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ASSESSING THE EFFICACY OF IDOL'S IMMERSION WATER POOL, A CASE OF BARHARWA GHAT, PATNA, INDIA

BIJAY KUMAR DAS[1], REENA SINGH[2], RAVISH KUMAR[3] AND ANJALI PATHAK[4]

[1]*Department of Architecture, National Institute of Technology Patna, India*
[2] *Department of Civil Engineering, National Institute of Technology, Patna, India*
[3]*Department of Architecture, National Institute of Technology Patna, India*
[4]*Department of Architecture, Birla Institute of Technology, Mesra, Ranchi, India*

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ABSTRACT

River Ganga is a lifeline to entire Indo-Gangetic Plain in India that flows through four states, emerging from the Himalayas and ultimately flows into Bay of Bengal covering a stretch of 2,525 km through four states. It is not only a perennial source of water but the river is imbibed in the socio-cultural fabric of India. There are many festivals and rituals in which idols are worshipped and later immersed into rivers like. These idols are mostly cast in clays but a few made of plaster of Paris. The application of synthetic paints and decoration is given to symbolize God or Goddess. The contact of synthetic paints with water contaminates and deteriorates the quality of water in all cases. Hence to facilitate devotees and simultaneously maintaining river water life, temporary immersion pond is constructed in the proximity of the river. This paper examines the water quality of temporary water pool created near river Ganga as part of River Front Development Project, after immersion and compared with water quality at the bank and also the mid-stream of Ganga.

KEY WORDS : Ganga water quality, Idol Immersion, Riverfront Development.

INTRODUCTION

The Ganga river originates from glaciers of *Gaumukh*, Garhwal of Himalayas (30° 552 N, 79° 72 E) well known as *Bhagirathi*, at an altitude of 4100 m above Mean Sea Level. The river follows a winding course through four different Indian states; Uttarakhand, Uttar Pradesh, Bihar and West Bengal. It divides into two branches as *Hoogly* in India and *Padma* in Bangladesh. Ganga Basin is some of the most fertile regions of the world. It is the home to endangered aquatic species Gangetic Dolphin, which is a national aquatic animal of India. The river basin comprises around one-fourth of the total geographical area of India, i.e. 26 per cent. The Ganga River has many tributaries, like *Kali, Ramganga, Yamuna, Gomti, Ghaghra, Gandak and Kosi* which are originating from the Himalayas. Similarly, the main plateau river tributaries are *Tons, Son, Punpun, Damodar and Kangsbasti*. These tributaries of River Ganga form the other perennial in India. The stretch of 2,525 km of river Ganga is a lifeline for habitation situated along with it. Rivers are imbibed deeply in the cultural roots of every Indian. The religious connections of Hindu festivals like a holy dip on full moon days, eclipse, *Makarshakranti*, *Chaath*, etc signifies the inter-relationship of people and rivers in India. There are many other festivals and rituals in which idols are worshipped and later immersed into rivers like *Saraswati Puja, Ganesh Chaturthi*, etc.

In the year 2014, Government of India initiated Namami Ganga, a flagship program with an objective of abatement of pollution, conservation and rejuvenation of river Ganga. A budgetary outlay of Rs 20,000 Crore was sanctioned for the project. Main features of Namami Ganga Project are (for the entire stretch) Sewage Treatment Infrastructure-63 SMP (Sewage Management Project); River Front Development- 28 RFD (River Front Development

Project) 182 Ghats, 118 Crematoria; River Surface Cleaning- 11 Locations; Bio-Diversity- 5 Biodiversity Centres; Afforestation- Budgetary provision of 2300 Crores; Industrial Effluent Monitoring- 1072 GPI (Gross by Polluting Industries) Identified Ganga Gram- 1674 Gram Panchayat at the bank of river Ganga. Its implementation is divided into three level activities. Seven Indian Institute of Technology are preparing the Ganga River Plan. The activities divided into three parts as entry-level activities (immediate visible impact), medium ten (5 Years) activities, long term (10 Years) activities. Besides NMCG (National Mission for Clean Ganga) deploys the best knowledge and resume for Ganga rejuvenation. Under Namami Ganga program, recently all ghats of Patna along river Ganga were developed in three phases. The first phase of the project is implemented between *Collectorate Ghat* and *Rani Ghat*. The second phase which is under approval is chalked out between *Naujar Ghat & Deedargunj*. Lastly, the third phase PMC (Patna Municipal corporation) will develop in six Km stretch from *Digha Ghat* to *Collectorate Ghat*, as a recreational area and walkable space under Phase III of Riverfront Development, Patna Project.

The practice of idol immersion in rivers is divine rituals in Hindu mythology. These idols are made of clay, plaster of Paris, hay, adhesive material reinforced with wood and bamboos. Clothes, jewellery adorn the idol and *Sindur* is applied over the forehead and along with hair partition on the head (Bajpai *et al.*, 2009). The paints applied on idols contain heavy metals like Mercury, Cadmium, Arsenic, Zinc, Chromium and Lead, which are carcinogens in nature. Heavy metals are the naturally occurring elements and have a high density of more than 5g/cm^3, an atomic number greater than 20 and its atomic weight is five times greater than water (Jarup, 2003). Adding to this, paints are a mixture of heavy metal compounds which are known as pigment. Pigments are mixed with binders which provide additional grip to paint on the surface. Likewise, fillers provide bulkiness to paint and help to create texture. Solvents are added to ensure consistency to cement. There are much other variety of additives which are required in paint formation.

In the action of immersion idols into the water, materials released through idols cause eutrophication and propel the heavy metal concentration rendering the river acidic. A study conducted during idol immersion in Ganga at *Chandernagore* in West Bengal revealed a significant increase in chloride and alkalinity and drop in total hardness and transparency (Sarkar, 2013). A study conducted at *Babughat*, Kolkata during August 2010 to Jan 2011 shows a significant variation in TDS (Total Dissolved Solids) in sample collected pre immersion and post immersion. It was inferred that DO (Dissolved Oxygen) is the most important factor to control (Sahu *et al.*, 2013). Research conducted in 2015 for Gomti River at Lucknow during Oct-Nov after idol immersion of Goddess *Durga* idol showed a significant increase in most of the water quality parameter (Tiwari and a Kisku, 2016). The paint applied on idols contains heavy metals such as Mercury, Cadmium, Arsenic, Zinc, Chromiumand Lead. The applications of *Sindur*, a traditional coloured material applied by married women on the head which symbolize their living husband, add Lead and Chromium in the water. The intake of these elements is quite toxic even in small quantity for a human being.

Several positive correlations were observed between the measured level of heavy metals in water bodies and heavy metal accumulation in aquatic organisms. There are chances when these harmful heavy metals enter the human body through the food chain. Immersed in degradable materials contaminate the water and bio-accumulate the heavy metals in biological systems, thereby transferring toxic elements from primary producer to consumer. This ultimately affects human health. Levels of lead and cadmium were recorded in fish muscles from the lake of Nagpur, from a study conducted on the lakes (Giripunje *et al.*, 2014)

Cadmium causes damage to the kidney and other organis. Studies in Europe have shown signs of cadmium-induced kidney damage in the population at urinary cadmium levels around 2–3 μg Cd/g creatinine (Buchet *et al.*, 1990). Studies were done for the *Shahpura* lakes of Bhopal, India shows an increased level of cadmium in the month of September and October, after the idol immersion (Dixit and Tiwari, 2008).

Historically, Mercury compound cinnabar (HgS) was used in ancient cave painting for red pigment (Egel and Simon, 2013). White lead was used in Greece for lighting the skin. The general population is exposed to mercury through fish which is a major source of methyl mercury exposure. Prolonged mercury exposure is dangerous for lungs. The infamous Minamata catastrophe in Japan in the 1950s was caused by methyl mercury poisoning from fish contaminated by mercury discharges to the surrounding sea. Coronary heart disease is another risk arises from mercury level in the body. Headache, irritability, abdominal pain and various symptoms related to the nervous system are the manifestations of acute lead poisoning. Long term low-level exposure of lead leads to reduced intellectual level in children (Assi *et al.,* 2016). Lead toxicity severely affects the Nervous System in child and adult. Exposure to lead may be through fruits and vegetables growing in lead-laden soil or water for irrigation (WANI, Ara and Usmani, 2015). It is also propagated through vehicular pollution which has lead in the form of tetraethyl lead. It is widely used in lead-acid paints. In several significant studies, it has been established that lead in the water of lakes and rivers were from idol immersion.

In another study conducted on urban lakes of Bhopal iterate the increased concentration of calcium, magnesium, cadmium, chromium manganese, lead, arsenic and mercury after the idol immersion (Bajpai *et al.,* 2009). In an earlier study conducted it was seen that, after shifting the site of immersion, the relative improvement was observed in the water quality (Vyas *et al.*, 2008)

MATERIALS AND METHODS

Study Area

This study was conducted at designated sampling points at *Barharwa Ghat*, Patna. Three sampling sites were identified as shown in Figure 1. Site S1 is the sample at the bank of river Ganga, site S2 is the sample in the middle of river Ganga and site S3 is the water sample of the immersion tank. The geographical setting and description of sampling sites are shown in Table 1. For the study, three different samples have been collected on the same day (4/2/2020).

Sampling Period

The samples were taken on 4 Feb 2020 at 11.30 AM. Idol immersion in the pool was over. A few idols were immersed in Ganga too.

Sampling Collection and Preservation

Three samples were collected**. S1** was taken from the bank of the river, **S2** was collected from the mid-stream of Ganga and **S3** was from the immersion pool.

All water quality parameters were determined as per APHA(1995).

RESULTS AND DISCUSSION

The temperature of the water sample collected from Ganga is the same (16 °C), while that of the immersion pool is 19 °C. This might be because of the static nature of water in the immersion pool. Turbidity level is low at midstream (8 NTU) while at the bank it is (11 NTU). The immersion pool records 14 NTU showing the impurities because of idol immersion. Apart from clay ashes of burnt puja

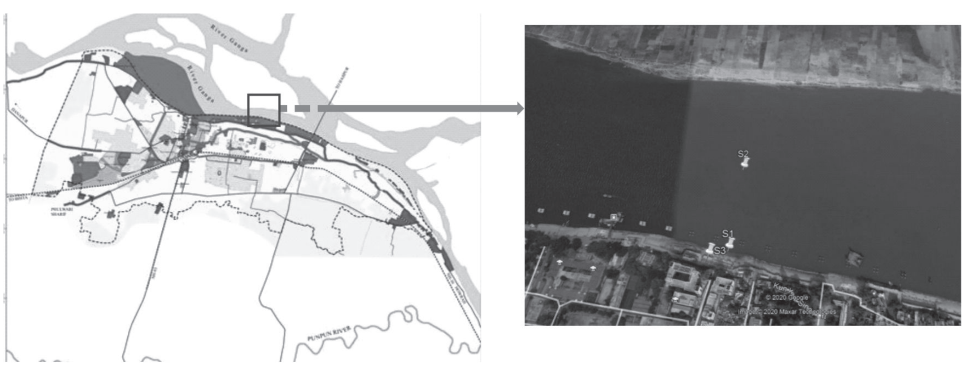

Fig. 1. Map of Patna on River Ganga representing sampling sites.

Table 1. Description of sampling sites.

Site code	Site name	Location
S1	water sample on the bank of River Ganga	25°37217.403 N Latitude and 85°10229.123 E Longitude
S2	water sample in the middle of River Ganga	25°37223.263 N Latitude and 85°10229.793 E Longitude
S3	water sample of the immersion tank	25°37217.203 N Latitude and 85°10227.853 E Longitude

material is also immersed thereby making the water more turbid. pH value shows the basic nature of water in mid-stream (pH=8), while at the bank it is almost neutral (pH= 7.15). Immersion pool is slightly acidic (pH= 6.03). Total hardness (as $CaCO_3$) of sample close to the pool is more (278 mg/L) as compared to mid-stream (260 mg/L). At the immersion pool, total hardness is 476 mg/l. Amount of chlorides is maximum at immersion pool (56 mg/l) while at mid-stream it is minimum (30 mg/l), and at the bank, it is 48 mg/l, which is much lower than the desirable limit of 250 mg/l as prescribed by WHO standards for drinking water. Total Dissolved Solids (TDS) is 511 mg/l at mid-stream, which is close to the prescribed limit of 500 mg/l for drinking water, while it is 556 mg/L on the bank and at the immersion pond, it is 798 mg/l. The relatively higher amount of Sulphate is seen in the immersion pool water. Nitrate and total alkalinity are within the permissible limit in all the three samples. Oxygen absorbed from $KMnO_4$ at 37 °C in 3 hrs is high in all the three samples with a range from 3.4 mg/l at the river bank sample, 3.1 mg/l of the mid-stream site and 2.6 mg/l at the immersion pool. Dissolved

Table 1. Average value of physio-chemical parameters of Ganga River at Barharwa Ghat, Patna for the sample taken on 4 Feb 2020 at 11.30 AM. HDL: Highest Desirable limit; MPL: Maximum Permissible limit

No	Parameters	Units	Drinking-Water WHO standards		Experimental Values (Range)		
			HDL	MPL	S1	S2	S3
1	Temperature	°C	-	-	16	16	19
2	Turbidity	NTU	5	10	11	8	14
3	pH value	-	6.5-8.5	No relaxation	7.15	8.00	6.03
4	Total hardness (as CaC mg/l	300	600	278	236	476	
5	Chlorides	mg/L	250	1000	48	30	56
6	Dissolved solids	mg/L	500	2000	556	511	798
7	Sulphate ·	mg/L	200	400	64.8	39.2	189.3
8	Nitrate	mg/L	50	No relaxation	0.705	1	0.24
9	Total Alkalinity	mg/L	200	600	304	224	376
10	Oxygen absorbed from KMn at 37°C in 3 hrs	mg/L	3.0	No relaxation	3.4	3.1	2.6
11	DO	mg/L			7.8	8.7	3

S1 = water sample on the bank of River Ganga
S2 = water sample in the middle of River Ganga
S3 = water sample of the idol immersion pool

Table 2. Summary statistics (Quantitative data)

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
pH	3	0	3	6.050	8.000	7.067	0.978
Temp (°C)	3	0	3	16.000	19.000	17.000	1.732
TDS (mg/l)	3	0	3	511.000	798.000	621.667	154.358
Cond. (µS/cm)	3	0	3	1019.000	1591.000	1240.000	307.361
Alkalinity	3	0	3	224.000	376.000	301.333	76.035
Chloride (mg/l)	3	0	3	30.000	56.000	44.667	13.317
Turbidity (NTU)	3	0	3	8.000	14.000	11.000	3.000
Hardness (mg/l)	3	0	3	236.000	476.000	330.000	128.172
Calcium Hard mg/l)	3	0	3	144.000	320.000	222.667	89.473
Mag. Hardness (mg/l)	3	0	3	74.000	156.000	107.333	43.097
Sulphate (mg/l)	3	0	3	39.200	189.300	97.767	80.297
Nitrate (mg/l)	3	0	3	0.240	1.000	0.648	0.383
DO (mg/l)	3	0	3	3.000	8.700	6.500	3.064
BOD (mg/l)	3	0	3	2.600	3.400	3.033	0.404

Table 3. Correlation matrix (Pearson)

Variables	pH	Temp	TDS	Cond.	Alkalinity	Chloride	Turbidity	Hardness	Calcium Hardness	Magnesium Hardness	Sulphate	Nitrate	DO	BOD
pH	**1**													
Temp	-0.901	**1**												
TDS	-0.954	0.989	**1**											
Conductivity	-0.955	0.989	**1.000**	**1**										
Alkalinity	-0.995	0.850	0.918	0.919	**1**									
Chloride	-0.958	0.737	0.828	0.829	0.982	**1**								
Turbidity	**-0.997**	0.866	0.930	0.931	**1.000**	0.976	**1**							
Hardness	-0.960	0.986	**1.000**	**1.000**	0.925	0.838	0.936	**1**						
Calcium Hardeness	-0.994	0.942	0.981	0.981	0.978	0.921	0.984	0.984	**1**					
Magnesium Hardness	-0.790	0.978	0.937	0.936	0.722	0.580	0.743	0.931	0.851	**1**				
Sulphate	-0.958	0.987	**1.000**	**1.000**	0.923	0.835	0.935	**1.000**	0.984	0.932	**1**			
Nitrate	**0.999**	-0.923	-0.969	-0.970	-0.987	-0.940	-0.992	-0.974	-0.999	-0.822	-0.972	**1**		
DO	0.955	-0.989	-1.000	-1.000	-0.918	-0.828	-0.930	-1.000	-0.981	-0.937	-1.000	0.969	**1**	
BOD	0.675	-0.929	-0.865	-0.863	-0.594	-0.434	-0.619	-0.855	-0.750	-0.986	-0.858	0.714	0.864	**1**

Oxygen (DO) is very less at the immersion pool with low as 3 mg/l as compared to 7.8mg/l at the bank and 8.7 mg/l at the mid-stream.

In Table 3, positive correlations are shown in red while negative correlations are shown in green. As per result pH has a negative correlation with most of the parameters except Nitrate and DO.

CONCLUSION

The ill-effects of paint and sindooris minimised with the construction of a temporary pool, otherwise, the idol immersed would have contaminated the water with heavy metals. It would have ultimately entered the food chain through bio-accumulation and bio-magnification posing a serious health hazard to the human population. This temporary pool should be created at all the ghats to facilitate the idol immersion.

According to the Central Pollution Control Board, India, 2010 general guideline, prescriptive in nature, for idol immersion is mentioned below. (CPCB, 2010)

- Idols should be made from natural materials as described in the holy scripts. Use of traditional clay for idol making must be encouraged and allowed rather than baked clay, plaster of Paris, etc.
- Painting of idols should be discouraged. In case idols are to be painted, water-soluble and non-toxic natural dyes should be used. Use of toxic and non-biodegradable chemical dyes for painting idols should be strictly prohibited.
- Worship material like flowers, *vastras* (clothes), decorating material (made of paper and plastic) etc. should be removed before immersion of idols. Biodegradable materials should be collected separately for recycling or composting. Non-biodegradable materials should be collected separately for disposal in sanitary landfills. Clothes may be sent to a local orphan house(s).
- The public should be educated on the ill-effects of immersion in the holy water bodies through mass awareness programme.
- The 'Idol Immersion Points' shall be cordoned and barricaded. The synthetic liner may be placed in the bottom, well in advance. The said liner shall be removed on completion of immersion ceremony so that remains of idols would be brought to the bank. Bamboo and wooden logs, if any would be reused. Clay etc. may be taken to a sanitary landfill for disposal.

The guidelines prescribed by Central Pollution Control Board (India) CPCB,and initiative taken by Namami Ganga Project by creating an idol immersion pool will reduce heavy metal concentration in the water body. It will keep the other parameters within the safe limits thereby maintaining a clean and natural habitat for flora and fauna.

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