Water Contamination Caused by Idol Immersion and Associated Environmental and Human Health Risks: A Scientific Review

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Received: Aug 20, 2026 Accepted: Sep 17, 2026 Published: Sep 22, 2026

Abstract

In India, idol immersion is a significant cultural and religious custom that is customarily carried out in rivers, lakes, ponds, and other bodies of water after religious celebrations. However, worries about the effects of immersion activities on the environment have been raised by the growing use of plaster of Paris (PoP), synthetic paints, plastic decorations, thermocol, metallic ornaments, and other non-biodegradable materials. This review looks at the main ways that idol immersion contaminates water and assesses the possible effects on aquatic ecosystems and human health. Changes in physicochemical properties and elevated metal concentrations after immersion activities have been documented in published studies from Indian water bodies. Lead (Pb), chromium (Cr), cadmium (Cd), zinc (Zn), copper (Cu), nickel (Ni), iron (Fe), and manganese (Mn) have all been found to be contaminated in investigations of the Hooghly River, Hussainsagar Lake, Upper Lake Bhopal, and lakes in Nagpur. However, the extent and persistence of contamination differ between locations and are impacted by other pollution sources. While synthetic materials contribute persistent solid waste, organic offerings and biodegradable materials can raise the biochemical oxygen demand and decrease dissolved oxygen during decomposition. When contaminated water finds its way into drinking water supplies or when pollutants bioaccumulate in aquatic organisms that humans eat, it poses the biggest threat to human health. Depending on exposure, chemical form, dose, and duration, lead, cadmium, chromium, and other toxic metals are linked to known negative health effects, such as neurological, renal, developmental, and other systemic effects. According to current Central Pollution Control Board (CPCB) guidelines, specific immersion facilities—ideally man-made tanks or ponds—as well as methodical monitoring prior to, during, and following immersion are advised. While preserving the cultural practice, the use of clay-based idols, natural pigments, biodegradable decorations, waste segregation, controlled immersion facilities, and post-immersion water quality monitoring can lower risks to the environment and public health.

Keywords: lead, cadmium, water quality, aquatic ecosystem, plaster of Paris, heavy metals, water pollution, idol immersion, and environmental health India

1. Introduction

Water bodies are significant from an ecological, social, cultural, and economic standpoint. Rivers, lakes, ponds, and reservoirs are often connected to religious and cultural customs in India. Visarjan, or idol worship and subsequent immersion, is a significant part of many festivals. Environmental concerns have been raised by changes in the materials used to make idols and the growing scope of festival activities, despite the fact that the practice itself is cultural and religious.In the past, natural clay, straw, bamboo, jute, and other biodegradable materials were used to make a lot of idols. Plaster of Paris (PoP), synthetic paints, varnishes, adhesives, plastic, thermocol, metallic ornaments, glitter, and other decorative materials may also be present in modern idols. While non-biodegradable materials can linger in aquatic environments for extended periods of time, synthetic pigments may contain metals or compounds containing metals. Increased concentrations of Zn, Pb, Ni, and Cr were found after immersion activities in a study of the Hooghly River, which also revealed significant differences in selected dissolved metals between pre- and post-immersion sampling [1].

Idol immersion has an impact on the environment that extends beyond chemical pollution. Microbial decomposition can occur when flowers, food offerings, leaves, cloth, straw, and other organic materials are placed in water. In addition to consuming dissolved oxygen, this process may raise the chemical and biochemical oxygen demands (COD and BOD). Furthermore, solid residues can change the physical properties of aquatic environments and increase turbidity. The environmental impact of idol immersion is site-specific and interacts with current pollution sources, according to evidence from multiple Indian water bodies. For instance, research at Hyderabad's Hussainsagar Lake found a variety of elements, such as As, Cd, Cr, Ni, Pb, Cu, Fe, Mn, Zn, and other metals; however, the study also found that untreated municipal sewage was a significant source of contamination. Therefore, rather than being the only factor contributing to the observed contamination, idol immersion should be viewed as an additional pollution pressure [2].

The current review summarises the evidence that is currently available on the following topics: (i) sources of pollutants linked to idol immersion; (ii) changes in water quality; (iii) ecological consequences; (iv) possible implications for human health; and (v) strategies for reducing pollution associated with immersion activities.

2. Materials and Methods

2.1 Literature review approach

Peer-reviewed research that was indexed in scientific and biomedical databases as well as environmental management guidelines released by Indian regulatory bodies were used in a narrative scientific review. We looked at the literature on idol immersion, water quality, heavy metals, aquatic life, and the impact of the environment on human health. Studies examining Indian water bodies both before and after idol immersion received special attention. Because these studies offer geographically varied evidence regarding physicochemical and metal contamination, published investigations involving Hussainsagar Lake, Upper Lake Bhopal, the Hooghly River, and lakes in Nagpur were taken into consideration.

2.2 Parameters considered

Thefollowingwerethemainenvironmentalfactorstakenintoaccount:

- pH
- Dissolved oxygen (DO)
- BOD, or biochemical oxygen demand
- COD, or chemical oxygen demand
- Electrical conductivity
- TDS, or total dissolved solids
- Turbidity
- TSS, or total suspended solids
- Hardness
- The main ions
- A few heavy metals, such as Pb, Cd, Cr, Zn, Cu, Ni, Hg, Fe, and Mn.

3. Sources and Pathways of Water Contamination

3.1 Idol construction materials

Idols made of clay are typically less harmful to the environment than those made of durable synthetic materials. After immersion, PoP, which is typically mostly made of calcium sulphate hemihydrate, can produce significant amounts of suspended and deposited material. Residues may build up close to immersion sites in bodies of water that are stagnant or have little flow. According to a Bhopal study, traditional idol materials included wood, bamboo, straw, jute, clay, and PoP in addition to vivid artificial colours. The investigators highlighted concerns about heavy metals in paints and linked immersion activities to variations in water-quality parameters. (PubMed)

3.2 Synthetic paints and pigments

One of the most significant possible sources of chemical pollution is synthetic paints. Lead, chromium, cadmium, zinc, copper, and other metals may be present in pigments and coatings, depending on how they are made.

Increased concentrations of dissolved heavy metals were found at multiple immersion sites in the Hooghly River, according to research that compared water samples taken before and after idol immersion. Zn, Pb, Ni, and Cr were among the metals examined (ScienceDirect).

Pigment composition, paint formulation, weathering, water chemistry, and the length of time the idol material is in contact with water all affect how much metal is released. As a result, different idols will yield different contaminant profiles.

3.3 Organic offerings

Along with idols, flowers, leaves, food items, grains, fruits, and other organic offerings may find their way into bodies of water. These materials' microbial breakdown raises the water's organic content.

Microbial respiration can be triggered by an increase in organic matter, which leads to the consumption of dissolved oxygen. Reduced DO can stress aquatic organisms under high organic loading and, in extreme situations, lead to hypoxic conditions.

Similar increases in organic pollution linked to human activity and materials related to idol-immersion have been found by CPCB monitoring of the Yamuna. (Board for Central Pollution Control)

3.4 Plastic and other persistent materials

After being submerged, plastic sheets, bags, synthetic cloth, thermocol, glitter, wires, decorative materials, and other non-biodegradable materials may stay in the aquatic environment. These substances could break up into smaller pieces and add to the persistent solid waste.

Apart from their immediate physical impacts, discarded materials can disrupt aquatic environments and provide avenues for additional contamination transportation and accumulation.

4. Effects on Water Quality

4.1 Heavy-metal contamination

Because many heavy metals are persistent and cannot be broken down by the body, they are especially dangerous. The concentration, chemical form, bioavailability, and exposure pathway of these substances determine their environmental significance.

Idol immersion has been linked to metal contamination, according to studies done in Indian water bodies. Researchers used ICP-OES to examine water and Oreochromis mossambicus (tilapia) in three lakes in Nagpur: Futala, Gandhisagar, and Ambazari. Fish and water were found to have elevated levels of Pb, Cd, Cu, Fe, and Mn; contamination was especially noticeable in Gandhisagar Lake after immersion activity. (PubMed)

26 elements, including several heavy metals, were found during the Hussainsagar investigation. However, at some sampling locations, untreated municipal sewage was found to be the primary source of contamination, highlighting the significance of differentiating idol-related pollution from background and co-occurring urban pollution. (PubMed)

4.2 Dissolved oxygen and organic pollution

Oxygen consumption may rise as organic materials break down. Fish, zooplankton, benthic organisms, and aerobic microorganisms may be negatively impacted by the ensuing decrease in DO.

Idol immersion and DO do not always have a consistent relationship. The number and size of immersed idols, temperature, flow, water-body size, organic pollution, and dilution capacity all affect the response that is seen.

4.3 Turbidity and suspended solids

By physically upsetting the water column, immersion can momentarily increase suspended particulate matter. Turbidity may be caused by clay, PoP, sediment, ornamental materials, and decomposing organic matter.

Increased turbidity can disrupt photosynthetic activity and decrease light penetration. Additionally, suspended particles can serve as surfaces for organic pollutants and metals to adhere to, which may aid in their transportation and deposition in sediments.

5. Impacts on Aquatic Ecosystems

Numerous interrelated pathways can have an impact on aquatic ecosystems.

5.1 Effects on fish and aquatic organisms

Aquatic organisms may experience physiological stress due to variations in dissolved oxygen, turbidity, pH, and metal concentrations. Exposure to metals can disrupt growth, reproduction, osmoregulation, enzymatic processes, and other biological processes.

Because it looked at both fish and water, the Nagpur study is especially pertinent. Tilapia were found to contain Pb and Cd, indicating the potential for contaminants to be transferred from water to aquatic life. The authors came to the conclusion that both human health and the environment were at risk due to the observed contamination. (PubMed)

5.2 Bioaccumulation and biomagnification

When uptake outpaces elimination, some metals can build up in living things. Metals may then travel through food chains. It should not be assumed that the degree of biomagnification is the same for all metals because it varies depending on the specific contaminant and ecosystem.

When contaminated water bodies are used for commercial or subsistence fishing, contamination of edible fish is especially significant.

5.3 Sediment contamination

Paints and other materials can release metals, which can then attach themselves to suspended particles and build up in sediments. As a result, sediments may serve as secondary sources of pollutants. The longer-term environmental burden may therefore be underestimated by environmental assessments that are restricted to water samples. During pre-, during-, and post-immersion monitoring, the updated CPCB guidelines expressly advise gathering and analysing sediment samples for metals. (Board for Central Pollution Control)

6. Potential Human-Health Implications

6.1 Exposure pathways

Human illness does not always follow from the presence of contaminants in an immersion site. The concentration of contaminants, the route of exposure, the frequency and duration of exposure, and the susceptibility of exposed populations all influence the risk to human health.

Among the possible routes of exposure are:

1. **Drinking tainted water**
2. **Eating fish or other aquatic animals that have been contaminated**
3. **Direct interaction with tainted water**
4. **Inadvertent consumption of water**
5. **Exposure at work when collecting and managing immersion waste**
6. **Secondary exposure via tainted food chains or sediments**

The biggest issue is when an immersion body of water is also used, either directly or indirectly, as a source of food or drinking water.

6.2 Lead exposure

Lead is a hazardous metal that has been shown to have negative effects on the nervous system, especially in young children. Long-term exposure can impact haematological function, behaviour, learning, neurodevelopment, and other physiological systems.

Therefore, even at relatively low concentrations, the presence of lead in water or fish should be taken seriously, especially if exposure is repeated.

6.3 Cadmium exposure

Because of its persistence, cadmium can build up in biological tissues. Renal toxicity and negative effects on the skeletal system are the main consequences of chronic exposure. When fish are eaten from contaminated water bodies, dietary exposure through contaminated aquatic organisms may be a pertinent pathway.

The Nagpur investigation's finding of Cd in both water and tilapia highlights the significance of looking at biological tissues and environmental media in addition to water-quality measurements. (PubMed)

6.4 Chromium exposure

The chemical form of chromium has a significant impact on its health effects. Under adequate exposure conditions, hexavalent chromium [Cr(VI)] is significantly more toxic than trivalent chromium [Cr(III)] and is linked to carcinogenic and other negative effects.

As a result, when chromium contamination is suspected, total chromium measurements might not adequately describe the health risk; chromium speciation can offer more details.

6.5 Microbial and indirect health risks

Water bodies that concurrently receive sewage, household waste, and other sources of microbial contamination may experience idol immersion. Therefore, chemical pollutants released from idols cannot be the only source of possible health risks.

Microbial pathogens may pose an additional risk in contaminated water bodies, especially when water is used for bathing, household tasks, recreation, or the production of drinking water.

7. Evidence from Indian Case Studies

Table 1. Selected evidence concerning idol immersion and water contamination in India

Study/site	Major observations	Environmental significance
Upper Lake, Bhopal	Changes in turbidity, DO, BOD, COD and metal-related water quality were investigated before and after management interventions associated with immersion practices	Demonstrates potential for management of immersion activities to improve water quality
Hussainsagar Lake, Hyderabad	Multiple elements, including Pb, Cd, Cr, Ni, Cu, Fe and Zn, were detected; idol-immersion sites showed elevated concentrations of selected elements	Indicates contribution of immersion activities within a water body affected by multiple urban pollution sources
Hooghly River, Kolkata	Pre- and post-immersion measurements showed changes in dissolved heavy metals, including Zn, Pb, Ni and Cr	Provides direct evidence of deterioration in selected water-quality parameters after immersion
Futala, Gandhisagar and Ambazari Lakes, Nagpur	Heavy metals including Pb, Cd, Cu, Fe and Mn were detected in water and Tilapia	Demonstrates potential transfer of contaminants from water to aquatic organisms

The Bhopal study demonstrated that management interventions can lessen environmental pressure on delicate water bodies by reporting an improvement in water quality after the idol-immersion site was moved. (PubMed)

Together, the case studies show that the environmental effects of immersion are highly dependent on local conditions and should be assessed in conjunction with background sediment contamination, urban runoff, sewage discharge, industrial activity, and hydrological conditions.

8. Recommended Environmental Monitoring Framework

Pre-immersion, immersion-period, and post-immersion sampling should all be part of a scientifically sound monitoring program.

Assessment at these stages and additional post-festival sampling are recommended by CPCB guidelines. Additionally, it suggests taking samples at representative sites far from the immediate turbulence produced at the immersion point. (Board for Central Pollution Control)

Table 2. Recommended monitoring parameters

Category	Parameters
Physical	Temperature, turbidity, TSS, TDS, conductivity
Chemical	pH, alkalinity, hardness, chloride
Oxygen-related	DO, BOD, COD
Nutrients	Nitrate, phosphate, ammonium
Metals	Pb, Cd, Cr, Hg, Zn, Cu, Ni, Fe, Mn, Ba, Co, Sb
Biological	Total coliforms, fecal indicators, phytoplankton, selected aquatic organisms
Sediment	Total and bioavailable metals, organic matter
Biological tissue	Metal accumulation in edible fish where relevant

Ideally, sampling should consist of:

- a reference or upstream location;
- the site of immersion;
- places downstream;
- samples of sediment;
- When appropriate, fish or other bioindicator organisms; and
- To assess persistence, post-immersion samples were repeated.

9. Conclusion

Although immersion in idols is a significant cultural custom, the materials used in modern idols and related decorations can put quantifiable environmental strain on aquatic ecosystems. Following immersion activities, published studies from a number of Indian water bodies have shown altered physicochemical properties and elevated concentrations of specific heavy metals. The Hooghly River and Nagpur lakes provide evidence that pollutants can affect aquatic life in addition to water.

When people use contaminated water or aquatic organisms, there is a greater potential risk to human health. Because of their known toxicity and persistence, metals like lead and cadmium are especially dangerous. However, the occurrence of idol immersion alone cannot determine the extent of health risk; site-specific measurements of contaminant concentrations, exposure pathways, duration, and population characteristics are necessary.

Eliminating cultural practices is not always necessary for effective pollution control. Natural clay idols, low-toxicity paints, the removal of plastic and thermocol decorations, special artificial immersion tanks, methodical residue collection, and scientifically planned water and sediment monitoring are other ways to lessen the environmental burden. Cultural customs can be reconciled with the preservation of aquatic ecosystems and environmental health through the implementation of these policies, which are backed by community involvement and regulatory supervision.

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