



Water quality of the River Ganga in and around the city of Kolkata during and after Goddess Durga immersion

Sufia Zaman^{1§}, Ricardo Gobato^{2Π}, Prosenjit Pramanick^{1◊}, Pavel Biswas^{1§}, Uddalok Chatterjee^{3♀}, Shampa Mitra^{1†} and Abhijit Mitra^{4✧}

¹Department of Oceanography, Techno India University, West Bengal, Salt Lake, Sector V, Kolkata 700091, India.

²Laboratory of Biophysics and Molecular Modeling Genesis, State Secretariat for Education of Parana, St. Rocha Pombo, 953, Bela Vista do Paraíso, 86130-000, Parana, Brazil.

³International Management Institute Kolkata (IMI-K), 2/4C, Judges Court Road, Alipore Kolkata 700027, India.

⁴Department of Marine Science, University of Calcutta, 35 B. C. Road, Kolkata 700019, India.

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Abstract

India, preferably the state of West Bengal is known for a number of religious festivals of which Durga Puja is perhaps the biggest. The tenth day of the Durga Puja, also known as Dashami is the day when Visarjan (immersion in water) of the idols occur with grand celebrations and processions. The idols are immersed from different ghats of the river. Along with the idols, puja articles such as flowers, food offerings, metal polish, plastic sheets, cosmetic items, polythene bags are also thrown into the water. The River Ganga, a sacred river originating from Gangotri in the Himalayas is the life-line of the city of Kolkata and hence any change in the water quality of the river is an issue of concern. The present paper is an attempt to assess the quality of the river before and after immersion of the idols during the Durga Puja festival of 2018. The increase and significant variations of dissolved heavy metals between pre- and post- immersion periods has been confirmed through ANOVA ($p < 0.01$). The variations in water quality (in terms of selective heavy metals) may be attributed to the immersion of idols, which are usually made up of Plaster of Paris (gypsum, sulphur, phosphorous and magnesium) and mostly painted with harmful synthetic dyes (contains mercury, chromium, cadmium and lead), which add heavy metals in the water body. Use of natural dyes sourced from flowers, leaves, seeds, bark, wood and roots of plants may reduce this hazard to a great extent.

Keywords: Durga Puja Festival, River Ganga, Pre- and post- immersion periods, Dissolved heavy metals.

§ Email: zamansufia123@gmail.com

Π Email: ricardogobato@seed.pr.gov.br

◊ Email: ppramanick660@gmail.com

§ Email: babanpavel@gmail.com

♀ Email: uddalokke@gmail.com

† Email: mitrashampa6819@gmail.com

✧ Email: abhijit_mitra@hotmail.com



1. Introduction

Durga Puja is one of the most famous festivals celebrated in West Bengal and particularly in Kolkata, for worshipping Goddess Durga during the period of Navaratri. It is celebrated for 10 days. However starting from the sixth day until the ninth day, the Pandals (Structures where the Goddesses are kept) with grand idols of Goddess Durga, are open for the visitors. The tenth day, also known as Dashami marks the Visarjan (immersion in water) of the idol with grand celebrations and processions. This year, Durga Puja 2018 started on October 15 and continued till October 19. However, Durga Puja 2018 celebrations in Kolkata started early, with Durga Mahalaya on October 9 and Visarjan on October 19. [1]

According to the Hindu Mythology, Goddess Durga emerged from the collective energy of all Gods/Goddesses as an embodiment of *Shakti* or divine feminine power, to destroy demon *Mahishasura*; who was blessed with the power of not getting defeated by any man or God, Figure (1). [1] This powerful form of Goddess Durga is highly revered in the Indian sub-continent and her return for destroying the evil forces is celebrated with much grandeur and ceremonies.

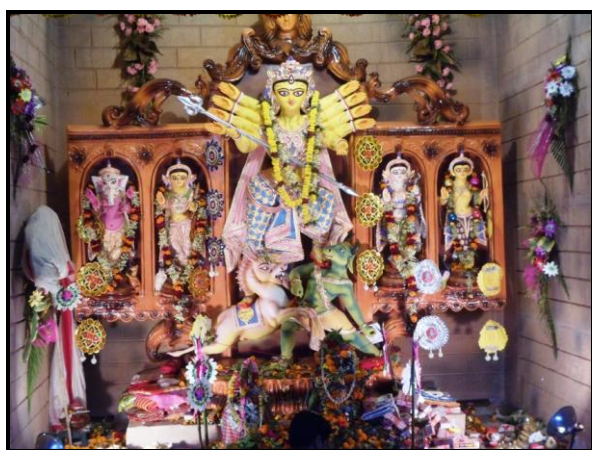


Figure 1: Goddess Durga with 10 arms (Dashabhuja). (Source: Mitra and Ray Chaudhuri, 2017) [1].

The 10th day of the Durga Puja festival is called Dashami; it is believed that on this day, Goddess Durga gained victory over the Demon and thus restored the balance on the Earth. It is also known as Vijayadashami. On this day,

Goddess Durga is worshipped and offered many things as she is prepared to leave. Highly enthusiastic devotees gather in large numbers to join the procession that carries the Goddess to the ghats (the banks of the River Ganga with bathing facilities and where several religious rituals are performed) to be immersed in water. Women, especially married woman initiate the procession by first applying red sindoor or vermilion powder on the Goddess and then to each other. In 2018, the date of immersion was 20th October. [1]

In this study we made a comparative assessment of the water quality, considering three toxic heavy metals lead, chromium and cadmium leached from idols in six major banks along the stretch of the River Ganga flowing through the mega city of Kolkata during 10th October 2018 (pre-puja/festival period) and 22nd October (post-puja/festival period). [1]

2. Materials and Methods

2.1 Site selection

Six ghats were selected for the study, which are basically the zones for immersion. Coordinates of all the study sites in the River Ganga are highlighted in Table (1).

2.2 Analysis of selective heavy metals

Surface water samples were collected from all the six ghats during high tide using 10-l Teflon-lined Go-Flo bottles, fitted with Teflon taps and deployed on a rosette or on Kevlar line, with additional surface sampling carried out by hand. Shortly after collection, samples were filtered through Nuclepore filters (0.4 μ m pore diameter) and aliquots of the filters were acidified with sub-boiling distilled nitric acid to a pH of about 2 and stored in cleaned low-density polyethylene bottles. Dissolved heavy metals were separated and pre-concentrated from the collected water using dithiocarbamate complexation and subsequent extraction into Freon TF, followed by back extraction into HNO₃ [2]. Extracts were analysed for Pb, Cr and Cd by Atomic Absorption Spectrophotometer (Perkin Elmer: Model 3030).



Table 1: Coordinates of all the selected sites/ghats along the River Ganga.

	
<p>Ramkrishna Ghat, 22°34'19.8" N 88°20'17.0"E.</p>	<p>Botanical Garden, 22°33'06.4" N 88°18'06.6"E.</p>
	
<p>Shibpur Ghat, 22°33'41.2" N 88°19'40.4"E.</p>	<p>Babughat, 22°34'10.3" N 88°20'28.5"E.</p>
	
<p>Princep Ghat, 22°33'30.9" N 88°19'52.5"E.</p>	<p>2nd Hooghly Bridge, 22°33'31.4" N 88°19'38.5"E.</p>



3. Results

The levels of dissolved Pb, Cr and Cd during the pre-immersion and post-immersion phases in the selected sites of the River Ganga are presented in Figures (2) – (4). The order of dissolved metals in the study area is $Pb > Cr > Cd$ irrespective of time periods and sites.

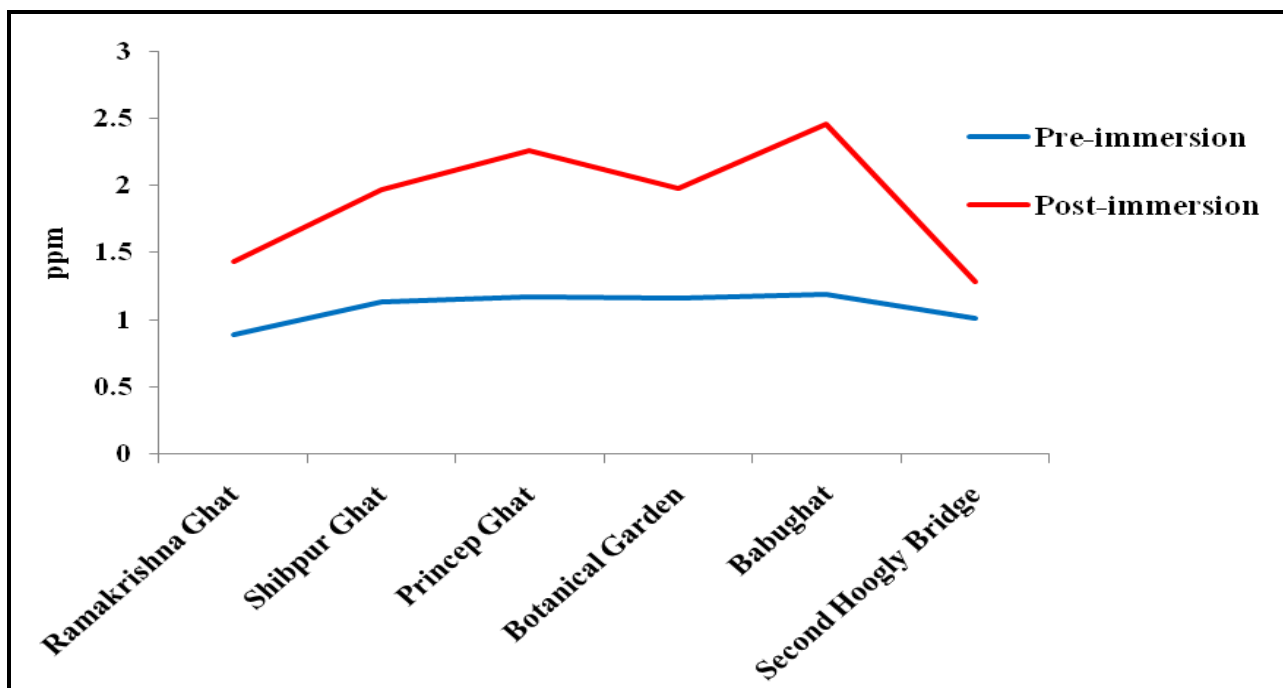


Figure 2: Dissolved Pb concentrations in (ppm) during pre-immersion and post- immersion phases.

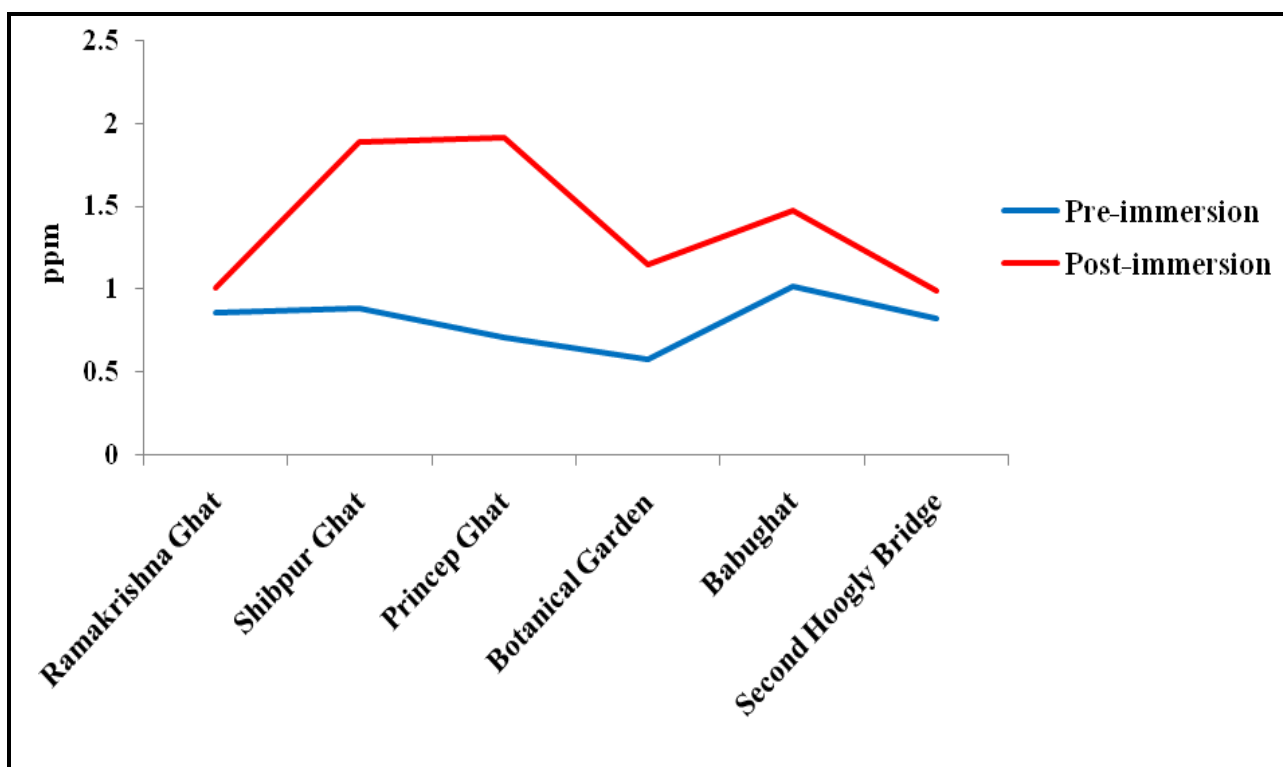


Figure 3: Dissolved Cr concentrations in (ppm) during pre-immersion and post- immersion phases.

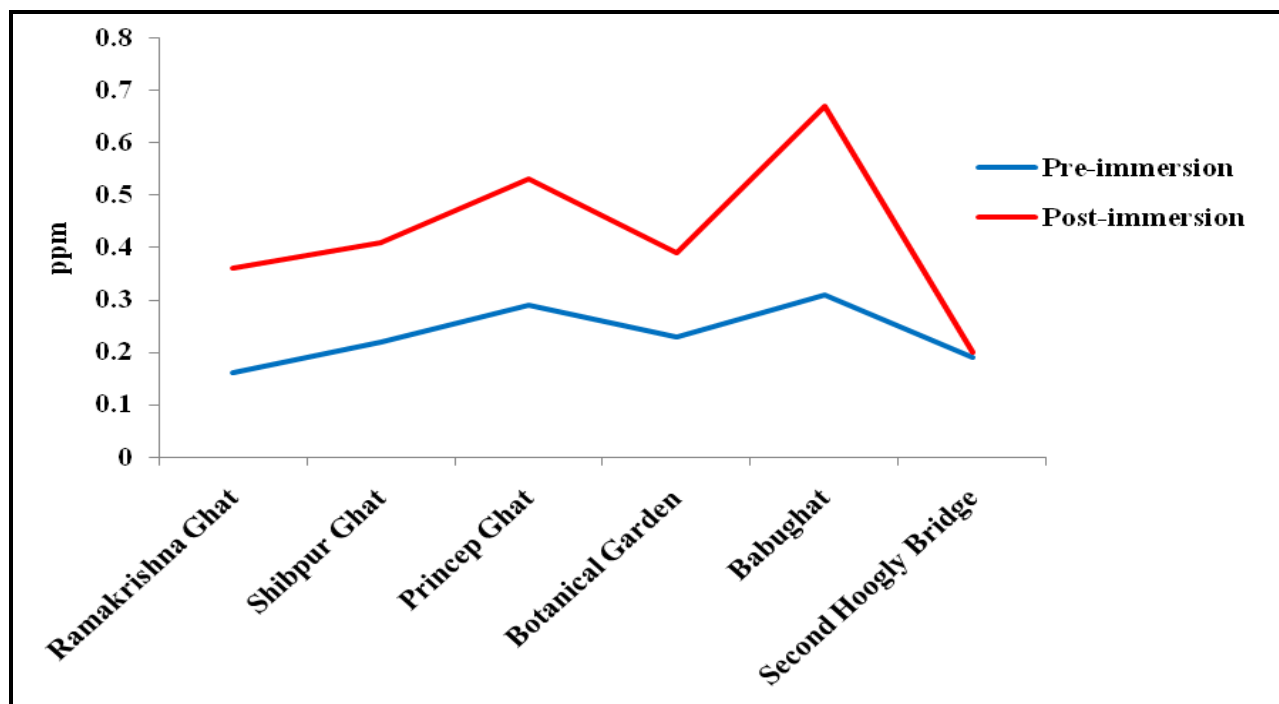


Figure 4: Dissolved Cd concentrations in (ppm) during pre-immersion and post- immersion phases.

4. Discussion

It is clear from the data sets that there has been considerable increase in the levels of dissolved heavy metals after the process of immersion of idols. For Ramakrishna Ghat, the levels of increase of Pb, Cr and Cd are 61%, 17% and 125% respectively. For Shibpur Ghat, the levels of increase of Pb, Cr and Cd are 74%, 111% and 86% respectively. For Princep Ghat, the levels of increase of Pb, Cr and Cd are 93%, 169% and 83% respectively. For Botanical Garden, the levels of increase of Pb, Cr and Cd are 71%, 98% and 70% respectively. For Babughat, the levels of increase of Pb, Cr and Cd are 107%, 44% and 116% respectively and for 2nd Hooghly Bridge the levels of increase of Pb, Cr and Cd are 27%, 19%

and 5% respectively. The left over straws and skeletons of the idols are shown in Figure (5).

Lead, a heavy metal that is used in batteries, paints and the oxide is employed in the production of crystal glass. A higher level of lead results in cognitive impairment in children to peripheral neuropathy in adults.

Intake of chromium in large amounts has severe detrimental health effects like renal, hepatic and gastro-intestinal damage [3-11].

Cadmium when consumed along with food and water for a longer period of time results in the bioaccumulation in the kidney and liver causing severe damage to these systems [12, 13].

Table 2: ANOVA for Pb in 6 sample sites during pre-immersion and post-immersion

Source of Variation	SS	df	MS	F	P-value	Fcrit
Between Stations	0.801342	5	0.160268	2.445538	0.174379	5.050329
Between Periods	1.944075	1	1.944075	29.6646800	0.002834	6.607891
Error	0.327675	5	0.065535	-	-	-
Total	3.073092	11	-	-	-	-

SS = Sum of Squares; df = degree of freedom; MS = Mean Squares; Fobs = F observed value; P = Probability value; Fcrit = F critical value.



Table 3: ANOVA for Cr in 6 sample sites during pre-immersion and post-immersion

Source of Variation	SS	df	MS	F	P-value	Fcrit
Between Stations	0.528967	5	0.105793	1.136911	0.445728	5.050329
Between Periods	1.032533	1	1.032533	11.096150	0.020754	6.607891
Error	0.465267	5	0.093053	-	-	-
Total	2.026767	11	-	-	-	-

SS = Sum of Squares; df = degree of freedom; MS = Mean Squares; Fobs = F observed value; P = Probability value; Fcrit = F critical value.

Table 4: ANOVA for Cd in 6 sample sites during pre-immersion and post-immersion

Source of Variation	SS	df	MS	F	P-value	Fcrit
Between Stations	0.111500	5	0.022300	3.444902	0.100403	5.050329
Between Periods	0.112133	1	0.112133	17.322350	0.008807	6.607891
Error	0.032367	5	0.006473	-	-	-
Total	0.256000	11	-	-	-	-

SS = Sum of Squares; df = degree of freedom; MS = Mean Squares; F_{obs} = F observed value; P = Probability value; F_{crit} = F critical value.



Figure 5: Straws and skeletons of idols (Source: Mitra and Ray Chaudhuri, 2017) [1]

ANOVA carried out with the data showed significant variations between two periods (pre-immersion and post-immersion periods) at $p < 0.05$, but no spatial variation was observed, Tables (2-4). This may be attributed to proximity of the sites and regular tidal actions in the study stretch that has spatially homogenized the dissolved heavy metals. However, concern is there on the point of significant variation in water quality between the pre-immersion and post-immersion phases.

5. Conclusion

In India the practice of idol worship is witnessed since ancient times. It has been a tradition to immerse the idols in water bodies after the festival is over. Consequent pollution of such water bodies has been a matter of concern and there have been public interests and litigations as well. In the present study also Pb, Cr and Cd increased in the water bodies of six ghats along the stretch of the River Ganga. In this context it is recommended to use traditional clay for idol making rather than baked clay.

Use of painted idols with chemicals should be prohibited as far as possible. In case painted idols are used, water soluble and non-toxic natural dyes may be used. Natural colours used in the food colours and permitted in pharmaceuticals may be preferred. Several dyes can be extracted traditionally from the vegetative and reproductive parts of plants. Red dyes can be sourced from madder, brazilwood, beetroot, cranberry, safflower and orchil. Orange dye is obtained from the stigmas of the saffron flower. The flowers chamomile and milkwort are the sources of yellow colour. The green colour can be obtained from ripe buckthorn berries and ragweed. The



blue colour can be sources from woad plant and indigo. It is also recommended that prior to immersion, worship materials like flowers, clothes, decorating materials like paper and plastics should be segregated and collected for recycling or composting.

A revolutionary concept may be a 'food for thought' for the policy makers in the domain of immersion of idols. This idea is based on the concept 'phytoplankton bloom through iron fertilization'. The idols made of iron, can not only be recycled for making several metallic structures, but can also trigger the growth of phytoplankton in the riverine stretch if left for few days. The phytoplankton being the major food for the fishes and a sink of carbon dioxide [14-16] would be an innovative spin-off benefit from this festival. Such concept may seem to be highly challenging, but if implemented with proper planning may be a footprint for improving fish population and ecological stability of the mighty River Ganga.

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