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Research Article

ANALYZING WATER QUALITY PARAMETERS DUE TO FESTIVAL WASTES IMMERSIONS: A CASE STUDY OF JODHPUR

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ABSTRACT
Over contamination of water-bodies due to ever growing festival waste has become a major concern and challenge for all as it directly impacts biological wealth and ecosystem of a water body. Decrease in water quality (unfit for human consumption) is also attributed to the fact that today most water bodies are been loaded with toxic material and chemicals, human and industrial waste, organic matter, and religious rituals of Idol immersions which is growing year on year basis. 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 this year and its comparison with results of last two year. Water samples were collected from three sites in Jodhpur city and were analyzed for various water quality parameters such as pH, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Turbidity, Conductivity, Hardness, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) following standard methods (APHA, 1985). 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. With growing magnitude of these religious activities, pollution load has increased tremendously in 2015. Generating awareness among the people and society about reducing pollution due to festival waste will help in conserving ecosystem of these water bodies. Municipal cooperation needs to be more proactive to not only protect the culture but also protect environment of these water bodies in a cohesive manner for benefit of all.

Keywords: *Physico-chemical Characteristics; Water Bodies; Pollutants, Contamination, Idol Immersion, Water Quality Assessment*

INTRODUCTION
On the onset pollution or contamination by itself is a small word but its impact is very broad and specific. Magnitude of growing water pollution is a major global problem and like other developing countries water pollution has reached to a level of no recovery and revival, causing alarming situation in India. Water resources of the earth are part of a finite close system and the water reservoirs from time immemorial had an aesthetic appeal, and helped in quenching the thirst of millions of people. However with rise in population, the per capita amount of water available for drinking purpose is inevitably decreasing. The issues related to water is becoming increasingly important to sustainable environment particularly with respect to human health and long term food security. Lakes and other heritage water bodies (talabs) are the most fragile, fertile, diverse, productive, and interactive ecosystem in the world. These lakes and other heritage water bodies are stagnant surface water bodies that receive, and stores fresh water received through rainfall. These stagnant water bodies have more complex and fragile ecosystem in comparison to running water bodies as they lack self-cleaning ability (Mehta, 2013). This results in ready accumulation of large quantities of toxic pollutants. Increased anthropogenic activities in and around these water bodies, damage the aquatic ecosystems and ultimately affect the overall physio-chemical properties of water (Upadhyay, 2010). These urban aquatic ecosystems are strongly influenced by long term discharge of untreated domestic and industrial wastewaters, storm water runoff, accidental spills, municipal waste, sewage, and direct solid waste dumping (Sarika, 2008). Such material may contain a wide variety of organic and inorganic pollutants including oil, grease, plastics, plasticizer, phenol, heavy metals, pesticides and suspended solids.

Generally water pollution is a state of deviation from pure condition, whereby its normal functioning and properties are altered or affected. It can be described as change or alteration in physical, chemical, and biological characteristics of water that will be harmful to human beings and other forms of life. The requirement of water in all forms of lives, from micro-organisms to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization (Singh, 2002). Water quality degradation by various sources has become an important issue around the world. Usage of more land for agricultural purposes, increase use of agricultural fertilizers, pesticide, soil salinization, and erosion have become problems threatening natural water source (Zalids, 2002) even more today.

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 and it is growing at an alarming rate year on year basis. The religious scripts, mythology and rituals have attempted to drive the importance of preserving nature by adoring it through the centuries. Bhagavadgita (9.26) states: "*PatramPushpamphalamtoyam, yomeybhaktyaprayachchatiTadahambhaktyupahrutam".* The eco-friendly idols were made with clay and then colored with natural colours like turmeric in that time. To worship god and goddess only natural things like milk, curd, ghee, coconut, beetal, and river water were usually used. In India idol immersion is another anthropogenic activity (Gupta, 2011). The idols of Lord Viswakarma, Lord Ganesh, 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 Mohram festival, tazias are being immersed by Muslims in the month of May every year (Mukherjee, 2003). The time span of festival may vary from one and half day to ten days.

Idols are immersed in lotic or lantic water bodies based on the difference in the water residence time and the flow velocity. However in present day scenario ever growing use of metals, ornaments, oily substances, and synthetic colours, chemical are used to make polish and decorate these idols for worship followed by large number of idols, immersion of these large idols in our surrounding aquatic environment severally affects the water body on its natural characteristics. For pollution generated from festival wastes (particularly idol immersion), many researchers have done work on the same in India (Karandikar, 2010; Malik, 2010).

When the idols (large and small) are immersed in these stagnant water bodies, their toxic colors, chemicals, and other components that are used for idol preparation get dissolved and leads to significant alteration in the water quality (Dhote, 2001). The chemical paints used to decorate the idols increases heavy metal concentration and acidity of the water (Vyas, 2007). When immersed, these colours and chemicals dissolve slowly leading to significant change in the water quality (Dhote, 2001). Lead and Chromium, which are part of colourful paints on idols, leach out into the water bodies. These heavy metals are very toxic even in very small quantity for human being through the process known as Bio-accumulation and Bio-magnifications (Bibicz, 1982). The input of bio-degradable 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 (Leland, 1991).

Ever growing religious activities and religious fanatics have now become a major threat to the ecosystem (Bajpai, 2003; Ujjain, 2011). Hence, there is urgent need to develop the guidelines for idol immersion and enforce them in totality. Pollution due to water immersion has many social, religious, scientific and environmental dimensions. I have carried out study at Kailana Lake, Gulabsagar Talab, and Baijika Talab in Jodhpur, Rajasthan where over the last three year's idol immersion activity has outgrown in number, quantity, variety, and compared my results with my previous two year of analysis and results.

MATERIALS AND METHODS

Sampling Sites and Sample Collection

Three important idol immersing sites at Kailana Lake, GulabsagarTalab, and BaijikaTalab in Jodhpur, were selected for the present study in 2015. The water samples were collected from surface layer during

morning hours. Pre-immersion samples were collected 3 days prior to immersion activities, immersion samples were collected during the immersion period and post-immersion samples were collected one week after the completion of *Ganesh Visaarjanin* the month of October. The samples collected were analyzed for various water quality parameters viz. pH, TSS (Total suspended solids), TDS (Total dissolved solids), TS (Total Solids), Turbidity, Conductivity, hardness, DO (Dissolved Oxygen), Biological Oxygen Demand (BOD), and COD (Chemical Oxygen Demand) as per Standard Methods (APHA, 1995).

Experimental

The water samples were collected from selected location by composite sampling method. All samples were collected in high density polypropylene bottles (Tarson make). In all cases plastic bottles were cleaned properly, first with dilute nitric acid and then with double distilled water before their usage for collection of samples. Analytical Reagent (AR) grade chemicals were used during the study. All results were checked within 6 hours of collection of water sample whereas parameters like pH, temp, DO checked at site itself using EI make water and soil analysis kit - Model 161. Some standard preservative media was used to preserve the samples till its use for analysis in laboratory (APHA, 1995). All results were evaluated with reference to WHO and ICMR (Maiti, 1990; WHO, 1993) standard for drinking water.

Preparation of Samples

Well agitated collected water sample was filtered through a weighed standard glass fiber filter. The residue retained on the filter was dried to constant weight to estimate Total Suspended Solid (TSS) while the filtrate obtained was evaporated to dryness till constant weight obtained in order to estimate Total Dissolved Solid (TDS). The sum total of TSS and TDS gives Total Solid (TS) value. Turbidity was estimated using Turbidity meter and Conductivity was estimated by Conductivity meter. Total Hardness was analyzed by titrimetric EDTA method. DO samples were fixed on the spot and analyzed immediately by Winkler's method with azide modification. The collected water samples were incubated at 200ºC for 5 days as per manual of water and pollution control 1.9 NEERI (1991). COD was determined by open reflux method using potassium dichromate solution. Temperature is one of the most important ecological features. It controls behavioral characteristics of organisms, solubility of gases, and salts in water. The surface water temperature of all the water bodies under study varied between 22°C to 27°C during pre-immersion, during immersion, and post-immersion period.

RESULTS AND DISCUSSION

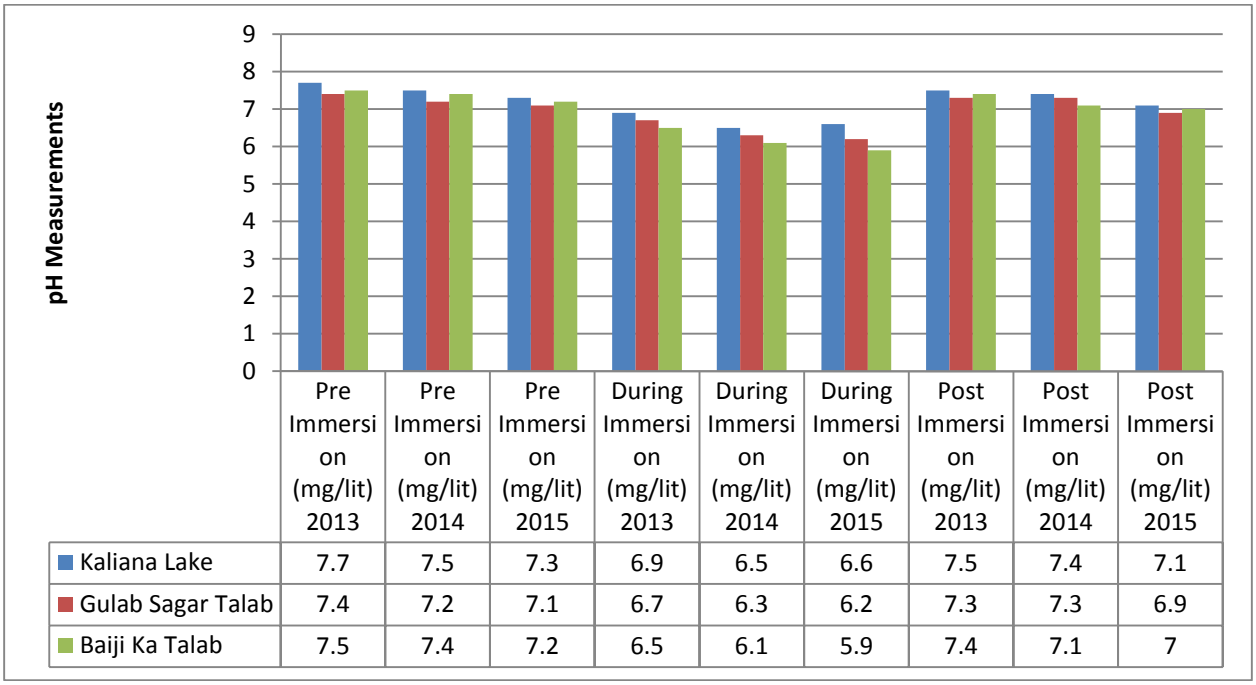
1. **pH -** The pH of water is important because it governs solubility of nutrients in water body. The pH ranged from 5.9 to 7.7. The minimum pH (5.9) was observed at immersion. This indicated acidity of water increases during immersion of idols. Post immersion pH increased to 7.0 showing re-stabilization of water body. Variation in pH in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 1.

2. **Total Suspended Solids (TSS) -** Total suspended solids shows a remarkable increase during immersion period and then decreased to almost original levels in the post immersion period in the collected water samples. It was still higher in year 2015 as compared to last two years. The increase is attributed to disposal of *Pooja samagri*, colour, *agarbatti*, coconut, flowers etc. in water bodies which has grown in variety and quantity. Decrease is attributed due to cleaning activity initiated by municipal body. Variation in Total Suspended Solid (TSS) in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from *Kailana* Lake, *Gulabsagar talab*, and *Baijika talab* in Jodhpur is shown in Table-Chart 2.

3. **Total Dissolved Solids (TDS) -** Total suspended solids show a remarkable increase during immersion period with reversal it almost reached original levels in the post immersion period in the collected water samples. The increase is attributed to increase in total ions or ionic content in the water body. TDS values were nearly comparable between 2013 and 2014 but high in 2015. Variation in Total Dissolved Solid

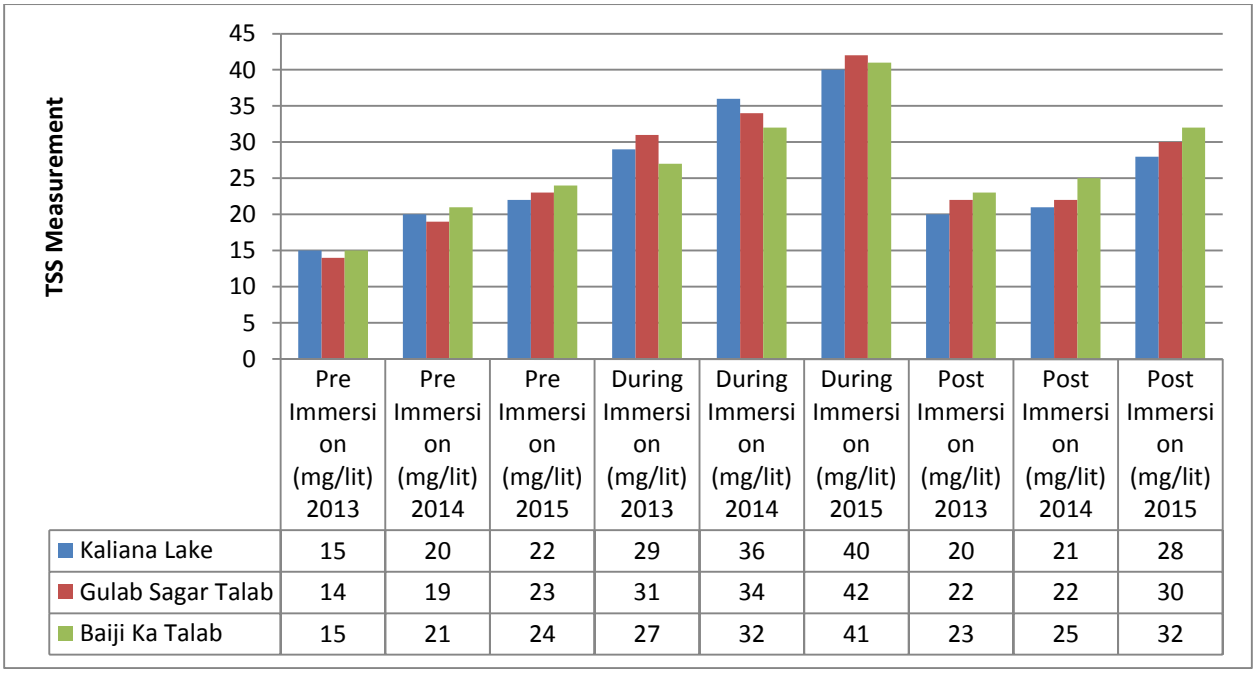
(TDS) in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 3.

4. **Total Solids (TS) -** On an average, Total Solids increased during immersion. This then declined to slowly to nearly in all post immersion samples to nearly pre immersion values however total solids were much higher in proportion in 2015 as compared to last two years. Variation in Total Solid (TS) in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab Jodhpur is shown in Table-Chart 4.



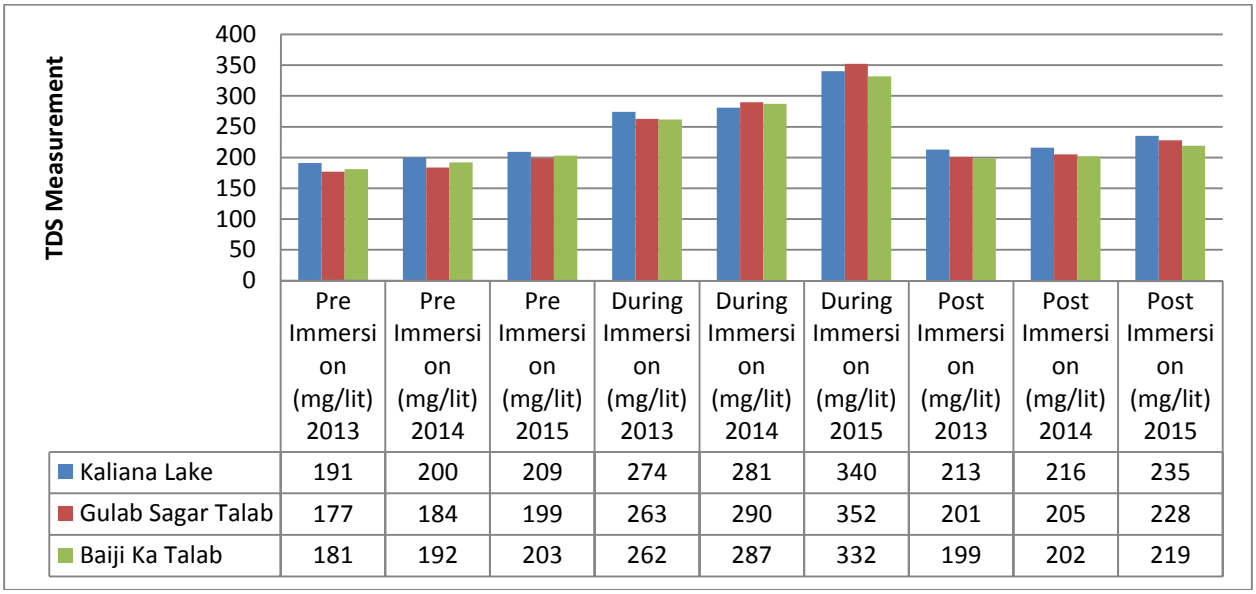
	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	7.7	7.5	7.3	6.9	6.5	6.6	7.5	7.4	7.1
Gulab Sagar Talab	7.4	7.2	7.1	6.7	6.3	6.2	7.3	7.3	6.9
Baiji Ka Talab	7.5	7.4	7.2	6.5	6.1	5.9	7.4	7.1	7

Table 1: pH Measurements



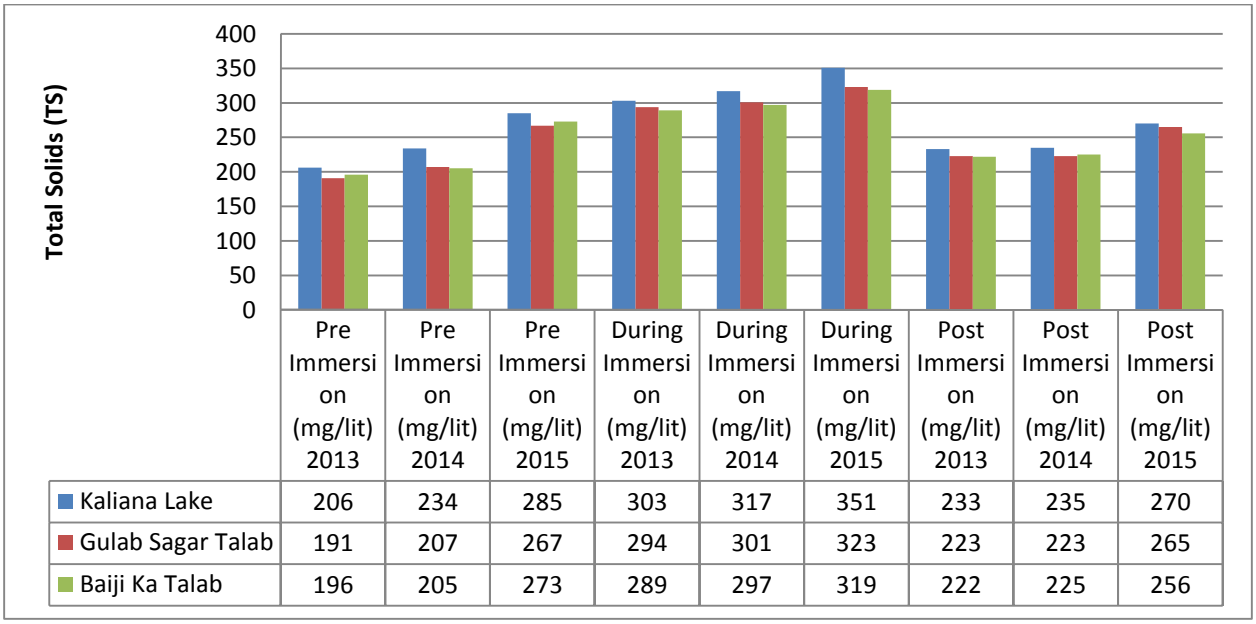
	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	15	20	22	29	36	40	20	21	28
Gulab Sagar Talab	14	19	23	31	34	42	22	22	30
Baiji Ka Talab	15	21	24	27	32	41	23	25	32

Table 2: Total Suspended Solids (TSS)



	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	191	200	209	274	281	340	213	216	235
Gulab Sagar Talab	177	184	199	263	290	352	201	205	228
Baiji Ka Talab	181	192	203	262	287	332	199	202	219

Table 3: Total Dissolved Solids (TDS)



	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	206	234	285	303	317	351	233	235	270
Gulab Sagar Talab	191	207	267	294	301	323	223	223	265
Baiji Ka Talab	196	205	273	289	297	319	222	225	256

Table 4: Total Solids (TS)

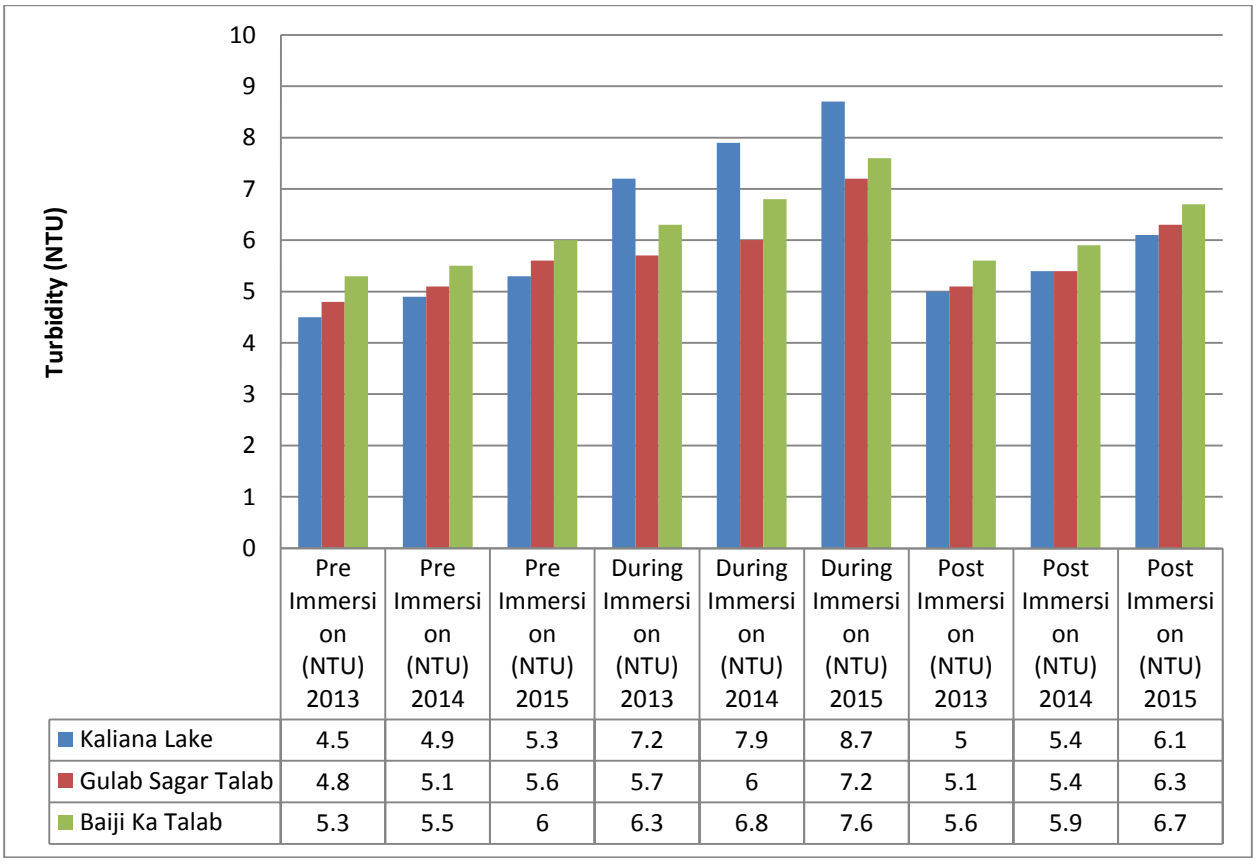
5. **Turbidity -** The observed turbidity level ranged from 4.5 to 8.7 NTU. The minimum and maximum turbidity was recorded in the same location (kailanalake) during pre and post immersion respectively. The turbidity also shows similar trend as that of TSS levels. The water colour is disturbed completely during the idol immersion causing high turbidity. Post immersion turbidity levels in water bodies were little higher as compared to 2013 and 2014 respectively. Variation in Turbidity in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart5.

6. **Total Hardness -** The hardness of water is not a pollution parameter but indicates water quality. The total hardness of water depends upon the origin of the water or the treatment of which the water has been subjected too. In the present study, the hardness was higher than of the permissible limit and increases after idol immersion. Significant reduction in hardness was not observed (Goyal, 2006). Hardness in both

talabs was higher than lake. This was due to mixing of domestic waste and sewage waste being poured in both talabs. Post immersion hardness levels in water bodies were higher as compared to results of 2013 and 2014 respectively. Variation in Hardness in collected (Goyal, 2006) water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 6.

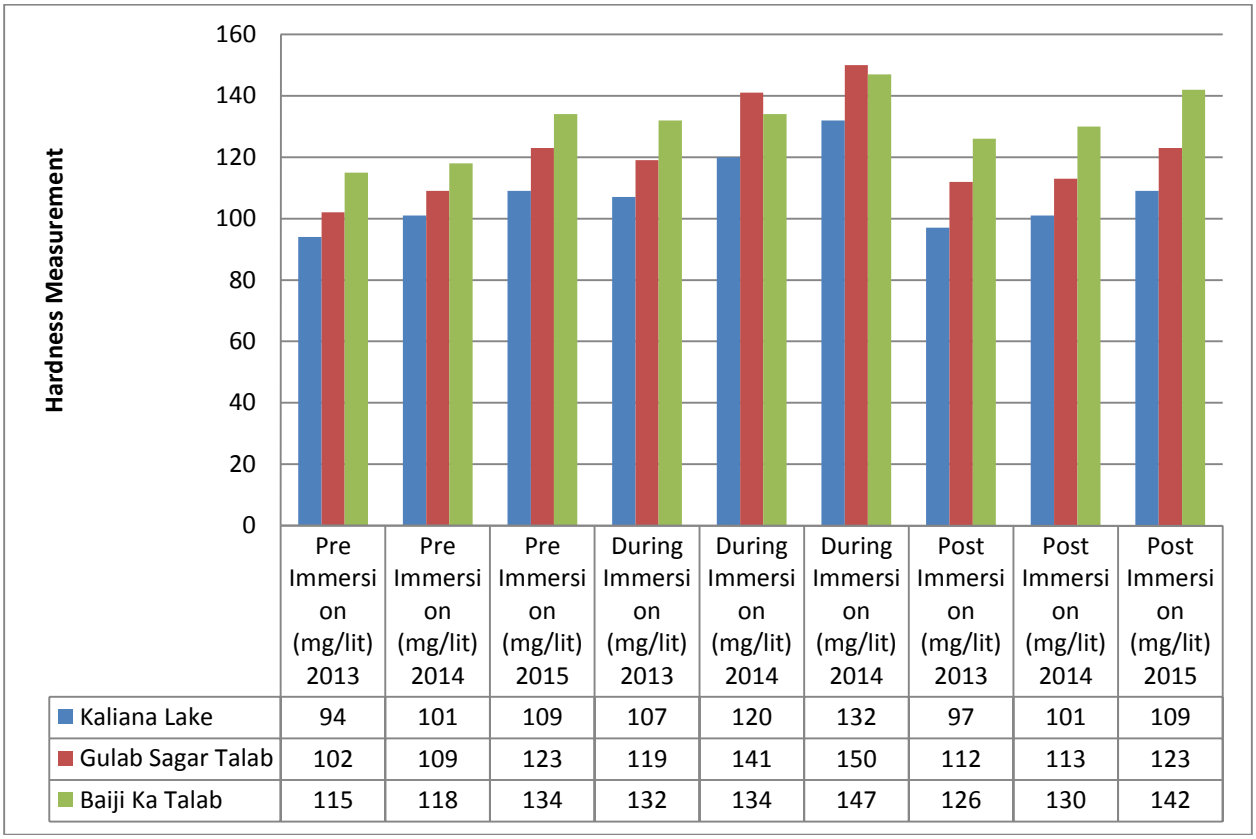
7. **Conductivity -** The conductivity of lake water after immersion of idol increased slightly than pre-idol immersion. Pure water is not a good conductor of electricity, because the electrical conductivity increases as the concentration of ions increases. TDS and electrical conductivity are interlinked. TDS was measure of the total ions in solution.TDS also increase after immersion of idols as shown in table-chart 3 above. Post immersion conductivity levels in water bodies were higher than 2013 and 2014 respectively. Variation in Conductivity in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 7.

8. **Dissolved Oxygen (DO) -** Dissolved Oxygen in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determines the biological changes. Adequate DO is necessary for good water quality and if DO drop below 5.00 mg/lit., aquatic life under stress. D.O. of lake water before immersion of idol was higher and it decreased sharply after immersion. The low value of DO is due to increase in amount of decomposition of organic matter and effluent of sewage, respectively. DO drop to 3.7 in Baijikatalab putting aquatic life under stress. Post immersion DO levels in water bodies further decreased in 2015 as compared to 2013 and 2014 respectively. Variation in Dissolved Oxygen (DO) in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 8.



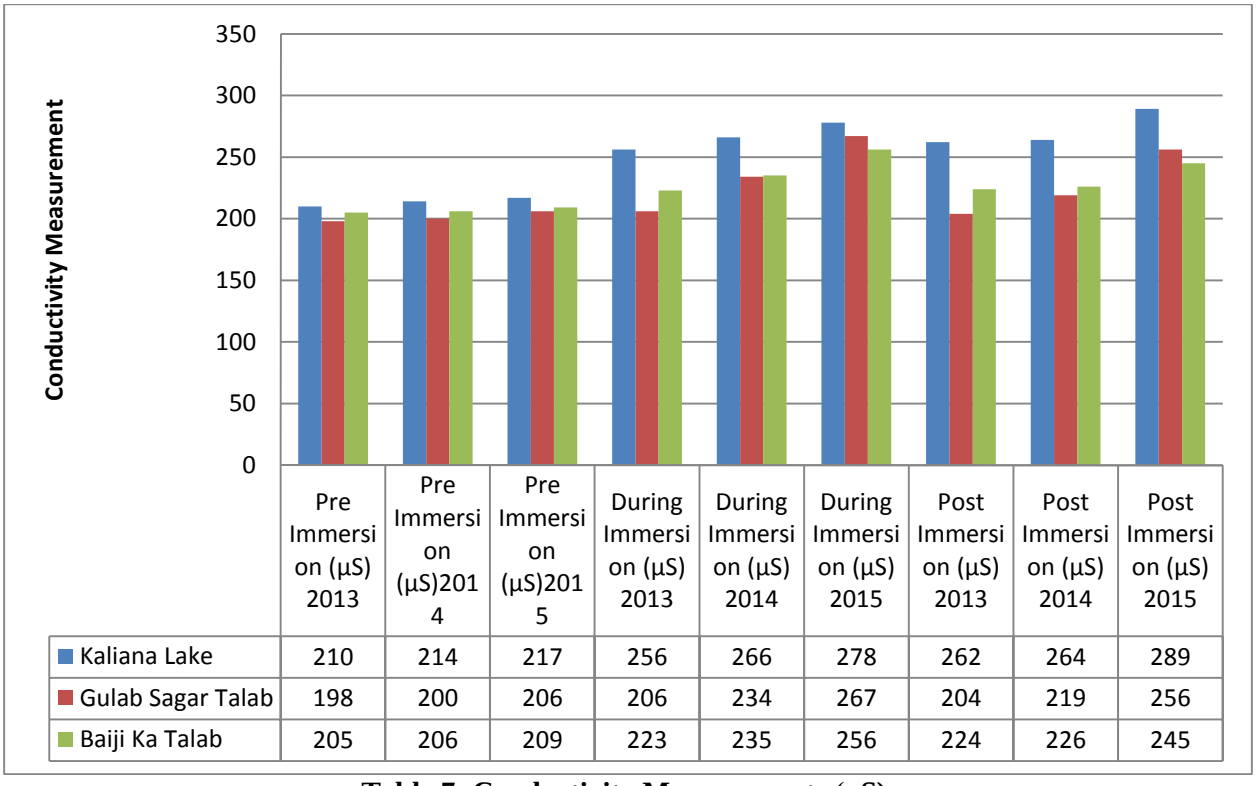
	Pre Immersion (NTU) 2013	Pre Immersion (NTU) 2014	Pre Immersion (NTU) 2015	During Immersion (NTU) 2013	During Immersion (NTU) 2014	During Immersion (NTU) 2015	Post Immersion (NTU) 2013	Post Immersion (NTU) 2014	Post Immersion (NTU) 2015
Kaliana Lake	4.5	4.9	5.3	7.2	7.9	8.7	5	5.4	6.1
Gulab Sagar Talab	4.8	5.1	5.6	5.7	6	7.2	5.1	5.4	6.3
Baiji Ka Talab	5.3	5.5	6	6.3	6.8	7.6	5.6	5.9	6.7

Table 5: Turbidity



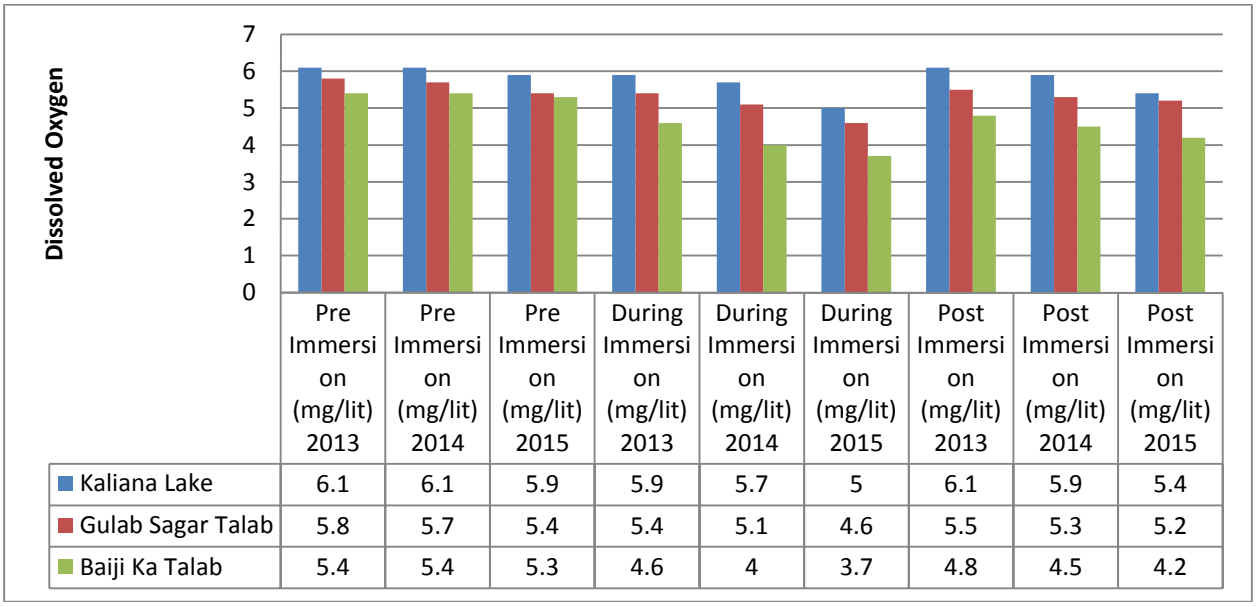
	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	94	101	109	107	120	132	97	101	109
Gulab Sagar Talab	102	109	123	119	141	150	112	113	123
Baiji Ka Talab	115	118	134	132	134	147	126	130	142

Table 6: Hardness Measurement



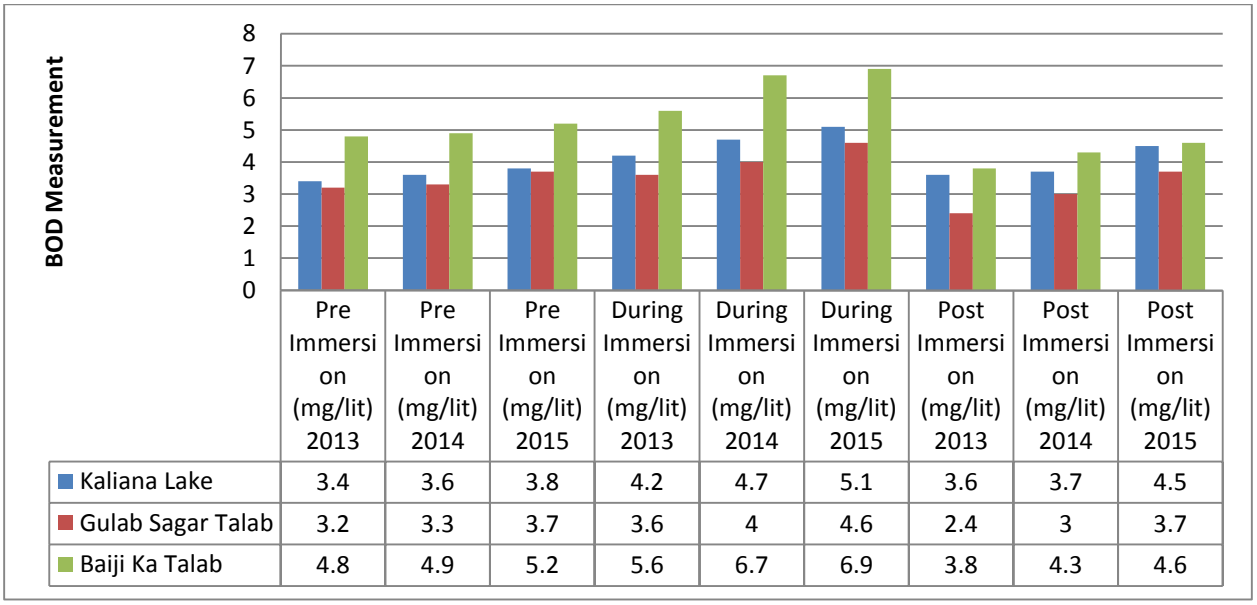
	Pre Immersion (µS) 2013	Pre Immersion (µS)2014	Pre Immersion (µS)2015	During Immersion (µS) 2013	During Immersion (µS) 2014	During Immersion (µS) 2015	Post Immersion (µS) 2013	Post Immersion (µS) 2014	Post Immersion (µS) 2015
Kaliana Lake	210	214	217	256	266	278	262	264	289
Gulab Sagar Talab	198	200	206	206	234	267	204	219	256
Baiji Ka Talab	205	206	209	223	235	256	224	226	245

Table 7: Conductivity Measurements (µS)



	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	6.1	6.1	5.9	5.9	5.7	5	6.1	5.9	5.4
Gulab Sagar Talab	5.8	5.7	5.4	5.4	5.1	4.6	5.5	5.3	5.2
Baiji Ka Talab	5.4	5.4	5.3	4.6	4	3.7	4.8	4.5	4.2

Table 8: Dissolved Oxygen (DO)

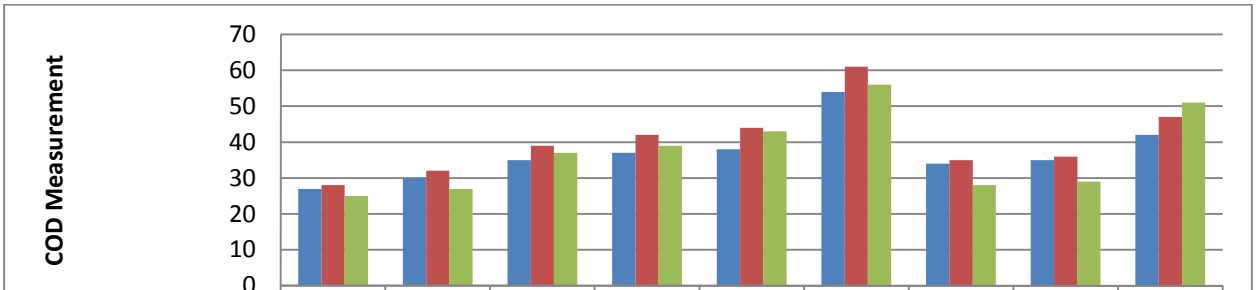


	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	3.4	3.6	3.8	4.2	4.7	5.1	3.6	3.7	4.5
Gulab Sagar Talab	3.2	3.3	3.7	3.6	4	4.6	2.4	3	3.7
Baiji Ka Talab	4.8	4.9	5.2	5.6	6.7	6.9	3.8	4.3	4.6

Table 9: Biological Oxygen Demand (BOD)

9. **Biological Oxygen Demand (BOD) -** BOD was noticed comparatively higher in during and posts immersion period at all the three locations**.** The higher values of BOD means present of more biodegradable organic material. However BOD values showed significant decrease after immersion. The higher values of BOD have direct correlation with the increase of nutrient level in the water body due to the immersion activity (McCoy, 1986).

These components (BOD) and (COD) are helpful to know the toxic conditions and presence of biologically resistant organic substances in water. Post immersion BOD levels in water bodies in 2015 increased significantly as compared to 2013 and 2014 respectively. Variation in Biological Oxygen Demand (BOD) in collected water sample: Pre-immersion, at immersion, and post-immersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 9.



	Pre Immersion (mg/lit) 2013	Pre Immersion (mg/lit) 2014	Pre Immersion (mg/lit) 2015	During Immersion (mg/lit) 2013	During Immersion (mg/lit) 2014	During Immersion (mg/lit) 2015	Post Immersion (mg/lit) 2013	Post Immersion (mg/lit) 2014	Post Immersion (mg/lit) 2015
Kaliana Lake	27	30	35	37	38	54	34	35	42
Gulab Sagar Talab	28	32	39	42	44	61	35	36	47
Baiji Ka Talab	25	27	37	39	43	56	28	29	51

Table 10: Chemical Oxygen Demand (COD)

10. **Chemical Oxygen Demand (COD) -** COD is the main parameter to access waste water quality, as far as drinking water quality is concern no limits of COD is given, but the COD data interprets the status of chemical load of the water bodies. From the results of COD all water bodies showed increase in COD after idol immersion. Post immersion COD levels in water bodies in 2015 were significantly higher than in 2013 and 2014 respectively. Variation in Chemical Oxygen Demand (COD) in collected water sample: Pre-immersion, at immersion, and postimmersion for water samples collected from Kailana Lake, Gulabsagartalab, and Baijikatalab in Jodhpur is shown in Table-Chart 10.

Conclusion

From the mythological point of view, the fresh water bodies are related to religious sentiments for ages however from the scientific point of view, these water bodies like ponds, lakes, and rivers are highly polluted are water is not suitable for human consumption. 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 present study on assessment of idol immersion on physico-chemical characteristics of water bodies in Jodhpur revealed that idol immersion activity has negative impact on water quality of the lake and more so in talabs due to input of domestic sewage, high siltation, and static water. Since KailanaLake is connected to Indira Gandhi canal for water input, water characteristics almost reverse after some time post immersion.

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. Problem becomes more acute when dissolution of input in the environment exceeds the decomposition, dispersal, or recycling capabilities. These enhanced toxics from anthropogenic inputs not only alter the natural fresh waters, but also have detrimental effects whose impact can be felt for long time.

The measured parameters of water quality standard show marked deviations from the established standards. Off all the parameters studied, it is well established that water quality in these water bodies had detoriated significantly in 2015as compared to 2013 and 2014. This means that pollution and pollutants load has significantly increased in 2015 in these water bodies. As such Municipal Corporation should act at the earliest to preserve these water bodies and restore their originality, or else they will become dead in few years from now.

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