.74	60.58

Table D: Water quality status based on water quality index [10].

Water Quality Index	Water Quality Status
WQI<50	Excellent Water Quality
50>WQI<100	Good Water Quality
100>WQI<200	Poor Water Quality
200>WQI<300	Very Poor Water Quality
WQI>300	Unfit for drinking

Variation in water quality index in collected water sample were 42.28 to 49.84 mg/L (August, pre-immersion period); 58.57 to 109.66 mg/L (September, immersion period) and 55.19 to 62.74 mg/L (October, post-immersion period) respectively.

CONCLUSION

The water pollution level increases in Ambazari Lake due to religious activities and cause adverse effect to the aquatic life and entire aquatic ecosystem. Far greater impact of pollution is seen during the festival season, when immersion of idols in these natural aquatic ecosystems destroyed the whole ecological balance. The water quality parameters like TSS, TDS, TS, turbidity, conductivity, hardness, DO, BOD and COD have shown significant increase during and after immersion of idols and then declined in the post immersion period. The input of biodegradable and non-biodegradable substances deteriorates the lake water quality and enhances silt load in the lake. Generating awareness among the people and society about reducing pollution due to festival waste will help in conserving ecosystem of these water bodies. (Lakes)

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REFERENCES

[1] H.P. Javie, B.A. Whitton, and C. Neal, *Science of the Total Environment*, **1998** 210-211, 79-109.
[2] S. Ravichandran, *Environmental Monitoring and Assessment*, **2003**, 87, 3, 293-309.

[3] A. H. Malvi, J. Nouri, A. A. Babael, and R. Nabizadeh, *International Journal of Environmental Science and Technology*, **2005**, 2, 1, 41-47.
[4] J. C. Vie, C. Hilton-Taylor, and S. N. Stuart, Eds., Species, IUCN, Gland, Switzerland, **2009**.
[5] P.C. Pande, K. Suryanarayan and G.G. Deshpande, *Mineral Research*,**1969,** 2(20)
[6] S. P. Pande, V.S. Narayanswami, and M. Z. Hasan, *Indian, J. Environ. Hlth*., **1979,** 21(1), 35
[7] S.H. Humne, P.R. Bokade, S.S. Humne, A.S. Wankhede, *Current Sci*, **2010**, 99,6.
[8] (APHA) Standard method for examination of water and wastewater, 21st edn. APHA, AWWA, WPCF, Washington, (**2005)**
[9] Bureau of Indian Standards (BIS) (1998) Drinking water specifications, IS: 10500, **2003**
[10] Ravikumar, P., Mohammad Aneesul Mehmud, Somashekhar, R. K., India *Appl Water Sci*. 3 (**2013),** 247-261
[11] P.Mehta, *The Experiment* **2013**, 17(1). 1166-1176.
[12] Karafislan, Aysel and Fatma Arik Colakoglu: Mitigat. *Adap. Strateg. Global Change*, **2005**, 10, 127-143.
[13] Hutter, L.A.: Water and water research. Otto Salle Verlag, Verlag Sauerlonder **1992.**
[14] Kaushik, S. and Saksena, D.N. **1999**. 1-58, 1-36.
[15] Ramesh, K. and Seetha, K, **2013,** 3(3), pp 36-47.
[16] Disli, Mehmet, Fatih Akkurt and Ahmet Alcilar; **2004**, 19, 287-294.
[17] Gopalkrushna, M.H., **2011**. 1(2), 183-187.
[18] Wetzel, R.G. *Liminology*, 1, **2000**, 3-9
[19] Tank, S.K. and Chippa. R.C, International Journal of Scientific and Research Publications **2013,** 3(3)**.**
[20] Fokmare, A.K. and M. Musaddiq *Nat. Environ. Pollut, Technol*, **2002**, 1: 261-263.
[21] Said, Ahmed, David K. Stevens and Gerald Sehilke: Publications of Sam- Environmental Technolgoy Centre. Istanbul **1999**.
[22] Sawyer C N, McCarthy P L Chemistry for environmental engineering, 3rd edn. McGraw-Hill Book Company, New York, (**1978)**
[23] Puri P.J., Yenkie, M.K.N., *Rasayan J. Chem*, 3(4), (**2010)**, 800-810
[24] Wetzel, R.G. Limnology. W.B. Sanunders Co. Philadelphia, (**1975)**, pp. 743