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The impact of idol immersion on the water quality of the waterbodies in Kolkata and Howrah, West Bengal, India

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Abstract - *Water pollution is one of the most widespread global problems which has been aggravated due to anthropogenic activities. The consequent effects of water pollution are far-reaching, detrimental to human health, aquatic ecosystems, and the environment as a whole. Contaminated river water can cause various chronic health issues, due to heavy metals and other toxicants. India is a culturally rich country and follows various diversified customs and tradition. Idol worship has been an integral part of this age-old tradition and aafter worship; these idols are immersed into various water bodies like seas, rivers, lakes, ponds, etc. These idols are generally made up of clay or mud, but sometimes they could be made of Plaster of Paris (POP) along with cloth, wooden structure or frame and are decorated with different paints which contain heavy metals like mercury, cadmium, lead, etc. Oother items are also used for decorative purposes which are mainly made of plastic, paper, thermocol, etc. To study the effect of idol immersion, water samples were collected from four immersion sites or ghats of Kolkata and Howrah and also from two community ponds of Howrah. These samplings were done in three stages pre-immersion, during immersion and post-immersion. Pparameter's like temperature, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) were recorded in-situ. Dissolved Oxygen, Total Suspended Solids (TSS) some, heavy metals were analysed in the laboratory. This study found marginal change in these water quality parameters before, during and after immersion. Bureau of Indian Standards (BIS 10500:2012) has been followed for the analysis.*

***Key Words*: Water Pollution, Idol Immersion, Ganga River, Kolkata, Howrah, Water Quality, Physicochemical parameters, Heavy metals**

1. INTRODUCTION

All forms of life (both plants and animals) depend upon water for its survival and daily needs. Human beings need water for drinking, bathing, washing, agricultural usage and industrial uses. The quantity & quality of water is deteriorateing over time due to overexploitation of both ground water and surface water. Another reason for water quality degradation is increase in pollution bbecause of the dumping of domestic, agricultural and industrial wastes. India is a country of religious diversity and people follow various rituals, customs and religious traditions. One of the religious traditions that is followed in India is idol worship. In earlier days till 1980s, idols were mainly made of clay or mud or terracotta (burnt mud or clay) and usually decorated with bio-degradable materials like paper, cloth, jute fibres. Even colours used were of natural ingredients or eco-friendly in nature. After worship, the idols were generally immersed in different water bodies like seas, rivers, lakes and ponds. But, since some years besides being made up of clay or mud, idols are sometimes made of Plaster of Paris (POP). Usually wooden structure or frame, small iron rod are also used and the idols are decorated with different synthetic paints, papers, plastics, thermocols and other non-biodegradable materials which can cause severe adverse effect to the environment as a whole. Most of the synthetic paints are of petrochemical origin and contains heavy metals like mercury, cadmium, lead, chromium, zinc, aluminium, etc. which are very toxic for our health and the environment. Vermilion or Sin door which is applied on the idols during worship or during other religious rituals contains sculpture and mercury. They contaminate the water and could be detrimental for health, if it crosses the permissible limits in water. Lead and Chromium are very toxic even in very small quantity for human beings through the processes known as bioaccumulation and biomagnification. Through food chains, these heavy metals can enter into the body systems of living organisms. The idol immersion activities pollute the ponds, lakes, rivers, seas and other waterbodies. The decomposition of the organic matters dumped with idol immersion process in the river and lake results in eutrophication increase in acidity and heavy metal concentration. Heavy metal pollution caused by idol immersion can damage the ecosystem as it kills fishes, damages plant, blocks the natural flow of the water, causing stagnation. It damages health of human beings also by polluting drinking water sources, causing breathing problems, blood and skin diseases (Bhattacharya et al., 2014).

Besides these, lot of organic wastes like flowers, garlands, grains, and other puja materials (offerings to Gods and Goddesses) are dumped into the waterbodies which results in various microbial growths. The decomposition of the organic waste reduces the Dissolved Oxygen (DO) of water and increases the Biological Oxygen Demand (BOD) of water thus degrading the quality of water. Due to excessive organic matter in the water various pathogens or disease-causing microbes like bacteria, viruses, protozoa, fungii and start multiplying and results in various water borne diseases like dysentery, cholera, diarrhoea, hepatitis, etc.

To study the effect of idol immersion, water samples were collected from four immersion sites or ghats of Kolkata and Howrah. Samples from two community ponds of Howrah were also collected and analysed. These samplings were done in three stages before immersion (pre-immersion), during immersion and after immersion (post-immersion). Analyses were done for various Physical as well as chemical parameters like temperature, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen, acidity, alkalinity, Total Suspended Solids (TSS), total hardness, metals and heavy metals like Na, K, Ca, Mg, Al, Fe, As, Cd and Hg.

When Idols are immersed in water bodies then all the chemicals present in them get dissolved into the water of the water bodies. The paints of the idols do not dissolve easily in the water bodies. Also, these paints generally contain various heavy metals such as Mercury, Lead, Arsenic, Cadmium, Chromium and Zinc and also other metals like Aluminium and Magnesium. Through food chain these heavy metals get into human bodies. These heavy metals have lots of adverse effect on human bodies. The adverse effects of various metals are mentioned below.

Mercury (Hg): Mercury pollution can be a serious health threat, especially for children and pregnant women. Health hazards can occur if fishes contaminated with mercury are consumed. Even in low doses, mercury may affect a child's development by shortening attention span and causing learning disabilities. Occasional exposure to mercury in high dose during prenatal and infant stages can cause mental retardation, cerebral palsy, deafness and blindness. In adults, mercury poisoning can adversely affect fertility and blood pressure regulation and can cause memory loss, tremors, vision loss and numbness of the fingers and toes (Bhattacharya et al., 2014). Mercury poisoning can cause Minamata disease which was first observed in Minamata of Japan in the year 1956.

Cadmium (Cd): Cadmium is primarily toxic to the kidney. Cadmium can cause bone demineralization, directly or indirectly as a result of renal dysfunction. Drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhoea, and sometimes death. If the levels reach a high enough level, the cadmium in the kidney will cause kidney damage, and also causes bones to become fragile and break easily (Bhattacharya et al., 2014). Chronic Cadmium toxicity can cause Itai- itai disease which was first time observed in Japan in the year 1968.

Arsenic (As): Arsenic is one of the most toxic elements. On being eexposeed to inorganic arsenic, various health problems, such as irritation of the stomach and intestines, decreased production of red and white blood cells, skin changes and lung irritation can occur. It is suggested that the uptake of certain concentration of inorganic arsenic can intensify the chances of cancer development, especially the chances of development of skin cancer, lung cancer, liver cancer and lymphatic cancer. A very high exposure to inorganic arsenic can cause infertility and miscarriages in women, and can also cause skin disturbances, declined resistance to infections, heart disruptions and brain damage. Moreover, inorganic arsenic can damage DNA. Ingestion of large amount of Arsenic can lead to gastrointestinal symptoms such as severe vomiting, damage to the nervous system, and eventually death (Bhattacharya et al., 2014).

Aluminium (Al): Aluminium when absorbed in excess concentration can cause neurological disorders, bone problems, kidney dysfunction. It can even cause anaemia and lung problem and associated respiratory problems.

Magnesium (Mg): Magnesium can cause diarrhoea, nausea, cardiovascular problems and a complex disease called hypermagnesemia.

2. STUDY AREA

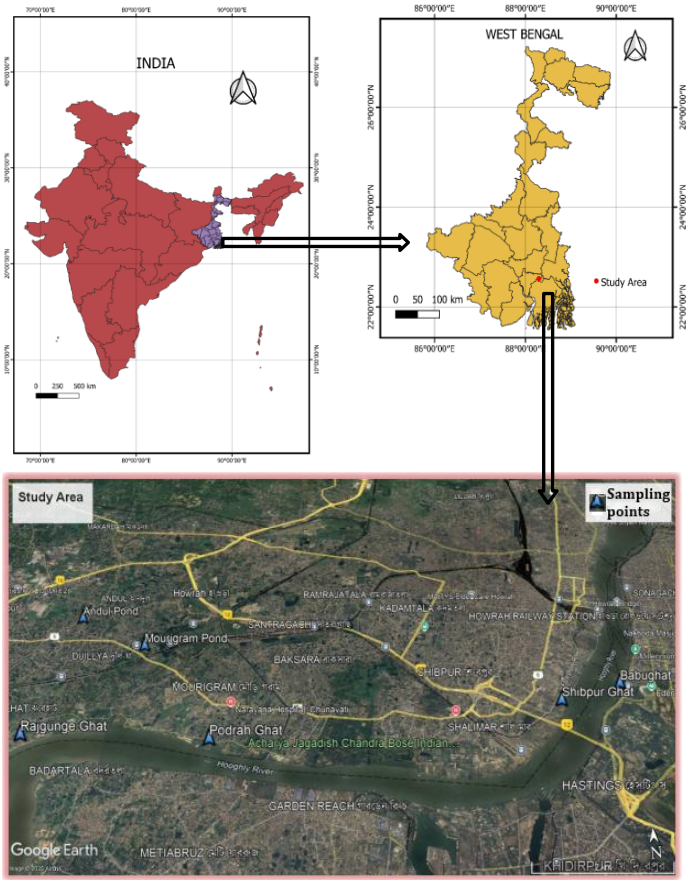

Fig1. Study area and sampling locations map

The study has been conducted at six different locations from both Kolkata and Howrah, whose details are given afterwards. Four immersion ghats were selected (from Kolkata and Howrah) and two community ponds (from Howrah) were selected for the purpose of the study. The ghats from where sampling is done are the popular locations for bathing and immersion activities. The two community

ponds selected for sampling is also used by local people for bathing, washing, and fishing and immersion purposes.

All the details of the sampling locations, their geographical coordinates (GPS location), sampling date and phase of the sampling (pre-immersion, during immersion, post-immersion) are mentioned in a tabular format below.

Table 1 (Details of sampling)

Sl. No.	Sample Name (Location)	GPS Location	Sampling Date
1	Podrah Ghat	22°33'34" N 88°16'5" E	Pre-immersion (03-10-2024) During-immersion (13-10-2024) Post-immersion (15-10-2024)
2	Rajgunje Ghat	22°33'46" N 88°14'16" E	Pre-immersion (03-10-2024) During-immersion (13-10-2024) Post-immersion (15-10-2024)
3	Babughat	22°33'52" N 88°20'18" E	Pre-immersion (06-10-2024) During-immersion (12-10-2024) Post-immersion (14-10-2024)
4	Shibpur Ghat	22°33'43" N 88°19'37" E	Pre-immersion (06-10-2024) During-immersion (12-10-2024)
5	Andul Pond	22°35'17" N 88°14'30" E	Pre-immersion (03-10-2024) Post-immersion (14-10-2024)
6	Mourigram Pond	22°34'48" N 88°15'17" E	Pre-immersion (05-10-2024) Post-immersion (15-10-2024)

Starting from the upper course to lower course of Ganga River, Babughat is on the upper stream part followed by Shibpur ghat, then Podrah ghat and Rajgunje ghat at lower most stream. As we move from west to east, only Babughat is situated on the left bank of Ganga River and the remaining three ghats are situated on the right bank on the river.

3. METHODOLOGY

3.1 Collection of water samples:

- Water samples were collected in 32 Polypropylene bottles of volume 200ml (each) from the sampling sites.
- 2 set of samples were collected from each location; one set was acidified for trace metal analysis.
- HNO_3 (1N) solution was prepared to acidify the samples which were to be analyzed for cations in the laboratory through ICP-MS (Agilent 7800 ICP-MS) and Flame Photometer (Reliable RLE-244X).
- Thermometer, EC meter, TDS meter and pH meter were also arranged for on-site (in-situ analysis).
- Gloves, sample bottles, HNO_3 (1N) solution, dropper, note book, pen and other accessory items were taken to the site during sample collection.
- Sampling was done in three phases, i.e. pre-immersion, during immersion and post-immersion for river water samples and in two phases i.e. pre-immersion and post-immersion for pond water samples.
- Four ghats were identified where idol immersion take place, first location Babughat (Kolkata) and three others ghats from Howrah; Shibpur ghat, Podrah ghat and Rajgunje ghat. Besides two ponds were also selected one in Andul and second one near Mourigram railway station where idol immersion take place.
- Each and every GPS coordinate values were taken down before sample collection. While collecting water sample, temperature, EC, pH and TSD values were noted down in the note book.
- Next, 2-3 drops of HNO_3 (1N) solution were added to 100 ml water samples for heavy metal and other cation analysis so that the metallic ions present in the water remains in suspended form.
- All the water samples were stored at around 4°C before being taken to the lab for other analysis.

3.2 Data Collection and Analysis:

Samples were taken to the laboratory for analysis. Samples were analyzed for physicochemical parameters. Before doing any chemical analysis of the water samples, samples were filtered through 0.2 micro meter (µm) nylon filter papers. Among the physical parameters, the following were considered:

- Temperature, pH, EC (Electrical Conductivity), TDS (Total Dissolved Salts) these physical parameters were already measured in-situ.
- TSS (Total Suspended Solids) analysis was conducted in the laboratory. Firstly, the dry filter papers were weighed (initial weight) then water samples were filtered and after that the filter papers were dried in a desiccator. After drying the filter paper again, the filter papers were weighed (final weight). Then by deducting the initial weight from the final weight we got the

weight of the TSS in g, which was later represented in mg/L.

Fig2. Post immersion image of Andul pond

Fig. 3. Mouri gram pond, Howrah

The chemical parameters that were considered for the analysis of the water sample are:

- Total Acidity, Total Alkalinity- These analyses were done with help of chemical reagents like Methyl Orange, Phenolphthalein, NaOH (0.02N) solution, Ethyl Alcohol and H_2SO_4 (0.01N) solution.
- DO (Dissolved Oxygen) analysis was done with the help of the reagents like, Mn SO_4 solution, Alkali Iodide solution (NaOH and KI), Starch solution and con. H_2SO_4.
- Total hardness was estimated with the help of EDTA (0.01N) solution, Eriochrome Black T (EBT) solution and Ammonium buffer solution with the help of titration.
- Cations like Sodium (Na), Potassium (K) and Calcium (Ca) were determined with the help of Flame photometer. Magnesium (Mg) was also estimated through titration.
- Some other cations and heavy metals like Mercury (Hg), Cadmium (Cd), Lead (Pb), Arsenic (As), Iron (Fe) and Aluminum (Al) were also determined with the help of ICP-MS (Inductively Coupled Plasma Mass Spectrometer.

All the results obtained from the physicochemical analyses were compared with the BIS (Bureau of Indian Standard) IS 10500:2012 Drinking Water Specification (https://cpcb.nic.in/wqm/BIS_Drinking_Water_Specification.pdf).

4. RESULTS AND DISCUSSION

4.1 Results

After analysis, the results were tabulated and compared with the BIS standard and checked for the parameters. Based on the values charts were also generated for easy and quick understanding.

Table 2 (Results of Physical parameters)

Sl. No.	Sample Name (Location)	Type of Sample	Tempe-rature (˚C)	pH	EC	TDS	TSS
1	Podrah Ghat	Pre-immersion	28	6.56	253	91	417.5
2	Podrah Ghat	During-immersion	29	7.74	339	230	483
3	Podrah Ghat	Post-immersion	30	7.5	284	150	640.5
4	Rajgunje Ghat	Pre-immersion	28	7.42	207	96	280
5	Rajgunje Ghat	During-immersion	29	7.82	249	161	396.5
6	Rajgunje Ghat	Post-immersion	30	7.58	301	129	339.5
7	Babughat	Pre-immersion	30	7.66	219	126	274.5
8	Babughat	During-immersion	31	8.38	243	161	334
9	Babughat	Post-immersion	31	7.42	288	138	294

10	Shibpur Ghat	Pre-immersion	30	7.34	207	124	416
11	Shibpur Ghat	During-immersion	30.5	7.66	342	189	451
12	Shibpur Ghat	Post-immersion	30	7.98	231	135	403.5
13	Andul Pond	Pre-immersion	29	7.66	498	211	266.5
14	Andul Pond	Post-immersion	29.5	7.84	496	267	322
15	Mourigram Pond	Pre-immersion	29	7.5	465	273	463
16	Mourigram Pond	Post-immersion	29.5	7.26	602	358	680

*** EC** (in µS/cm), **TDS** and **TSS** (in mg/L)

The above table shows the values of Temperature, pH, EC, TDS and TSS. The parameters were below the prescribed limit as per BIS (IS 10500:2012). In case of Podrah Ghat and Babughat only, the pH value was almost touching the Acceptable Limit. In terms of TDS and TSS values, among the immersion ghats Podrah Ghat is showing higher values than the other ghats and in case of ponds, Mourigram pond was showing higher values than Andul pond.

Table 3 (Results of Chemical parameters)

Sl. No.	Sample Name (Location)	Type of Sample	Total Acid-ity	Total Alkali-nity	Total Hardness	DO
1	Podrah Ghat	Pre-immersion	32	36	142	16.4
2	Podrah Ghat	During-immersion	36	40	168	12
3	Podrah Ghat	Post-immersion	28	22	148	14.8
4	Rajgunje Ghat	Pre-immersion	28	38	124	11.6
5	Rajgunje Ghat	During-immersion	24	50	134	10
6	Rajgunje Ghat	Post-immersion	24	40	126	10.8
7	Babughat	Pre-immersion	24	16	100	25.2
8	Babughat	During-immersion	28	44	164	12.6
9	Babughat	Post-immersion	28	14	122	22.4
10	Shibpur Ghat	Pre-immersion	28	22	158	20.5
11	Shibpur Ghat	During-immersion	32	34	186	18
12	Shibpur Ghat	Post-immersion	32	18	128	22
13	Andul Pond	Pre-immersion	48	40	168	18
14	Andul Pond	Post-immersion	50	60	156	12
15	Mourigram Pond	Pre-immersion	40	30	182	24
16	Mourigram Pond	Post-immersion	80	70	208	20.8

* All values are in mg/L

The above results reflect the values obtained for Total acidity, Total alkalinity, Total hardness (in terms of $CaCO_3$) and Dissolved Oxygen (DO). All the values are within the permissible limit. But in terms of DO, the value came down during immersion period at Rajgunje Ghat and Podrah Ghat. Possible reason could be influx of biodegradable wastes like flowers and other puja offerings while immersion process. Between the two ponds, the DO value of Andul pond was much lower in the post immersion phase than Mourigram pond. The water samples were also analyzed for cations (Na, K, Ca) with the help of Flame Photometer and Heavy metal (Hg, As, Al, Cd, Fe) with the help of ICP-MS whose results have been tabulated below. The concentration of Sodium (Na), Potassium (K) and Calcium (Ca) where found to be in the Acceptable Limit. But the concentration of Magnesium (Mg) exceeded the permissible limit as per BIS standard. The highest concentration was found was in Shibpur Ghat **169.7** mg/L (well above 100 mg/L Permissible limit as per BIS) during immersion period among all the four immersion ghats. Between the two ponds, the highest concentration was found in Mourigram pond **182.1** mg/L (exceeding 100 mg/L Permissible limit as per BIS) in the post-immersion phase.

The values obtained for all the results are in mg/L (milligram per liter) or ppm (parts per million).

Table 4 (Results of analysis for Cations)

Sl. No.	Sample Name (Location)	Type of Sample	Na+	K+	Ca+	Mg+
1	Podrah Ghat	Pre-immersion	9.6	2.9	15.6	126.4
2	Podrah Ghat	During-immersion	11.4	4.7	17.9	150.1
3	Podrah Ghat	Post-immersion	13.9	4.7	17.6	130.4
4	Rajgunje Ghat	Pre-immersion	11.1	2.6	12	112
5	Rajgunje Ghat	During-immersion	11.5	3.4	14.5	119.5
6	Rajgunje Ghat	Post-immersion	15.1	3.8	17.9	108.1
7	Babughat	Pre-immersion	8.7	2.5	9.6	90.4
8	Babughat	During-immersion	21.5	4.2	13.4	150.6
9	Babughat	Post-immersion	16.8	3.5	16	106
10	Shibpur Ghat	Pre-immersion	11.8	3.3	11.9	146.1
11	Shibpur Ghat	During-immersion	22.4	3.9	16.3	169.7
12	Shibpur Ghat	Post-immersion	11.2	3.2	12.5	115.5
13	Andul Pond	Pre-immersion	42.9	13.4	22.4	145.6
14	Andul Pond	Post-immersion	46.3	12.9	18.8	137.2
15	Mourigram Pond	Pre-immersion	38.3	16.2	18.3	163.7
16	Mourigram Pond	Post-immersion	42.7	18.4	25.9	182.1

* All values are in mg/L

The heavy metal analysis reveals that the concentration of the heavy metals; Mercury (Hg), Arsenic (As), Cadmium (Cd) and Iron (Fe) are below Permissible limit. But the concentration of Aluminum has crossed the Acceptable limit (0.03 mg/L) as per the BIS standard (IS 10500:2012). Aluminum concentration is almost near the Permissible limit of 0.2 mg/L in two ghats, Babughat and Podrah Ghat. Cadmium concentration is nearing the Acceptable limit in case of Shibpur Ghat during immersion phase **0.00275** (0.003 as per BIS Standard). In overall physicochemical parameters only Magnesium and Aluminum have been found to be above the Acceptable or Permissible limit. The term **BDL** in the following table stands for Below Detection Limit.

Table 5 (Results of Heavy metal analysis)

Sl. No.	Sample Name and Type	Al	Fe	As	Cd	Hg
1	Podrah Ghat (Pre-immersion)	0.0931	0.1173	0.00017	BDL	BDL
2	Podrah Ghat (During-immersion)	0.0472	0.0626	0.00026	BDL	BDL
3	Podrah Ghat (Post-immersion)	0.1200	0.1674	0.00014	0.00003	BDL
4	Rajgunje Ghat (Pre-immersion)	0.0399	0.0333	0.00014	BDL	0.00001
5	Rajgunje Ghat (During-immersion)	0.0330	0.0372	0.00021	BDL	BDL
6	Rajgunje Ghat (Post-immersion)	0.0373	0.0496	0.00016	BDL	BDL
7	Babughat (Pre-immersion)	0.0428	0.0464	0.00021	BDL	BDL
8	Babughat (During-immersion)	0.1403	0.2515	0.00029	0.00002	BDL
9	Babughat (Post-	0.0410	0.0547	0.00021	0.00038	BDL

	immersion)					
10	Shibpur Ghat (Pre-immersion)	0.0497	0.0535	0.00024	0.00032	BDL
11	Shibpur Ghat (During-immersion)	0.0345	0.0458	0.00026	0.00275	BDL
12	Shibpur Ghat (Post-immersion)	0.0313	0.0358	0.00018	BDL	BDL
13	Andul Pond (Pre-immersion)	0.0075	0.0133	0.00040	BDL	BDL
14	Andul Pond (Post-immersion)	0.0018	0.0092	0.00030	BDL	BDL
15	Mourigram Pond (Pre-immersion)	BDL	0.0266	0.00016	BDL	0.00001
16	Mourigram Pond (Post-immersion)	BDL	0.0191	0.00012	BDL	BDL

* All values are in mg/L

The location wise Bar diagrams generated from the tabular format of the data reflects that in major cases EC, TDS, TSS, Total Hardness (in terms of $CaCO_3$), Total acidity and Total alkalinity have increased in the during-immersion phase compared to, pre-immersion and post-immersion phase. In case of both the ponds (both Andul and Mourigram) all these factors were noticeably high in the post-immersion phase compared to the pre-immersion phase. Although all these parameters were under the permissible limit but still the TSS value were comparatively very high during the post-immersion phase in Podrah Ghat (640.5 mg/L) among all the immersion ghats and in Mourigram pond (680 mg/L) in between the two ponds. On the other hand, although the Total Hardness was within limit in almost all locations, Total Hardness in Mourigram pond was slightly high than the Acceptable limit **208** mg/L (BIS standard 200 mg/L) during the post-immersion phase.

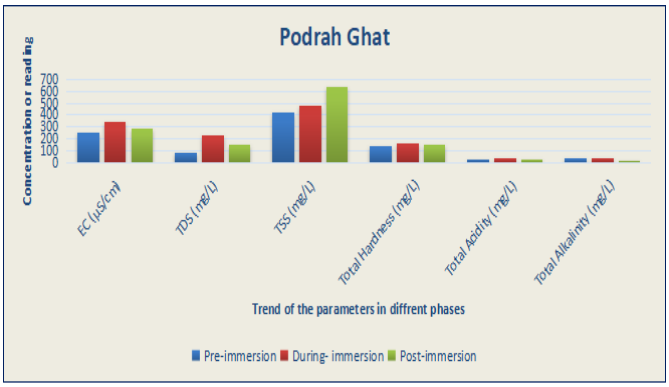

Fig.4.(Diagrammatic representation of various parameters at Podrah ghat)

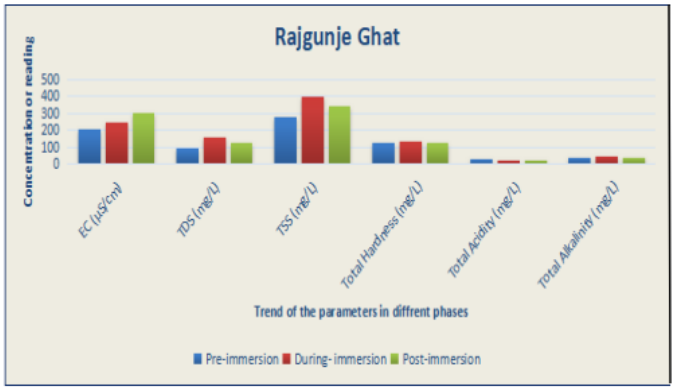

Fig.5.(Diagrammatic representation of various parameters at Rajgunje ghat)

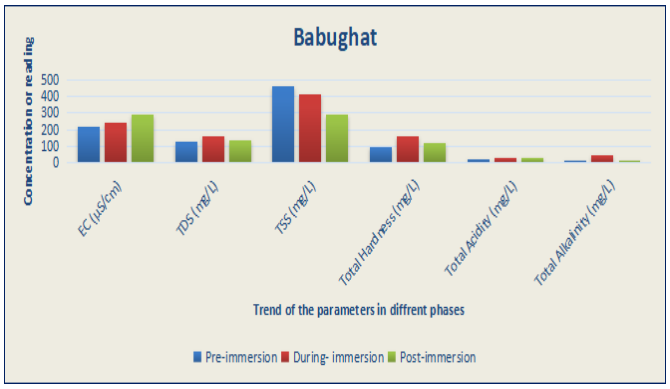

Fig.6.(Diagrammatic representation of various parameters at Babughat)

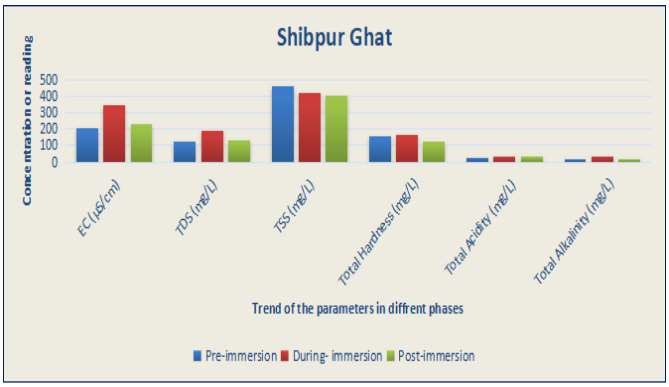

Fig.7.(Diagrammatic representation of various parameters at Shibpur ghat)

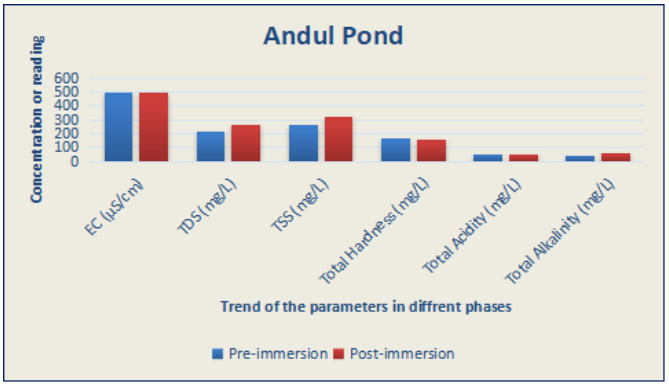

Fig.8.(Diagrammatic representation of various parameters at Andul pond)

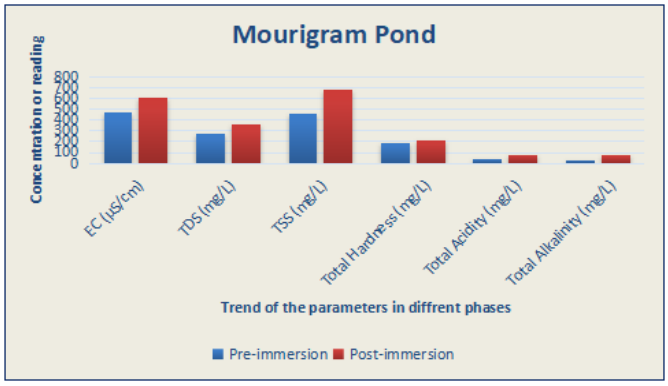

Fig.9.(Diagrammatic representation of various parameters at Mourigram pond)

Variation in pH value was observed throughout different phases; pre-immersion, during immersion and post-immersion, which indicates the alteration in the chemical parameters of the water. This variation has been observed in all the four immersion ghats as well as two ponds. Major variations were observed in the river water samples compared to the pond water samples.

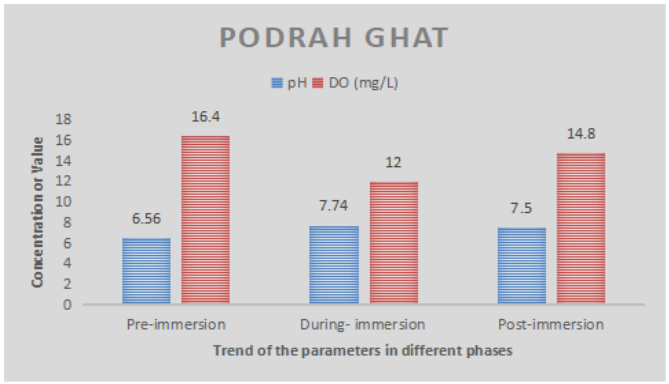

Fig.10.(Diagrammatic representation of DO and pH values at Podrah ghat)

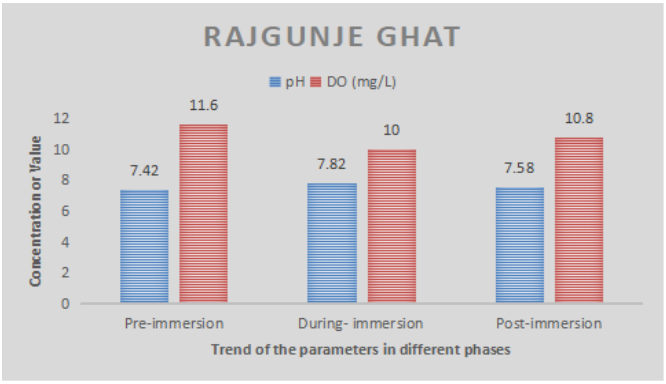

Fig.11.(Diagrammatic representation of DO and pH values at Rajgunje ghat)

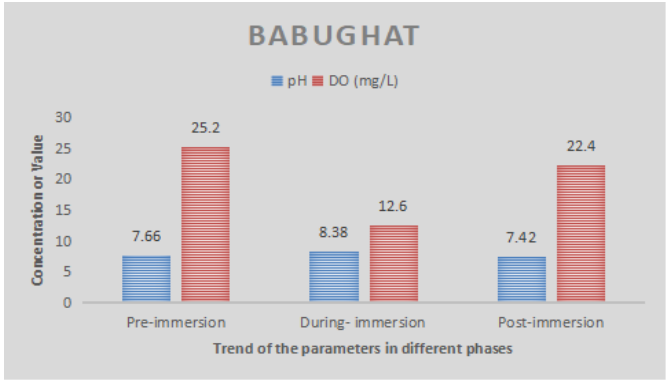

Fig.12.(Diagrammatic representation of DO and pH values at Babughat)

For Dissolved Oxygen (DO), it has been observed that it has slightly come down during immersion phase as compared to pre-immersion and post-immersion phase. The lowest value of DO has been observed in Rajgunje ghat due all three phases indicating one of the polluted ghats in terms of organic matter among all the four ghats. On the other hand, lowest DO value was observed in Andul pond between the two ponds. Even in case of the two ponds the DO level has also come down during the post-immersion phase indicating possible influx of organic matter into the ponds.

But there has been slight change in the pH value in the pond water both in pre-immersion and post-immersion phases.

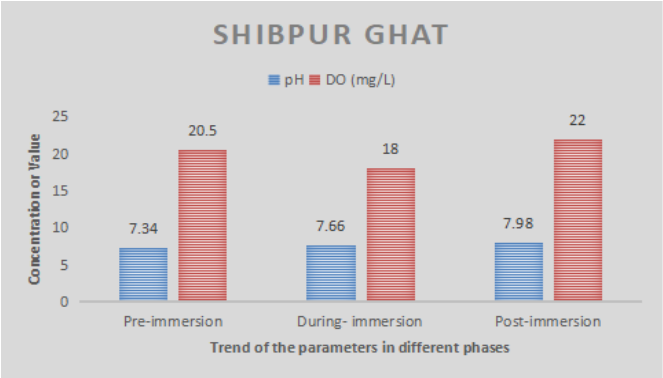

Fig.13.(Diagrammatic representation of DO and pH values at Shibpur ghat)

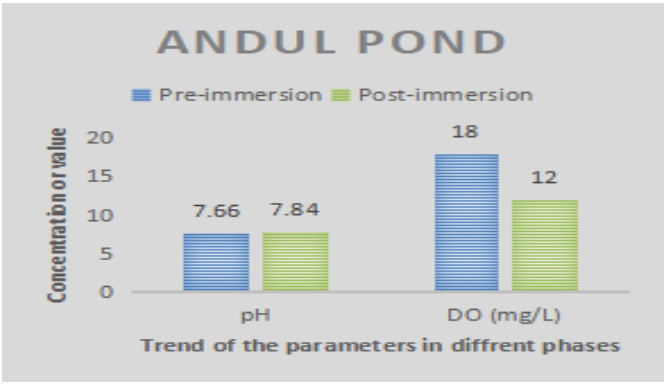

Fig.14.(Diagrammatic representation of DO and pH values at Andul pond)

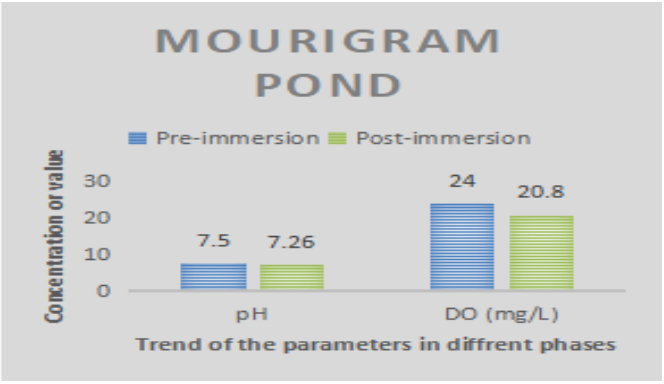

Fig.15.(Diagrammatic representation of DO and pH values at Mourigram pond)

Of the two ponds, lower DO value was observed in Andul pond. The DO level has also come down during the post-immersion phase indicating possible influx of organic matter into the ponds. But there has been slight change in the pH value in the pond water both in pre-immersion and post-immersion phases.

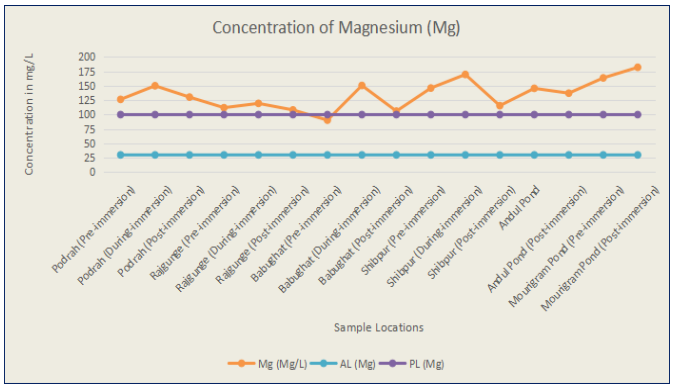

Fig16. (Diagrammatic representation of concentration of Magnesium)

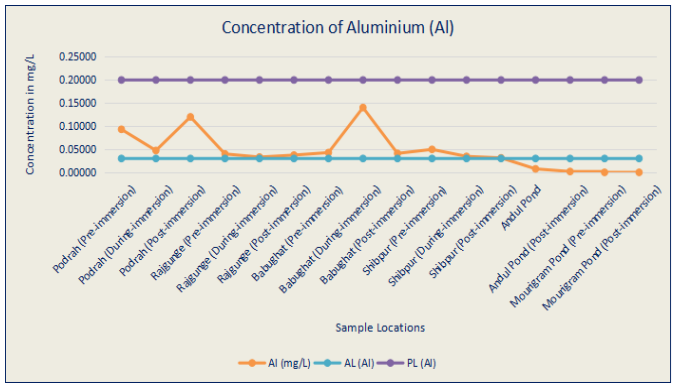

Fig17. (Diagrammatic representation of concentration of Aluminum)

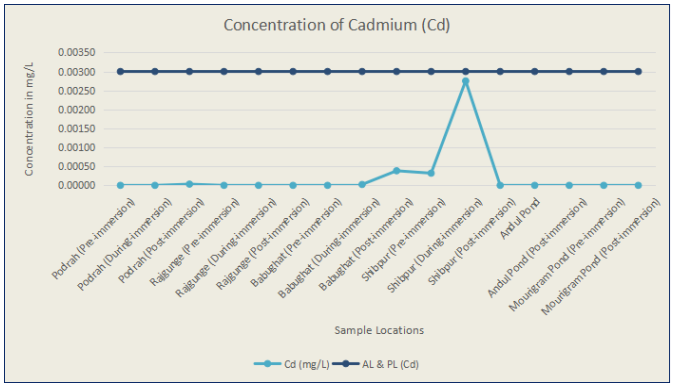

Fig18. (Diagrammatic representation of concentration of Cadmium)

*N.B. AL: Acceptable Limit PL: Permissible Limit

Among the cations, concentration of Sodium, Potassium and Calcium were within the acceptable limit but concentration of Magnesium was beyond limit both against Acceptable limit (BIS standard 30 mg/L) as well as Permissible limit (BIS standard 100 mg/L). The highest concentration was shown by Shibpur ghat (169.7 mg/L) during immersion phase and between the two ponds, Mourigram pond showed highest concentration (182.1 mg/L) in the post-immersion phase. AL denotes Acceptable Limit and PL denote

Permissible Limit in the figures. Among the other cations, all were within the limit except Aluminium, which was within Permissible limit but beyond Acceptable limit for all the immersion ghats. But in case of the ponds, concentration of aluminium was within the limits.

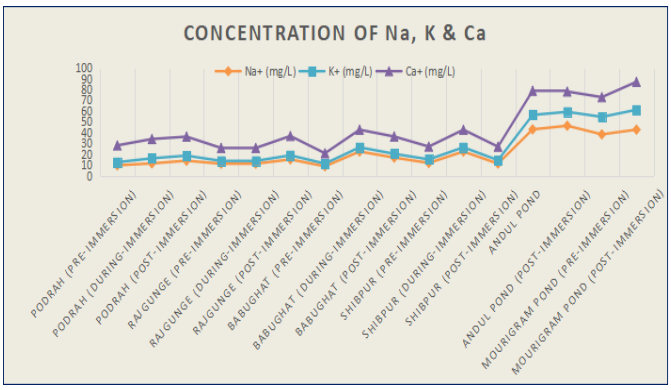

Fig19. (Diagrammatic representation of concentration of Na, K & Ca)

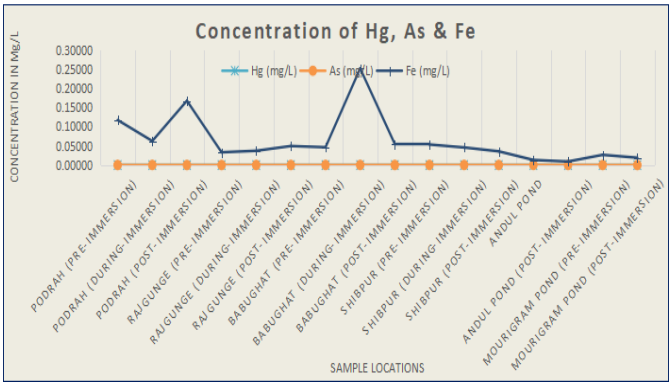

Fig20. (Diagrammatic representation of concentration of Hg, As & Fe)

The concentration of all the heavy metals Hg, Pb, Cd, As were in prescribed limit but only in case of Shibpur ghat the concentration of Cadmium was almost near the Permissible limit **0.00275** mg/L (0.003 mg/L as per BIS standard).

4.2 Discussions

After analyzing the physicochemical parameters of the water samples, we can come to a conclusion that immersion activities have increased the concentration of the pollutants in the waterbodies (both river and ponds). Most of the water quality parameters were within the prescribed limit as per BIS (IS 10500:2012) except for concentration of Aluminum and Magnesium.

In majority of the cases it was observed the water quality deteriorated during the immersion phase. The major contaminants behind the deterioration of the water could be organic pollutants like flowers, garlands, rice, fruits and other puja offerings which are directly dumped into the water and as a result of it DO value has marginally come down during-immersion in case of the river water and post-immersion phase in case of pond water. The water quality of these waterbodies and need to be controlled to some extent, otherwise in near future it would become one of the major water-pollution contributing factor.

Paints contain chemicals, binders, thinner and other synthetic components which are non- biodegradable and pollutes the water. Moreover, the plastic items, thermocol, synthetic textiles and other decorative items immersed with the idol are responsible for the water quality degradation. All these items affect the aquatic organisms as well as the entire aquatic ecosystem as a whole, disrupting their normal activities. Like, slight change in pH value or any other chemical parameter like DO could result in the reduction in the population of an aquatic species or even complete extinction.

Aluminium concentration, which has found to be beyond acceptable limit, can cause neurological disorders, bone problems, kidney dysfunction. It can cause anaemia and lung problem and associated respiratory problems. Again, Magnesium whose concentration is also above permissible limit can cause diarrhoea, nausea, cardiovascular problems and a complex disease called hypermagnesemia.

Idols made of clay or muds are easily soluble in the water but the ones made from POP or won't disintegrate easily creating pollution. Major source of heavy metals are the puja items like vermilion (Hg) or sin door, paints (Pb, Cd, Zn) which unless controlled, the concentration might go on increasing over the years.

Among the four immersion ghats Babughat of Kolkata shows lower concentration of the pollutants which could possibly due to the strict control of the immersion processes by the Kolkata Police, Kolkata Municipal Corporation (KMC) officials and workers and all other local authorities. Once the idols are immersed the KMC cranes and earthmovers installed there were picking up the frameworks within 2-3 minutes on immersion. Finally, the frameworks of the idols were been loaded into the trucks and been shifted and dumped into the Corporation's dumping sites and landfill sites. Even no kind of decorative items, flowers and garlands were also been allowed to be dumped in the river. On the other hand, this type of strict vigilance was absent in the other three ghats of Howrah, where it should be implemented.

Another important observation was as we go downstream through the River Ganga i.e. from Babughat (upper stream) to Rajgunje ghat (downstream), we noticed that the two upper stream ghats (Babughat and Shibpur) had slightly better water quality compared to the other two downstream ghats (Podrah and Rajgunje). The possible reason could be the increase in concentration of the contaminants in downstream region. Thus, in the downstream ghats more

monitoring should be done by the local authorities of the government.

In case of the two ponds, the Andul pond exhibited better water quality compared to Mourigram pond. Almost 20-25 idols are immersed in these two ponds but although the frameworks are removed after immersion from the Andul pond, but frameworks in Mourigram pond remain there for several days. Thus, local authorities must monitor and be more responsible in the entire Howrah district region.

Fig. 21. (A Durga idol in making) **Fig. 22.** (Removal of the frameworks in Babughat immersion ghat post immersion)

5. CONCLUSIONS

- In earlier times, idols were mostly made from bio-degradable products only like mud or clay and decorated with paper and cloth instead of present day's POP (Plaster of Paris) and synthetic ingredients. Even synthetic colures should be replaced with natural colures or eco-friendly colures.
- The heights of idols could preferably be restricted or reduced and all artificial decorations are to be removed before the immersion process.
- Local authorities, Municipal Corporations should control and monitor the immersion processes and keep a strict vigil that no organic waste, flowers and food items non-biodegradable items are dumped in the waterbodies.
- The idols should be immersed at then pulled up as soon as possible just to maintain the religious customs and traditions.
- Government authorities should look for alternative places or select inland waterbodies for the immersion activities. Even they can construct special artificial tanks where entire immersion can be done.
- Lakes, community ponds tried need to be avoided for immersion activities as in certain places this water are used for drinking purpose as well beside bathing and washing. Even in some places these water bodies are used for pisciculture and in that cases the fishes might get contaminated with heavy metals and other pollutants.
- Moreover, common people should be made more aware through public campaigns about the ill-effects of water pollution and the health risks related with this.

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