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Original Article

Impact of Durga Puja on River Ganga

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Abstract *- For Bengalis worldwide, celebrating Durga Puja is quite significant. The annual five-day festival honours and worships the goddess Durga while commemorating the triumph of good over evil. The idols were made from organic matter and natural colours, but POP (Plaster of Paris) has now substituted it. This has led to a complete water column disturbance during the idol immersion phase, leading to the aquatic life's quietus. Chemical paints are primarily used to coat the idol, which includes mercury, cadmium, lead, cobalt, zinc, and carbon. This releases toxic elements during immersion of the idol and raises acidity, solid matter, and heavy metals in the river. Precisely, lead or Pb is neurotoxic and carcinogenic. It is persistent in the aquatic environment due to the most important factor: it cannot be broken down because it is a natural component of the earth's crust. Therefore, it gradually accumulates and magnifies through bioaccumulation and biomagnification, moving up across the food chain and causing severe health repercussions in human beings. Therefore, there is a dire need to advocate for a ban on POP and chemical colours. The simplest, best alternative is to return to our roots and begin large-scale production of organic dyes and idols using the sophisticated, antiquated custom of borrowing clay from the bank of a river used historically for making idols without impacting the environment. Further, adopting these practices will also lead to a surge in employment opportunities, particularly for skilled rural artisans.*

Keywords *- Chemical colour, Durga puja, Health hazard, POP, Water pollution.*

1. Introduction

Durga Puja is the celebration of the victory of good over evil. This annual five-day celebration which pays homage and reverence to Goddess Durga, is of high significance to Bengalis all over the world.

There is a versatile history of idol-making or idolatry in Hindu culture. Kumartuli is a location in North Kolkata, situated on the banks of the Hooghly River, dating back to the 17th century; it holds a great ancient legacy of idol-making (Hindustan Times, 2021). This process is filled with love, reverence, and gratitude, wherein the potters follow steps that include material collection, moulding, painting, and decorating. The main materials used here are bamboo, straws, husk, and Puniya mati, *which* is the mud from the banks of the river Ganga, cow dung, cow urine, and mud from the brothel (GOVERNMENT OF INDIA, n.d.).

To understand the scale of the annual five-day celebration (Durga Puja) in Bengal, we must realise the heights of the economic affair in this period which includes transactions of Rs. 40,000 crores and provides employment opportunities for around three lakh people from different sectors such as for pandal structuring, idolatry, priests, dhakis, and other important members of the craftsmanship. The apparel industry blossomed as well. Moreover, the leisure industry enjoyed a spike in sales and profit margins. A probable amount of ₹50,000 crores in transactions takes place in this period, with an estimated value of creative industries at ₹33,000 crores (USD 4.5 billion) in 2019 (Business Insider India, 2022).

The goddess is embraced on the auspicious day of Mahalaya, ushering in Durga Puja. The rite of idol immersion, which marks Durga Maa's triumph over the demon ruler Mahishasura, is performed on Vijaya Dashami on the banks of the Ganges River. Even though Ganga is revered for its healing powers and is regarded as "holy," pollution is annihilating it at an alarming rate.
The vital sources of degradation are:

- Released sewage and industrial effluents from cities
- Cremation of the deceased
- Agricultural practises' runoff
- Disposal of biomedical and solid waste
- Textile washing
- Discarded temple waste materials
- Bathing animals
- Occupational Pollution
- A significant amount of water was removed from the river using a lift canal.
- Forest destruction in the river's catchment and its origin.
- Building dams in the Himalayan region and other large developments in the catchment area results in the extraction of plenty of water from the Ganga when it enters the lowlands for industrial use. The only thing left is filthy drains, and when they combine with the river, the level of toxins rises (Jhariya & Tiwari, 2020).

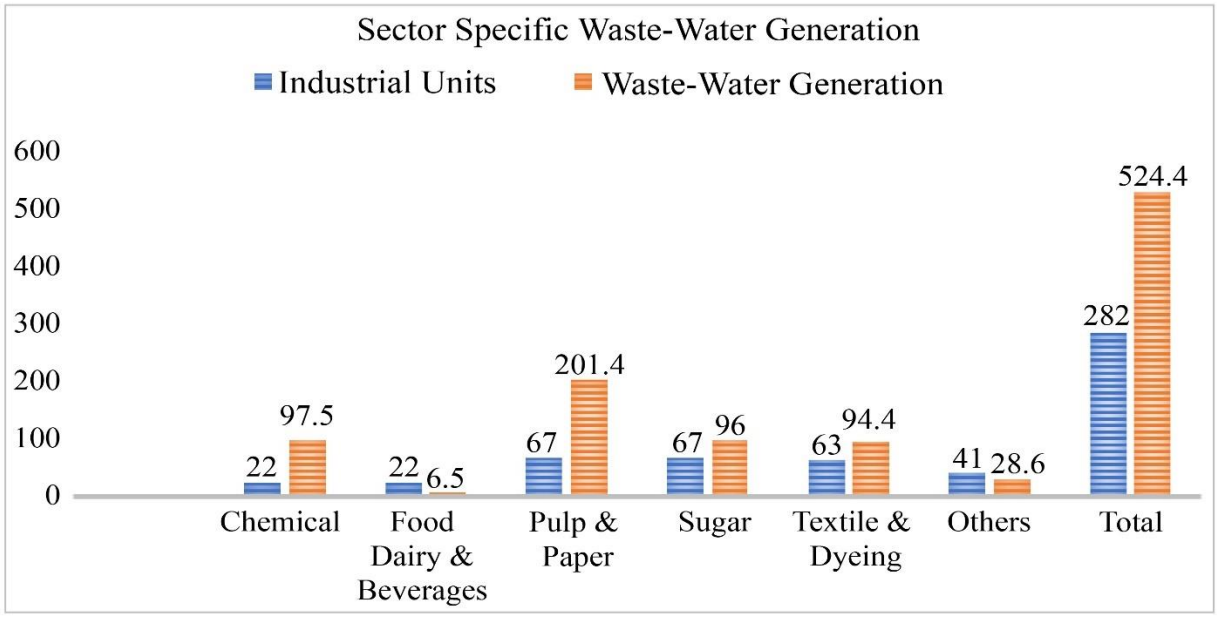

Fig. 1 Graph on sector-wise degradation of river ganga

It is important to note that idol immersion plays a vital role in water pollution, except for the above-mentioned factors. Nowadays, the traditional clay idol-making procedure has been replaced by POP (Plaster of Paris) which has chemical components like gypsum, sulphur, phosphorus, and magnesium. In addition, chemical paints are mostly used, including mercury, cadmium, lead, and carbon. This releases toxic elements during the idol immersion and raises the level of acidity, solid matter, and heavy metals in the river (Banerjee, 2022). A 2015 internal research by the West Bengal Pollution Control Board reported that the lead concentration had risen by around 51%, and the concentration of heavy metals had increased by 148%. These components do not readily dissolve and lower oxygen levels in the water, thus affecting aquatic life (Basu, 2020).

2. Methodology

The study aims to reinforce the approach to the hazardous environmental situation that people are experiencing due to water contamination. Here, the effect of idol immersion in the River Ganga has been highlighted. This is a secondary research paper that focuses on applied research. The report establishes itself by outlining the causes of the degradation in the Ganga River while highlighting the causative agents such as POP and chemical colours. Then, the persistence of hazardous metals and health risks brought on by bioaccumulation and biomagnification has been underlined. Due to the fact that it includes numerous informational tables and statistical graphs, this essay is both quantitative and qualitative. The paper's conclusion highlights the remedies to this issue in a sustainable approach.

3. Results & Discussion

Durga Puja begins on the first phase of the waxing moon in Ashwin. This day is known as Mahalaya, which marks the end of the Pitri-paksha and the start of the Devi-paksha. This day is essential for idol-making as the most important ritual, 'Chokkhu Daan,' takes place at this hour. The phrase 'Chokkhu Daan' refers to the surreal ritual of painting the eyes of the idol. This holds a special significance in our culture; only one senior artist in the community can perform this ritual. The artisan is supposed to be the only one present, and in complete darkness, this fine work of art is performed.

Paint is a liquid or mastic substance that solidifies into a film when applied in a thin layer. When painting an idol, the pigment and binder (the glue in which the pigment is suspended) come first. Additionally, significant quantities of paints include drying catalysts, biocides, solvents, and fillers.

Mercury, cadmium, cobalt, zinc, chromium, and lead are only a few heavy elements in the paints used to colour the idols (Gupta et al., 2020). Mercury, zinc oxide, chromium, and lead are particularly strong carcinogens that can be found in the colours red, blue, orange, and green (Dubey & Dubey, 2016).

3.1. Bioaccumulation & Biomagnification

The chemical paints used in idols contain lead which is hazardous and biomagnifies along the food chain. Pb is neurotoxic and even carcinogenic, thus added to Ganga during idol immersion (Goswami & Mazumdar, 2016). Pb is of high density and poisonous at low concentrations. In adults, it has been observed that Pb poisoning can result in sensory organ nerve damage, which can result in neurodegenerative disorders, including Alzheimer's and Parkinson's disease, as well as eyesight loss, schizophrenia, and poor cognitive function (NCBI, 2010). Intake of lead and other metals has been estimated to have contributed to more than 9 million years of disability-adjusted life and 56,000 deaths worldwide (NCBI, 2020).

Table 1. Chemical composition of metal-based pigments (Dubey & Dubey, 2016)

	PIGMENTS	METALS & COMPOUNDS
1	**PURPLE PIGMENT**	**Aluminum pigment:** Ultramarine violet: Silicate of sodium and aluminum containing sulfur **Copper pigments:** Han Purple: $BaCuSi^2O^6$ **Manganese pigments:** Manganese violet: $H^4MnP^2O^7$ (PV16) Manganic ammonium pyrophosphate
2	**BLUE PIGMENT**	**Aluminum pigments:**Ultramarine: a complex naturally occurring pigment of sulfur-containing sodio-silicate (Na8-10Al6Si6O24S2-4) **Cobalt pigments:** Cobalt Blue and Cerulean Blue: cobalt (II) stannate **Copper pigments:** Egyptian Blue: a synthetic pigment of calcium copper silicate ($CaCuSi^4O^{10}$). Thought to be the first synthetically produced pigment. Han Blue: $BaCuSi^4O^{10}$ **Iron pigments:** Prussian Blue: a synthetic pigment of ferric hexacyanoferrate ($Fe^7(CN)18$). The dye Marking blue is made by mixing Prussian Blue and alcohol. **Manganese pigments:** Manganese Oxide Blue
3	**GREEN PIGMENT**	**Cadmium pigments:** Cadmium Green: a light green pigment consisting of a mixture of Cadmium Yellow (CdS) and Viridian (Cr2O3) **Chromium pigments:** Chrome green: chromic oxide (Cr^2O^3) Viridian: a dark green pigment of hydrated chromic oxide (Cr^2O^3•H^2O) **Copper pigments:** Paris Green: cupric acetoarsenite ($Cu(C^2H^3O^2)2·3Cu(AsO^2)2$) Scheele's Green (also called Schloss Green): cupric arsenite $CuHAsO^3$
4	**YELLOW PIGMENT**	**Arsenic pigments:** Orpiment natural monoclinic arsenic sulfide (As2S3), **Cadmium pigments:** Cadmium Yellow: cadmium sulfide (CdS) **Chromium pigments:** Chrome Yellow: natural pigment of plumbous chromate ($PbCrO^4$). **Cobalt pigments:** Aureolin(also called Cobalt Yellow): Potassium cobaltinitrite ($Na^3Co(NO^2)6$). **Iron Pigments:** Yellow Ochre: a naturally occurring clay of monohydrated ferric oxide ($Fe^2O^3.H^2O$) **Lead pigments:** Naples Yellow; lead-tin-yellow **Titanium pigments:** Titanium Yellow **Tin Pigments:** Mosaic gold: stannic sulfide (SnS^2)
5	**ORANGE PIGMENT**	**Cadmium pigments:** Cadmium Orange: an intermediate between cadmium red and cadmium yellow: cadmium sulfoselenide. **Chromium pigments:** Chrome Orange: a naturally occurring pigment mixture composed of lead (II) ($PbCrO^4$ + PbO), chromate, and lead(II) oxide. ($PbCrO^4$ + PbO)
6	**RED PIGMENT**	**Cadmium pigments:** Cadmium Red: cadmium selenide (CdSe) **Iron oxide pigments:** Sanguine, Caput Mortuum, Venetian Red, Oxide Red Red Ochre: anhydrous Fe^2O^3 Burnt Sienna: a pigment produced by heating Raw Sienna **Lead pigments:** Red Lead: lead tetroxide, Pb^3O^4 Mercury pigments: Vermilion: Synthetic and natural pigment: Occurs naturally in mineral cinnabar. Mercuric sulfide (HgS)

7	**BROWN PIGMENT**	**Clay earth pigments (naturally formed iron oxides)** Raw Umber: a natural clay pigment consisting of iron oxide, manganese oxide, and aluminum oxide: $Fe^2O^3 + MnO^2 + nH^2O + Si + AlO^3$. When calcined (heated), it is referred to as Burnt Umber and has more intense colours. Raw Sienna: a naturally occurring yellow-brown pigment from limonite clay. They have been used in art since prehistoric times.
8	**BLACK PIGMENT**	**Carbon pigments:** Carbon Black, Ivory Black, Vine Black. Lamp Black **Iron pigments:** Iron black: Fe^3O^4 **Titanium pigments:** Titanium Black
9	**WHITE PIGMENT**	**Antimony pigments:** Antimony White: stibous oxide (Sb^2O^3) **Barium pigments:** Barium sulfate ($BaSO^4$) **Lead pigments:** Cremnitz White: basic plumbous carbonate (($PbCO^3$)2·Pb(OH)2) **Titanium pigments:** Titanium White: titanic oxide (TiO^2) **Zinc pigments:** Zinc white: Zinc Oxide (ZnO)

Table 2. Descriptive Statistics for Lead Content in Sindoor (NCBI, 2017)

Descriptive Statistic	Sindoor
No. with ≥ 1 μg/g of lead (%; 95% CI)	18.0 (78.3; 60.5, 96.1)
Geometric mean lead levels, μg/g (SD)	28.1 (32.4)
Median lead levels, μg/g (SD)	12.7 (14.2)
SD for samples with lead content < 100 μg/ga	23.9
25%–75% IQR, μg/g	3.4–69.2
95th percentile of lead content, μg/g	270 511.1
Maximum lead concentration detected, μg/g	> 300 000
No. with > 20 μg/g of lead (%)	10.0 (43)

Human beings who are exposed to Pb may have a range of health repercussions that harm their central and peripheral nervous systems. It has a detrimental effect on how red blood cells are made. High levels of Pb exposure can result in unconsciousness, delirium, and even death. Children who are exposed to Pb at low levels may experience developmental delays, lowered IQs, hyperactivity, learning impairments, behavioural issues, hearing loss, and stunted growth. (ENVIS- Tripura State Pollution Control Board, n.d.).

Pb is persistent in the aquatic environment due to the most important factor; it cannot be broken down because it is a natural component of the earth's crust (Goswami & Mazumdar, 2016). Consequently, it gradually expands and becomes more substantial through the processes of bioaccumulation and biomagnification, progressing up the food chain.

Even in minimal amounts, lead and chromium are exceedingly hazardous to human beings. Manufacturers add red lead or lead tetroxide to the water bodies through the sindoor to give it an evident red colouring (Dubey & Dubey, 2016).

During idol immersion, heavy metals such as mercury, cadmium, cobalt, zinc, chromium and lead enter the river body through the presence of chemical paints and sindoor. Through food chains, these heavy metals can infiltrate into the living body. These materials do not dissolve and reduce O2 levels. This happens through the following process:

Bioaccumulation is the process of accumulating substances or toxins inside a living organism over time. The fish will absorb them. Even though it will absorb in small amounts at a time, it remains in the fish's body for months. Biomagnification plays an essential role as it is the process by which a compound or toxin becomes concentrated in the tissues of organisms. Therefore, it can be understood that idol immersion plays a significant role in water pollution.

3.2. Analysis of Variation in Water Quality Parameters

The following table includes findings from an investigation that articulate the influence on parameters before, during, and after immersion. Research has suggested that all the parameters (temperature, pH, CO^2, biochemical oxygen, COD, total dissolved solids, hardness, conductivity, nitrate, phosphate, sulphate and chloride & total suspended solids, turbidity, and smell) have highly increased in the water body (Dubey & Dubey, 2016).

A temperature rise can be noticed due to the chemical & aerobic, and anaerobic biological reactions. This enhances the solubility of other newly produced chemical products as well. The pH of water is essential as it affects many chemical reactions and microbial activities.

Algal growth is the most crucial requirement for photosynthesis, and CO^2 is essential for algal growth, which is churned out by microbial activities. When CO^2 disintegrates in water, it reacts chemically in small proportions with H^2O to form carbonic acid, H^2CO^3. The rapid dissociation of H^2CO^3 impacts the carbonate equilibrium and pH into H+ and HCO^3 ions in H^2O.

DO decreased continuously till it reached 0 levels, which could create dangerous anaerobic conditions. This indicated that it is not suitable for idol immersion.

The biochemical oxygen demand or the amount of oxygen bacteria require to decompose organic matter in the water, is determined by the quantity of biodegradable organic compounds in the water. Although they have a strong inverse relationship with DO, higher BOD values correspond directly with higher nutritional levels. For example, the table below shows an increase caused by an increase in the idols' organic material decomposition.

The potential of water to absorb oxygen during the decomposition of organic waste, which indicates the level of pollution in the water body, is referred to as COD. Due to the decay of materials used in idolatry, the incubation period also increased, which led to an increase in COD.

The total amount of mobile charged ions, minerals, salts, and metals in a given unit volume of water, which is directly related to the purity and quality of water, is called TDS. TOD increased significantly due to the dispersal of chemical colours used in idolatry and different days of incubation.

The impotent eutrophication index in water transparency is the presence of suspended solids. The increase in TSS was due to vast quantities of inorganic and organic materials. In addition, the turbidity and bad smell increased due to the discolouration of chemical paints from the idol.

Hardness is a crucial indicator of water quality. A high overall hardness value was noted upon immersion, according to various researchers.

The conductivity of water indicates the existence of charged ions and particles capable of carrying an electric current. It is reliant on the ions' existence, overall concentration, mobility, and the system's temperature. A reliable indicator of water quality is discovered to be electrical conductivity.

Table 3. Variation in water quality parameters - pre-immersion, during immersion & post immersion (Dubey & Dubey, 2016)

	PARAMETERS	PRE-IMMERSION	IMMERSION	POST-IMMERSION	SITE 1	SITE 2
1	**Temperature**	22.3	26.76	23.7	27.2	28.3
2	**pH**	7.2	6.8	7.3	5.7	5.9
3	**Free CO2 (mg/L)**	14.06	16.22	15.04	32.9	37.4
4	**DO (mg/L)**	8.8	8.2	8.7	4.7	3.8
5	**BOD (mg/L)**	2.4	2.9	2.8	14.7	17.4
6	**COD (mg/L)**	19.7	28.8	22.3	57.4	63.6
7	**TH (mg/L)**	124.7	168.9	129.6	254.8	314.7
8	**TA (mg/L)**	175.3	196.8	182.6	247.9	298.6
9	**TDS (mg/L)**	87.4	149.5	98.4	614.7	878.5
10	**Conductivity (mS/Cm)**	0.32	0.98	0.38	1.24	1.76
11	**Turbidity (NTU)**	9.7	14.8	10.4	67.2	94.6
12	**Smell/Appearance**	Nil	Nil	Nil	bad/black	Bad/Black
13	**TSS (mg/L)**	143.5	214.7	165.2	1830.8	2353.6
14	**TMP (cfu/mlx 10-4)**	0.03	0.05	0.04	4.9	7.8
15	**NO^3**	0.023	0.056	0.47	79.56	87.9
16	**PO^4**	0.043	0.087	0.047	0.64	0.84
17	**SO^4**	34.53	54.9	38.9	78.9	107.6
18	**CL^-**	8.21	23.5	13.8	38.9	56.7

The higher levels are directly associated with an increase in the metabolic activity of microorganisms in stagnant water during idol immersion. These studies demonstrate that the formation of hazardous intermediates and harmful gases under stagnant water conditions is considerably more toxic than that under flowing water.

The table illustrates that microbial attacks on idol-making materials have increased the concentration of all anions, including nitrate, phosphate, sulphate, and chloride. Increased concentration of chloride indicates pollution.

Nitrogen is present as ammonia or nitrate, whereas phosphorus is phosphate. Ammonia is toxic in nature and originates from idol wastes. Aquatic bacteria quickly utilise nitrogen and phosphorus, which could result in excessive development. Then, a drop in DO could result in anaerobic conditions.

The table above provides a comparison between different phases of idol immersion among various parameters.

Refer to the appendix section for a visual or graphical representation (Figure 2, Figure 3 & Figure 4) of various parameters across different years.

3.3. Description of Health Hazards by Toxic Metals

There are a number of health hazards due to exposure to this toxic heavy metal concentration. Some of them are as follows:

Table 4. Health hazards associated with heavy metals in chemical colours

METAL	HEALTH EFFECT
MERCURY	Elemental (inhaled): ALI, fever, vomiting, and diarrhoea; Caustic gastroenteritis caused by ingesting inorganic salts nephrotic syndrome, nausea, a metallic taste in the mouth, gingivostomatitis, tremor, neurasthenia, and hypersensitivity (Pink disease) Eye, skin, and stomach irritation; a cough; chest pain; difficulty breathing; lack of sleep; excitement; confusion; a headache; sensations of weakness or exhaustion; and weight loss. *(Centres for Disease Control & Prevention, 2019) & (ENVIS- Tripura State Pollution Control Board, n.d.)*
CADMIUM	Oxide fumes, proteinuria, lung cancer, osteomalacia, kidney illness, and brittle bones are all examples of pneumonitis *(Centres for Disease Control & Prevention, 2017) & (ENVIS- Tripura State Pollution Control Board, n.d.)*
COBALT	Fibrosis of the lungs, irritation in the skin, eyes, nose, and throat, cancer hazard, reproductive hazard, asthma, affect heart, thyroid, liver & kidneys skin, eye, nose, and throat irritation *(New Jersey Department of Health & Senior Services, 1998) & (ENVIS- Tripura State Pollution Control Board, n.d.)*
ZINC	Vomiting, diarrhoea, and abdominal pain are symptoms of MFF (oxide fumes), and copper deficiency causes anaemia, neurologic degeneration, osteoporosis, pancreas damage, and a drop in HDL cholesterol levels. *(Centres for Disease Control & Prevention, 2018) & (ENVIS- Tripura State Pollution Control Board, n.d.)*
CHROMIUM	Some of the side effects that can happen include GI haemorrhage, hemolysis, acute renal failure (Cr6+ingestion), pulmonary fibrosis, lung cancer (inhalation), perforated eardrums, kidney damage, liver damage, pulmonary congestion and edoema, upper abdominal pain, nose irritation and damage, respiratory cancer, skin irritation and erosion, tooth discoloration, and allergic contact dermatitis. *(United States Department of Labor, n.d.) & (ENVIS- Tripura State Pollution Control Board, n.d.)*
LEAD	Anaemia, stomach discomfort, nephropathy, foot-drop/wrist-drop, encephalopathy (headache, convulsions, ataxia, obtundation), and encephalopathy are all symptoms of this condition. Young children: Slower growth, problems with learning and behaviour, damage to the brain and nervous system, and difficulties with speech and hearing. *(Centres for Disease Control & Prevention, 2022) & (ENVIS- Tripura State Pollution Control Board, n.d.)*

The sophisticated ancient tradition of borrowing clay from the riverside, transforming it into idols, and immersing it back in the river completes the auspicious cycle which symbolises the cycle of creation and dissolution in nature. Materials such as clay from the riverside, wooden sticks, metals, cloth, and natural colours were used to make the idols. However, this has now been replaced by modern methods such as POP (Plaster of Paris).

Plaster of Paris is a quick-setting gypsum plaster that hardens when moistened and dried and is composed of a fine white powder (calcium sulphate hemihydrate). POP is also known as calcined gypsum plaster. It is mainly used in building plaster for ceramic moulds, pottery, and surgical plaster. Gypsum being a natural material, does not dissolve in water. It raises its hardness and reduces its life-carrying capacity, thereby killing a large number of fish and other aquatic life. In the samples, pH varied significantly between the Pre and post-immersion phases, making the water more alkaline, and the average conductivity values in water significantly increased during the immersion phase. While the water's turbidity varies between the permissible and not permissible limits during the immersion phase, this indicates that the water column is entirely disrupted throughout the idol immersion period, which completely disrupts the aquatic ecosystem—the reason being the usage of plaster of Paris & other calcium compounds in making of the idol.

Table 5. Variation in concentration of Pb (highest desirable limit= 0.05) (Goswami & Mazumdar, 2016)

PARAMETERS	PRE-IMMERSION	AT IMMERSION	POST-IMMERSION
Lead (Pb) (mg/L)	0.41± 0.11	1.14 ± 0.27	0.76 ± 0.16

Table 6. Variation in pH (highest desirable limit=6.5-8.5) (Goswami & Mazumdar, 2016)

PARAMETERS	PRE-IMMERSION	AT IMMERSION	POST-IMMERSION
pH of water	8.04 ± 0.12	8.69 ± 0.15	8.21 ± 0.17

Table 7. Variation of turbidity (highest desirable limit= 5-10 NTU) (Goswami & Mazumdar, 2016)

PARAMETERS	PRE-IMMERSION	AT IMMERSION	POST-IMMERSION
Turbidity (NTU)	8.2 ± 0.2	10.3 ± 0.5	8.7 ± 0.1

Table 8. Variation of Conductivity (highest desirable limit= 250-750) (Goswami & Mazumdar, 2016)

PARAMETERS	PRE-IMMERSION	AT IMMERSION	POST-IMMERSION
EC Conductivity (in µS/cm at 250 C)	475.92±7.69	586.61±10.13	492.83±32.61

The following table shows the health of hazards due to exposure to toxic heavy metals which are found in POP:

Table 9. Health hazards associated with heavy metals in plaster of paris

METAL	HEALTH EFFECT
GYPSUM	respiratory, auditory, and neurological symptoms include tinnitus, auricle pus, aberrant muscular tension, muscle numbness, joint discomfort, chest pain, and breathing problems. *(NCBI, 2019)*
SULPHUR	asthma episodes, bronchitis, nose, throat, and lung irritation, coughing, wheezing, phlegm, nasal mucus, choking, and reflex bronchoconstriction, as well as cardiovascular disease. *(Centres for Disease Control & Prevention, 2019)*
PHOSPHOROUS	Heart artery hardening, an uptick in coughing and wheezing, skin and eye irritation with a chance of eye damage, and an increased risk of cardiovascular illness. *(New Jersey Department of Health & Senior Services, 1986)*
MAGNESIUM	a disease that feels like the flu and causes coughing, chest tightness, headaches, fever, chills, and a metallic taste in the mouth. *(New Jersey Department of Health & Senior Services, 1999)*

Table 10. Statistical significance between the various parameters (Goswami & Mazumdar, 2016)

PARAMETERS	PRE-IMMERSION	AT IMMERSION	POST-IMMERSION
Lead (Pb) (mg/L)	<0.0001	<0.0001	<0.0001
pH of water	<0.0001	<0.0001	0.0008
Turbidity (NTU)	<0.0001	<0.0001	<0.0001
EC Conductivity (in µS/cm at 250 C)	<0.0001	<0.0001	0.0298

After considering the negative impacts, it is strongly suggested to prepare idols with clay or mud instead of Plaster of Paris. This is because it is organic & biodegradable and does not contain toxic chemical metals; therefore, it does not impact the water's acidity levels negatively. Additionally, Plaster of Paris does not dissolve in water and leads to a long-term impact on the water body. Hence, the idol floats on water post-immersion. In cities, when the idols pile up in the water bodies, it is later collected with bulldozers and dumped. On the other hand, clay dissolves in water because it is a by-product of water. Nevertheless, heavy toxic metals disrupt the water levels at full capacity during this period.

3.4. Sustainable Solutions

History shows us that many pieces of art made of clay have lasted over a millennium, wherein the oldest piece dates back more than 18,000 years. Additionally, we have noticed museum relics from the Roman Empire, ancient Greece, and ancient Egypt.

It has been noticed that pottery has more longevity than any other artefacts made with other conventional materials. This is due to fired or burned clay used in the making. As for other materials, metals tend to rust over time, while other organic materials rot.

The origin of clay comes from river banks. The characteristics of the clay that further forms depend upon its purity and the distance travelled by the silt. This process takes place when the water pressure pulverises the particles.

The earliest technique for pottery is hand building. Another method is slab-building. The potter's wheel, created around 5000 BC, was highly efficient and streamlined in nature, allowing the potter to mould symmetrical shapes. After the formation, it is dried and fired to achieve permanency and longevity, known as burnt clay pottery or terracotta.

In Bengal, India, traditional pottery (terracotta) is produced by the native potters or Kumhars. The traditional terracotta and carved bricks have been utilised mostly in the architectural structuring of temples and mosques. This is due to the lack of stone produced in this region.

As we know, chemical paints negatively impact the environment. The toxic chemicals released through them raise acidity and lower the oxygen level. Thereby reducing the life span of aquatic animals or proving to be fatal. Instead of the chemical colours, we can use the following set of naturally derived pigments:

Tempera Paint has unique characteristics such as crisp, luminous, almost linear effects. We can use egg yolk, water, and earth pigments to make this colour. This ancient technique makes paint soluble in nature in water, yet it is fast-drying in nature, which further allows over-painting with more tempera or other mediums. The steps we can follow are:

Separation of the yolk from the white, removal of yolk from the sack and mixing with pigments, then usage of water in order to thin the paint. Following this, a drop or two of clove oil could be added to the spoilage.

NOTE: This paint cannot be stored.

Natural pastels which Renaissance artists used. Materials required in the making are:

Earth pigment, water, binder (limestone powder/wheat paste/honey/white soap). This needs to be grated and dissolved in a small amount of water (1:5 ratio). The binder must be included, rolled, and dried on an absorbent surface.

Mural earth paint can be produced using elements like a wheat paste/white glue, water, and earth pigment. A combination of one to two parts water with one part wheat paste is required, and then the addition of colours in a 20% by volume ratio.

Casein Paint was commonly used during the Renaissance and dated back to Asian cave paintings. It is imperishable, quick to dry, and water-soluble. Here, casein powder, borax, and earth pigment are needed ingredients.
2 tbsp of casein powder will be combined with 5 oz of warm water, then let sit overnight. Get rid of the extra water that has gathered. After that, add a casein/water mixture and combine a tablespoon of borax with 4 oz of hot water. Let it sit for an hour. After that, combine a small amount of the casein mixture with the colour when painting.

Gouache paint is comparable to illuminated watercolours. Addition of 15 cups of honey after mixing 12 cups of gum arabic powder with 1 cup of boiling water in a cup. Two drops of clove or thyme essential oil must be added in order to preserve it. In a different bowl, we will mix 1 tbsp of honey with 9 tbsp of the foundation mixture. After that, add some coloured limestone powder. (1:6 ratio). Then combine the pigment or limestone mix with the base. (1:1 ratio). NOTE: to be stored in an airtight container

3.4.1. Milk Paint & Linseed Oil Paint are the Best Options for Painting on Burned Clay Pottery or Terracotta

Milk paint has the principal ingredient, as the name suggests - milk, which acts as a binder for pigments. This

usage has been found in artefacts dating back to the ancient Egyptian period. The important factor here is that this does not release noxious vapours or VOCs. Additionally, we get saturated colours with a translucent finish.

Lemon, a quart of skim milk, a sieve, cheesecloth, and dried colour paints or acrylic paint are necessary ingredients.

One quart of skim milk needs to be combined with lemon juice before being left overnight to curdle. Pass the mixture through a cheesecloth-lined sieve to separate the curds from the whey. 4 tbsp of the dry colour pigment should be added to the curd and mixed until equally distributed. In addition, acrylic paint can be used in place of powdered colour. To get the desired colour, add one drop and stir continually.

NOTE: it can spoil quickly. Hence, it should be used within a few hours of mixing.

Linseed oil paint is composed of linseed oil, which persists for a long time. Its use has been mostly observed in Europe, where using linseed oil paint for painting has had a long tradition. Additionally, it has been noted that houses dating back 500 years still have their original linseed paint layers on them. Flax seed generates this paint, which is then processed to create raw linseed oil. It is then heated to increase its durability and speed of drying. Powdered colours and a tiny amount of a natural drying agent can be added. The only oil and pigments in this product are from natural flax seeds, making it environmentally friendly. So, there are not any kind of hazardous solvents, binders, or emulsifiers.

A few other colours that can be obtained are mentioned below, along with their chemical class. colouring matter, origin, and colour obtained:

Table 11. Types of natural dyes and their origin (CPCB, 2020)

CHEMICAL CLASS	COLOURING MATTER	ORIGIN	COLOUR OBTAINED
VAT DYES			
Indole	Indigotin	Woad, indigo	Blues
Quinone	Juglone	Walnut	Browns
MORDANT DYES			
Anthraquinones	Alizarin	Madder roots	Reds, oranges, browns
	Pseudopurpurin	Madder roots	Reds, oranges, browns
	Munjistin	Munjeet stems	Reds, browns, maroons
	Laccaic acids	Lac insects	Reds, purples, Maroons
Flavoid tannins	Catachin	Cutch	Browns, grays
Saffron, Flavone	Luteolin	Weld	Yellows, khaki
Flavonol	Quercetin	50% of all plants	Yellows, khaki
Anthocyanins	Cyanidin	Elderberries	Purples
Neoflavanoidones	Haematoxylin	Logwood	Violets, blacks
	Brazilin	Brazilwood	Reds, purples
Isoflavanoid	Pterocarpin	Sanderswood	Oranges
DIRECT DYES			
Cartinoid	Curcurmin	Turmeric	Yellows
	Crocin	Saffron, gardenia	Yellows
Alkaloid	Berberine	Mahonia wood	Yellows
Orinol	Orcein	Orchil	Purples
Benzoquinone	Carthamine	Safflower	Pinks
REACTIVE DYES			
Depsides	Atranorin	Lichens	Fawns
Despidones	Salazinic acid	Lichens	Browns

4. Conclusion

At this hour, there is an alarming need to focus on the issue of water pollution. It can be viewed from two different perspectives when it is examined. The dual personality comes into the limelight. The pandal structures follow strict government norms and are made sustainable.

There is a considerable measure of sustainability awareness with pandal committees as they rigorously adhere to stringent standards and spread awareness through their artistic exhibits in pandals. Alternately, while maintaining the sustainability perspective in the pandal

structure, the pandal committees continue to neglect to pay attention to the idol itself.

As a society, we need to take responsibility for the impact our traditions have on the environment. We must embrace sustainable practices and find ways to celebrate our festivals without compromising the world around us. It is thus time to shift our focus from just making the pandal structure sustainable to making the entire festival sustainable.

It has become progressively more crucial to draw attention to the tragedy of rampant water pollution caused by the immersion of these idols at the completion of the grand festival. This is happening due to the coatings of chemical paints and the use of POP in making the idol. This is essential to pay attention not only due to the negative impacts on aquatic life but also because these heavy metals can infiltrate the living organisms in the marine ecosystem, resulting in long-term harmful health repercussions for humans and other animals. Therefore, there is an alarming need to advocate a ban on POP and chemical colours. The best alternative is to return to our roots and begin large-scale production of idols using clay, organic matter, and organic dyes & paints that have been used historically for making idols without impacting the environment. This will lead to a surge in employment opportunities, particularly for skilled rural artisans. In conclusion, the use of sustainable materials and techniques for making idols is not only essential for the environment but also for the long-term preservation of our own culture and traditions. Therefore, together, there is a possibility to create a sustainable future, one festival at a time.

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Appendix

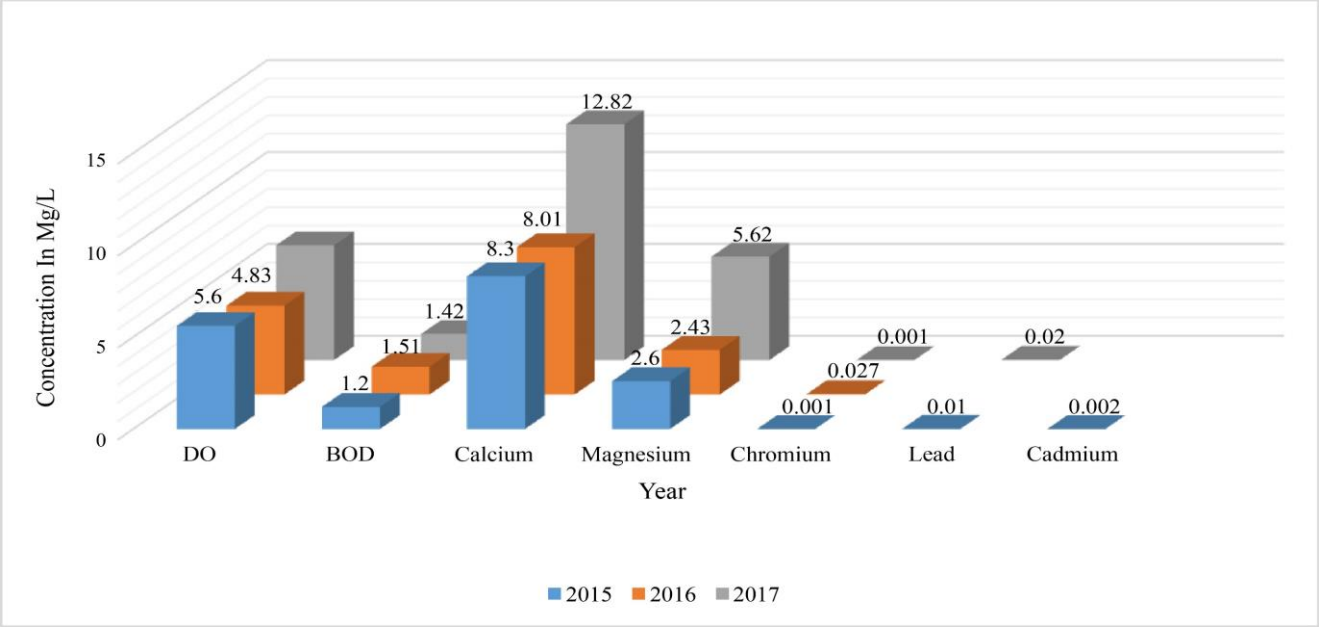

Fig. 2 Year-wise variation in water quality (Pre-immersion) (ENVIS- Tripura State Pollution Control Board, n.d.)

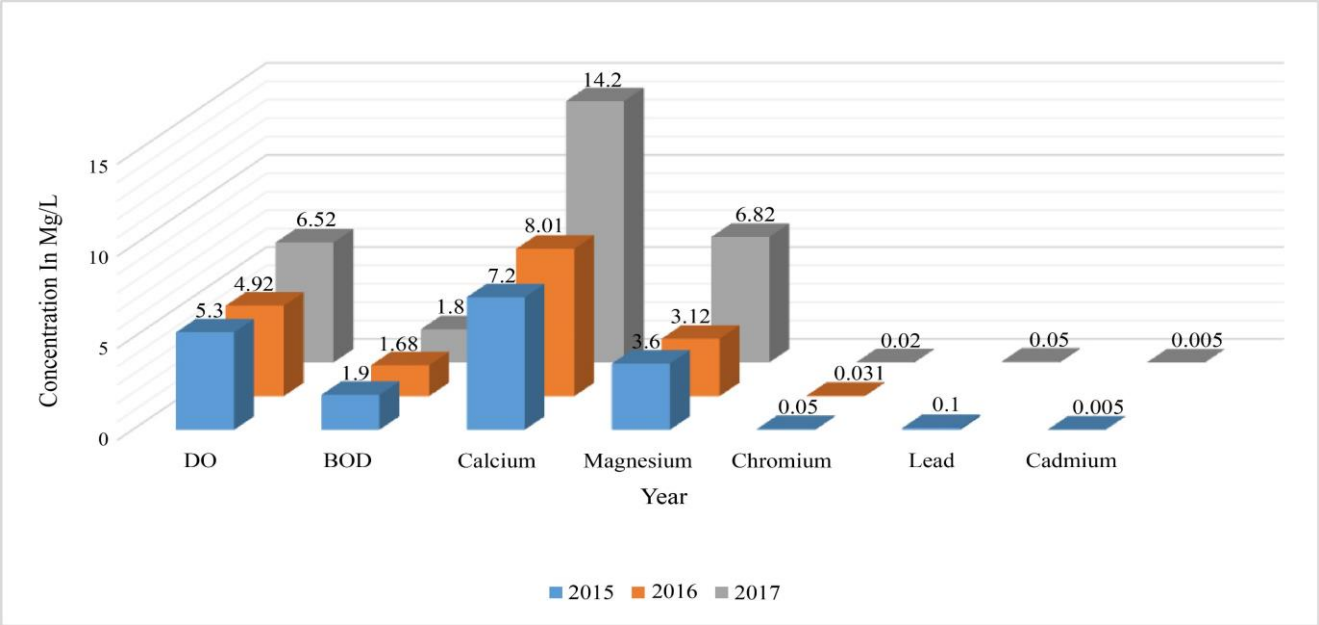

Fig. 3 Year-wise variation in water quality (During immersion) (ENVIS- Tripura State Pollution Control Board, n.d.)

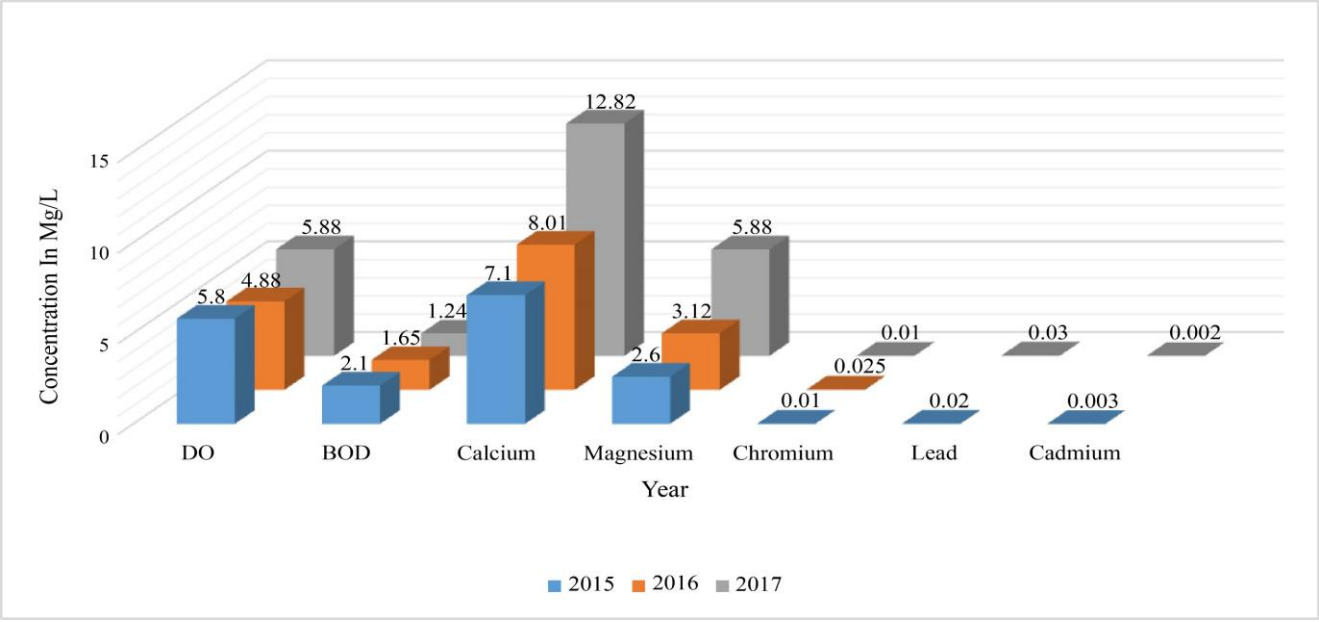

Fig. 4 Year-wise variation in water quality (Post-immersion) (ENVIS- Tripura State Pollution Control Board, n.d.)