



## ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF POWAI LAKE DURING FESTIVE SEASON IN MUMBAI METROPOLIS

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### **Abstract**

Water is a valuable natural asset and also a fundamental natural resource and is the most essential necessity of life. In India, lot of religious activities take place throughout the year. The immersion of idol during festive seasons is a major source of contamination and sedimentation to the lake water. The Ganesh festival is one of the biggest festivals in Mumbai. The festival also generates a large amount of holy waste (Nirmalya) in the form of flowers, decoration materials, oil and other religious offerings. After the festival the Ganesha idols are immersed at the various beaches and lakes across the Mumbai city. These idols are made up of non-biodegradable materials like plaster of Paris (PoP) and synthetic paints used for making these idols. This can pose a serious threat to water quality and aquatic life and water environment.

To access the water quality, the water samples were collected from Powai Lake points before, during and after the Ganapati visarjan and analyzed for different physico-chemical parameters. The parameters like pH, Temp., DO, COD, Chloride, Sulphate, Phosphate, turbidity etc. were considered to find out the effect of idol immersion activates on quality of water. It has been observed that the values of some parameters were significantly increased during the immersion period and then declined in the post-immersion period.

### **Key Words:**

Water, natural resource, Ganesh festival, idol immersion, water pollution water quality, physico-chemical, contamination, sedimentation

### **Introduction**

Water is strength of the plant and a source of energy for living organism. Human beings depend on water for many purposes, which can be broadly classified as domestic and industrial. Fresh water is required for all these purposes. Water pollution occurs due to the city sewage and industrial waste discharge into the river in addition to many religious activities and now become





a threat to the ecosystem (Bajpai et al., 2008). Festivals are an integral part of rich and diverse cultural heritage of India. In Maharashtra the Ganesh festival is celebrated traditionally in the month of August- September every year. But in Mumbai Ganpati festival is one of the prominent festivals celebrated by all communities irrespective of cast creed and religion with full swing every year.

The Ganesh chaturathi is one of the important festivals of Hindu and during this festival thousands of Ganesh idols of various sizes are immersed every year in different water bodies of the city (Reddy and Kumar, 2001). Ganesh idols are installed in colorfully decorated homes as well as at specially created structures, known as Pandals, in numerous localities. This festival is celebrated for 10 days from Ganesh chaturthi to Anant chaturdashi. Ganesh Chaturthi Festival involves processions which gathers large amount of crowd who bother little about the effects caused due to immersing these idols & dumping garlands & non-biodegradable waste in & near the lake area.

During the immersion articles such as flowers, polythene bags, foam, decorations, metal, polish, plastic sheets are thrown into the water adding to the already caused damage. In present situations the materials used for making idols has led to use of non-biodegradable materials like Plaster of Paris, Plastic, thermacol, synthetic colours etc. which deteriorate the water quality (Singh et al., 2014). Moreover the chemical paints used to paint these idols contain heavy metals which are potentially hazardous and bio-magnify along the food chain. Pollution due to water immersion has many social, religious, scientific and environmental dimensions.

People focus on the economics of livelihoods and money- making activities to the extent that they forgot consideration of the importance of the environment and natural resources. Thus, there is a need to ensure that lake stakeholders are better aware of this linkage. The goals and hopes espoused in the closing sentence in the World Lake Vision report (World Lake Vision Committee, 2003) are as relevant today as they were when the World Lake Vision was developed, and are worthy of reiteration here: –Indeed, if we are able to use lakes in a





sustainable and responsible manner, there is much hope we can meet the needs of the human and natural communities that depend on them for clean freshwater resources, the key to life.

Environmentalists & Scientists are concerned about the water pollution caused due to immersion of Idols during festivals like Ganesh Chaturthi, Durga Puja Celebrations all over India. One look to assess the harmful effects of this practice has proved to be an eye opener to many. Water is the elixir of life referred as nature, polluting it with our activities is the most devastating situation we are creating for ourselves. Festivals like Ganesh Chaturthi & Durga Puja involves processions which gathers large amount of crowd who bother little about the effects caused due to immersing idols & dumping garlands & non biodegradable waste in & near the river banks. During the immersion articles such as flowers, polythene bags, foam, decorations, metal polish, plastic sheets, and cosmetic items are thrown into the water adding to the already caused damage.

Natural sources of water have an inbuilt process to purify water to a certain extent through physical, chemical and biological means. However, these processes cannot handle excess of pollutants which are being discharged into the water bodies. Over population, and related human activities are causing a change in the delicate water balance (Trivedi et al., 1989-90). In India, clean drinking water is available to only 12% of the people. The rest have to use polluted sources of water, which causes diseases, health & hygiene problems (Trivedi et al., 2004). The importance of clean drinking water cannot but be overemphasized.

Mumbai is one of the important cosmopolitan cities. It is the most populous city in India, second most populous metropolitan area in India, and the fifth most populous city in the world. Mumbai is also called the financial, commercial and entertainment capital of India. Fresh water is one of the most important resources crucial for the survival of all the living beings. It is even more important for the human being as they depend upon it for food





production, industrial and waste disposal, as well as cultural requirement (Agarwal et al., 1982). The WHO reports that about 36% urban and 65% of rural Indian are without safe drinking water (Nidhi Saxena et al., 2011).

Impacts of Dussehra Festival on the River Hooghly: A case study has been carried out which revealed that every year at least 15,000 idols of Goddess Durga are immersed in the Hooghly river alone. The study states that this releases 16.8 tonnes of varnish and garjan oil and 32 tonnes of colours in the water. These colours contain a good amount of heavy metals like manganese, lead, mercury and chromium. The study also found that during Dusshera festival, oil and grease in the river increased by 0.99 milligram per litre (mg/l) and the concentration of heavy metals increased by 0.104 mg/L.

Earlier studies revealed that the immersion of Ganesh and Durga idols along with continuous flow of industrial effluents, municipal sewage and untreated waste water, has polluted the lake resulting in vector transmitted diseases and lose of biodiversity and aquatic plants (Salaskar et al., 2004; Kolyar et al., 2008; Nayana et al., 2011). Consumption of fish caught from such polluted lake over a period of time is leading to serious diseases. When organic compounds of mercury enter human body, they concentrate in the brain and destroy the cells which control the central nervous system. The toxic substances can trigger chronic ailments. Heavy metals like cadmium, lead and mercury may magnify in their concentrations and finally reach human body (**Reddy et al.**, 2001).

Environmentalists now are worried about the water pollution and public health consequences of immersing idols in lakes and rivers. The present investigation is focused on the water pollution of a lake caused due to immersion of Ganesha idols which is made up of plaster of Paris and chemical paints and the other religious materials (Nirmalya).





## Material And Method

The present investigation has been carried out at Powai Lake Mumbai. Powai lake is surrounded by IIT, NIIE, Hotels and residential buildings. The waste water and sewage is also flows in lake at certain points. At Ganapati visarnjan lots of idols are immersed in lake. Powai is large artificial lake situated in northern suburb of Mumbai between two hollocks across Powai basin. Coordinates: 19.13°N 72.91°E. Catchment area 6.61Km<sup>2</sup> and maximum depth is around 12 m. It was created by British authorities in 1889, across Mithi River to control and provide water supply to the city.

To assess the water quality the water samples was collected from surface during morning time from Ganapati Ghat at different intervals i.e. pre-immersion, during immersion and post immersion during Ganesh festival in the month of September. Pre idol immersion samples were collected a week before the commencement of the immersion activities. During idol immersion samples were collected during the immersion activities. Post idol immersion samples were collected after the completion of immersion activities. All the samples were collected in high density polypropylene bottles (Tarson make). The bottles were cleaned properly, first with dilute nitric acid and then rinsed with double distilled water before use for collection of samples. The water analysis has been carried out as per APHA (1995).

The water quality assessment methods include monitoring to define the condition of water, to provide the basis of detecting trends and to provide the information enabling the establishment of cause effective relationships (UNEP, 1996.). By using different physico – chemical parameters like temperature, pH, DO, BOD, COD, Chloride, Sulphate, , Nitrate and Hardness, Turbidity etc. were analyzed in the laboratory and as per Standard Methods for the examination of Water and waste water.





**Figure 1:** Location of Powai Lake n Mumbai



**Fig.2:** Powai Lake view which is surrounded by hills and residential areas





**TABLE 1:** Different physico-chemical parameters studied during the period of investigation

PARAMETERS	ONE WEEK BEFORE GANAPATI VISARJAN			DURING GANAPATI VISRJAN			AFTER GANAPATI VISRJAN		
	pH	8.5	8.3	8.6	5.6	6.4	5.9	7.6	7.9
Temperature (°C)	23.4	22	22.4	23.1	26.4	25.3	25.4	28.3	29.4
DO (mg/L)	3.7	3.6	4.9	3.7	2.6	3.9	4.7	5.3	6.7
BOD (mg/L)	10	18	25	12	20	36	60	40	20
COD (mg/L)	25	25.2	28	34	22	30	32	32.3	32.4
Total Hardness (mg/L)	91	80	85	150	178	250	198	208	158
Chloride (mg/L)	2.1	2.8	3	4	5	6	7.6	9.4	10.6
Nitrate (mg/L)	0.190	0.329	0.495	0.65	0.79	0.65	0.505	0.548	0.565
Sulphate (mg/L)	2.2	2	2.1	2.5	2.8	2.5	3.0	2.8	3.5
Phosphates (mg/L)	0.15	0.16	0.15	0.27	0.23	0.25	0.21	0.19	0.22
TSS (mg/L)	10	15	12	20	25	32	30	25	20
TDS (mg/L)	125	158	150	180	225	285	281	225	220
Turbidity NTU	3.1	3.5	3.2	4.7	4.9	5.5	3.6	3.8	4.2
Oil & Grease	0	0	0	0	0.021	0.10	0.032	0.010	0

## Result & Discussion

There are gradual changes in all physico-chemical parameters before during and after Ganapati Visarjan.

**pH** is most important parameter it determines the solubility of nutrients. Photosynthetic activity is depends upon pH value. pH is determine by using standard pH meter. The average pH of water is 8.5 before Ganapati immersion, 6.0 during immersion and 7.8 after Ganapati immersion (Table 1). There is change in pH due to the chemical or material used during the making idols.

The paints and plaster of Paris contain various chemicals which affects on pH of water. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is more due to change in physico-chemical condition (Karanth, 1987).





### **Temperature:**

Temperature is parameter which gives an idea of self purification. It is also important for calculating the solubility of oxygen and Carbon dioxide. The temperature changes from 22.6 in before, 24.9 during immersion and 27.7 degree Celsius after immersion of idol.

**DO** It is dissolve oxygen. Amount of DO indicates the suitability of water for flora and fauna. The DO fluctuate from 4.1 mg/l before immersion to 3.4 mg/l during immersion and 5.6 mg/l after immersion. This is due to increase in organic matter and chem. Oxygen (DO) is essential for water quality, ecological status, productivity and health of a lake. This is due to its importance as a respiratory gas, and its use in biological and chemical reactions (Mustapha, 2008).

**Biochemical Oxygen Demand (BOD)** was noticed comparatively higher during and post immersion period. It was found in the range of 10-25 mg/L. in pre, while 12- 36 mg/L. and 20-60 mg/L. during and past samples respectively. The higher values of BOD means present of organic materials. The higher value of the BOD has direct correlation with the increase in nutrient level of the lake due to immersion activity (Mc Coy & Olson, 1986).

**Chemical Oxygen Demand (COD)** determines the amount of oxygen required for chemical oxidation of organic matter with the help of chemical oxidant, value ranges from 26.1mg/L, 28.7mg/L and 32.2 mg/L before, during and after immersion. This fluctuation shows that there is increase in chemical substances which affect on phytoplankton.

**Total Hardness** – Hardness is variable and complex mixture of cations and anions. Water with hardness below 60 mg CaCO<sub>3</sub>/L is soft, between 61 to 120 mg CaCO<sub>3</sub>/L is moderately hard; between 121 to 180 mg CaCO<sub>3</sub>/L is hard and







more than 181 mg CaCO<sub>3</sub>/L is very hard (Durfor et al., 1964). It changes from 85.3 mg/L before immersion, 192.7 mg/L during and 188 mg/L after immersion. Increase in hardness is indicating that there is decrease in water volume and rate of evaporation is increases.

**Chloride** - The ranges of chlorides changes from 2.1 mg/L – 6 mg/L before and during immersion and 10.6 after immersion. There is increase in pollution after Ganapati visarjan. Umavathi et al., (2007) showed that higher concentration of chloride is association with increased level of pollution.

**Nitrate** – Amount of nitrate indicate that the water is toxicity of water due to increase in amount of pollutants. Nitrates were available during the study period. This is due to run-off from the surrounding area. It ranges from 0.3 mg/L – 0.7 mg/L and 0.5 mg/L in before, during and after immersion (Fig. 3). According to Ganapati (1960) the non-polluted tropical waters are generally deficient in nitrate but the factors like discharge of sewage, run-off and nitrogen fixation may increase its concentration in water bodies. High concentration of nitrate is drinking water is toxic (Umavathi et al., 2007).

**Sulphate:** The average amount of sulphate was 2.1mg/L in before and during the idol immersion 2.6, after immersion 3.1mg/L this indicates that the water gets polluted due to the colours, binders etc. used for making idols.

**Phosphates:** The phosphate values ranged between 0.15 to 0.16 mg/L before idol immersion activity. During activity it was 0.23 to 0.27 mg/L while after activity 0.19 to 0.22 mg/L. The increase in phosphate level during immersion may be due to the material (Flowers, garlands, fruits and Prasad, etc.) is added along with the idols.





**TSS:** Total suspended solid shows gradual changes in before and during immersion it changes from 12.3 mg/L – 25.7 mg/L. TSS increases after immersion was 25mg/L. Powai lake water was clear before the immersion, during and after the post immersion effect of idol (Plaster of Paris and clay etc.) was seen showing comparatively high values of TSS

**TDS:** The amount of Total Dissolve Solids before immersion 144.3 mg/l, during 230 mg/l and 242 mg/l after immersion. Increase in values of TDS during immersion may be due to the material added while immersion of idols having solubility in water.

**Turbidity:** It observed 3.3 NTU before immersion 5.0 NTU during immersion and 3.9 after immersion. The lake water was less turbid before immersion, high turbidity during immersion may be due to immersion of large numbers of idols, and this was reduced to some extent after immersion (after one week) may be due to addition of fresh water or settlement of clay and other material.

**Oil and grease:** It was noticed comparatively higher in during and post period. It was found in nil before the immersion activity. While during and after activity was slightly dictated i.e. 0- 0.021 and 0- 0.032 mg/L respectively. The concentration of oil & grease is quite negligible.

As civilization progressed man invented new techniques to exploit water ecosystems. As industrialization grew, mass production was started in factories. The industrial units which came up began generating scrap and wastes. The river and ponds systems were seen as convenient and cheap way to dispose of the wastes. This had an adverse effect on human health and environment. Though not specifically intended, the process of development, urbanization, globalization and industrialization, and many anthropogenic activities leads to an adverse effect on the ecosystem (**Tanner et al., 2001**). In India idol immersion is another anthropogenic activity. Mumbai alone absorbs





immersion of more than 1.5 lakh idols annually. In this festival number of Ganesh idols in different sizes are immersed in Powai Lake after worship of 10 days. When the idols are immersed, their colors, chemicals and other components that are used for idol preparation get dissolved and lead to significant changes in the water quality (Dhote et al, 2001). Hence this problem requires an input to find the correct solution.

Reddy et al., (2001) observed that Ganesh idol increases pollution in Hussainsagar Lake in Hyderabad. Malik et al., (2012) reported deterioration in water quality of rivers due to idol immersion in south Gujarat. The input of biodegradable and non biodegradable substances deteriorates the river water quality and enhances silt loaded in the river. The floating materials released through idol in the river and lake after decomposition result in eutrophication of the river, lake etc. (Leland et al, 1991).

Heavy metals and other chemical contamination cause due to Idol Immersion Activities in Urban Lake, India, have been studied by Tamot et al., 1988; Vyas et al., 2006, 2007 & 2008; Dhote et al., 2008. In their studies they reported that idol immersion has become a major source of contamination and sedimentation to the lake water. They warn that idol-derived heavy metals, especially nickel, lead and mercury, are likely to find their way into fishes and birds inhabiting the lake, which finally reach the humans through food. Essential to ensuring a balanced relationship between nature and humans is the inherent quality of the lake, and the culture of the people dependent on the resource. Local communities that directly benefit from the lake have customary laws that take into account the sustainable use of the resource.

PoP is not a naturally occurring material. Plaster of Paris is a calcium sulfate hemi-hydrate: ( $\text{CaSO}_4, \frac{1}{2} \text{H}_2\text{O}$ ) derived from gypsum, a calcium sulfate dihydrate ( $\text{CaSO}_4, 2 \text{H}_2\text{O}$ ), by firing this mineral at relatively low temperature and then reducing it to powder. While idols made out of naturally occurring





clay (Shaadu in Marathi) dissolve within hours of immersion in water, PoP idols may take anywhere between several months to years to fully dissolve. In addition, when chemical paints are used to decorate the idols, these paints contain heavy metals such as mercury and lead, which seep into the water as the idol dissolves

The Main Pollution is caused by the Plaster of Paris Ganesh idols and the Chemical paints used in them. Plaster of Paris is not a naturally occurring material and contains gypsum, sulphur, phosphorus and magnesium. The idols take several months to dissolve in water and in the process poison the waters of lake, ponds, rivers and seas. The Chemical Paints used to decorate the Ganesh idol contain mercury, lead, cadmium and carbon and this increases the acidity and heavy metal content water. Several accessories used during the Ganesh Puja like Thermocole, plastic flowers, cloth, incense, camphor and numerous other materials dumped carelessly adding more strain to the already polluted rivers and lakes. Careless immersion of Ganesh Idols in Water bodies blocks the natural flow of water. This results in stagnation and breeding of mosquitoes and other harmful pests.

## **Conclusion**

Balancing the challenges of development and environmental protection should form a basis for a strong mutual link, thereby enhancing a harmonious relationship between humans and nature and, in turn, enhancing the goal of sustainability. In the present study the immersion of Ganapati idols has bad (negative impact or effect) on water quality. The result shows gradual changes before and after Ganapati immersion. There is increase in organic matter and chemicals which affects on flora and fauna of water. Scientists in India, worried about the public health consequences of immersing idols in lakes and rivers, have been looking anew at water pollution.





The main reason of the deterioration of water quality is various religious activities with special blame given to the plaster of Paris, clothes, iron rods, chemical colours, varnish and paints used for making the idols and also to the Nirmalya and other things immersed with the idol. Though a lot had been done to create awareness and implement preventive measures, the efforts have not had an impact. Year after year, the number of idols being immersed is rising significantly. It is recommended that the meticulous monitoring of the water quality for better prediction and management for maintaining cleanliness in the lake has to be carried out every year during the festive seasons. This may to some extent reduce the pollution of water of Powai Lake.

### **Possible solutions:**

Since the main issue around water pollution has got to do with the idol immersion ritual. The remedial or control measures should be taken by every individual to check the pollution at point source level especially activities like idol immersion during festival seasons. Followings are some remedial measures which may reduce the pollution level up to some extent.

Use of traditional clay like shadu

Water soluble natural paints & colours

Idols must be as small as possible

Immersing the idol in an artificial water tanks instead of directly into natural water bodies like lake, rivers and sea.

The use of non-biodegradable materials like thermocole, plastics etc.

The offering to the god like flowers, garlands, durva etc. which are biodegradable materials should be disposed off separately and converted in to bio-fertilizers.

Mass awareness Campaigns & Programmes for the students, citizens

Sensitize people about the issues of environment degradation which occur during festivals

Encourage people to opt environment friendly celebrations





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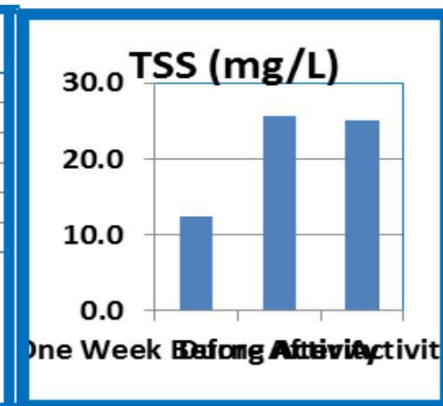
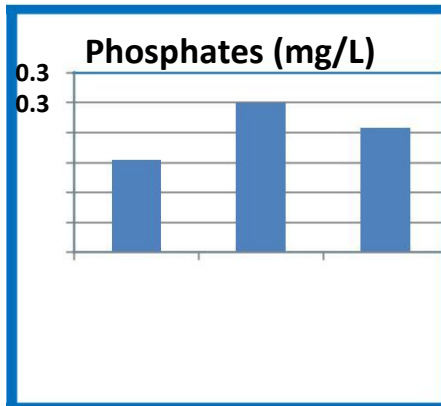
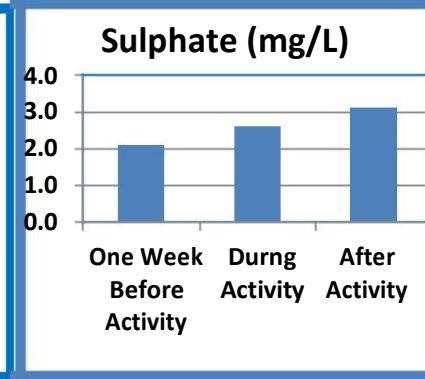
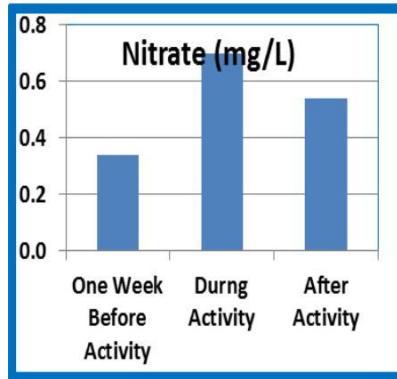




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One Week Before Activity    Durng Activity    After Activity

