Available online at www.ilcpa.pl

International Letters of Chemistry, Physics and Astronomy

20(2) (2014) 234-263 ISSN 2299-3843

Effects of idol immersion on the water quality parameters of Indian water bodies: Environmental health perspectives

Sayan Bhattacharya[1,3,a], Arpita Bera[1,b], Abhishek Dutta[2], Uday Chand Ghosh[3]

[1]Department of Environmental Studies, Rabindra Bharati University, Kolkata, India

[2]Department of Environmental Studies, Visva Bharati University, India

[3]Department of Chemistry and Biochemistry, Presidency University, Kolkata, India

[a,b]E-mail address: sayan_evs@yahoo.co.in , sayan.evs@gmail.com

ABSTRACT

India is a rich cultural country in which diverse cultural and religious festivals are organized. Idol is an image of a god which is used as an object of worship. After worshipped, these idols are immersed into water bodies. Idols are constructed by plaster of paris, clay, cloths, small iron rods, bamboo and decorated with different paints such as varnish, water colors etc. which can lead to significant alteration in the water quality after immersion. Paints which are used to colour these idols contains various heavy metals such as Mercury, Cadmium, Arsenic, Zinc, Chromium and Lead. Particularly, red, blue, orange and green colours contain mercury, zinc oxide, chromium and lead, which are potent carcinogens. Two heavy metals such as Lead and Chromium also add in the water bodies through *Sindoor* (a traditional red colored cosmetic powder, usually worn by married women and often used in the festivals). The floating materials released through idol in the river and lake after decomposition result in eutrophication, increase in acidity and heavy metal concentration. Heavy metal pollution caused by idol immersion can damage the ecosystem as it kills fishes, damages plants, blocks the natural flow of the water, causing stagnation. The effects of idol immersion on various water bodies of India like Bhoj wetland, Budhabalanga river, Ganges river, Hussainsagar lake, Kolar river, Sarayu river, Tapi river, Chhatri lake, north and west lakes of Bangalore and Yamuna river have been observed so far. Investigations were carried out to find out the effects of immersion of idols on water quality by collecting and analyzing the water samples from the immersion sites of the rivers. The samplings were done before the immersion, on the day of immersion and after the event and several parameters like Temperature, pH, Dissolved Oxygen, BOD, Dissolved CO_2, Conductivity, Salinity, Alkalinity, TDS, Total Hardness, Chlorides etc. are estimated. Most of the studies found significant changes in the water quality parameters during and after immersions. Central Pollution Control Board has formulated guidelines on the practice of idol immersion in water bodies, which should be followed for controlling pollution.

***Keywords*:** quality of water; rivers; dirt of waters; India

1. INTRODUCTION

India is a rich cultural country in which diverse cultural and religious festivals are organized. Idol is an image or other material object representing a deity to which religious worship is addressed or any person or thing regarded with admiration, adoration or devotion and also a religious Idol is an image of a god which is used as an object of worship [1]. In India, lots of idols are worshipped with all rituals in different time in a year. The time span of these kinds of festivals may vary from one and half day to five days, seven days or ten days. After worshipped, these idols are immersed (Figure 1, 2) into water bodies. Among the significant Indian festivals, some important examples are *Durga puja, Jagadhatri puja, Laxmi puja, Tazia, Ganesh puja* etc. In which the incidences of idol immersions can be observed. Thousands of *Ganesh* and *Durga* idols of various sizes reaching heights up to 20 to 40 feet are immersed every year in different water bodies [2]. These idols are made by plaster of paris, clay, cloths, small iron rods, bamboo and decorated with different paints such as varnish, water colors etc. [3]. Plaster of Paris (POP), which is cheaper and lighter, has become the favoured material to mould these idols. POP contains chemicals such as phosphorus, gypsum, sulphur, and magnesium. These idols are decorated with plastic and thermocols. Out of the all materials used in making the idol, thermocol and plastic is non bio-degradable, hence are toxic [4]. Most importantly, paints which are used to colour these idols contains various heavy metals such as Mercury, Cadmium, Arsenic, Zinc, Chromium and lead. Particularly, red, blue, orange and green colours contain mercury, zinc oxide, chromium and lead, which are potent carcinogens [5]. Two heavy metals such as Lead and Chromium also add in the water bodies through *Sindoor* (a traditional red or orange-red colored cosmetic powder from India, usually worn by married women along the parting of their hair, often used in the festivals, especially in *Durga Puja*). Lead and Chromium are very toxic even in very small quantity for human being through the process known as Bioaccumulation and Biomagnifications [6]. Through food chains, these heavy metals can enter into the living systems (may be directly incorporated through the digestive tract due to the consumption of contaminated water or food, or through non-dietary routes across permeable membranes such as gills) [7]. Immersion of these idols poisons the waters of lakes, rivers and the sea by increasing acidity and the content of heavy metals. Heavy metal pollution caused by idol immersion can damage the ecosystem as it kills fishes, damages plants, blocks the natural flow of the water, causing stagnation. It damages health of human beings also by polluting drinking water sources, causing breathing problems, blood and skin diseases [5].

When these idols are immersed in the water, these constituting components lead to significant alteration in the water quality. The floating materials released through idol in the river and lake after decomposition result in eutrophication of the river, lake etc. [8]. Non-degradable metals and organic pollutants tend to accumulate in various vital organs of fishes and lead to long term toxic effects. They also induce structural and functional abnormalities in different organs of fishes and humans [9]. However, amidst the celebrations, people tend to forget the ill effects of the practice. The most serious impact of idol immersion is on the environment. It disturbs the ecological balance by polluting water and adversely affecting the flora and fauna. The requirement of water is in all lives, from microorganisms to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization [10]. But nowadays, idol immersion is another significant cause of water pollution. In this review, the effects of idol immersion on various water bodies of India like Bhoj wetland, Budhabalanga river, Ganges river, Hussainsagar

lake, Kolar river, Sarayu river, Tapi river, Marine and fresh water bodies, Chhatri lake, north and west lakes of Bangalore and Yamuna river are highlighted.

Figure 1 & 2. Show immersions of *Durga* and *Ganesh* idols.

2. COMPOSITION AND INGREDIENTS OF PAINTS

Paint is any liquid, liquefiable, or mastic composition that, after application to a substrate in a thin layer, converts to a solid film. It is most commonly used to protect color or provide texture to objects. After detailing work over the prepared idol is sent for painting process [11]. In its most basic form, paint consists of color (the pigment) and the glue in which the pigment is suspended (the binder). Many paints also contain ingredients that add texture and bulk (fillers), a thinner (the solvent) and other additives, such as biocides and drying catalysts [11].

Pigments: Safer alternatives to the toxic compounds and heavy metals used to color conventional paint include natural pigments derived from plants, insects, iron oxides and minerals. These are usually in powder form [11].

Binders: Binders keep paint glued to a surface. The acrylic and vinyl binders in commercial paints are derived from the by-products of refining crude oil. The binders in natural paints rely instead on materials such as starch (from flour), casein (the protein in milk) and linseed oil (from pressed flax seeds) [11].

Fillers: Fillers create texture and add bulk to paint. Common fillers include whiting (powdered chalk), talcum, limestone, silica and marble. Clay is a popular filler to pair with flour, because it reinforces the binding ability of starch, and it's abundant and potentially free if you have clay soil [11].

Solvents: Solvents, or thinners, help achieve a workable consistency. The solvents in commercial paints are usually made from organic materials, but they will evaporate or "outgas," causing that new paint smell. The outgassing of these volatile organic compounds (VOCs) can cause headaches, nausea, dizziness, blurred vision and fatigue, especially in areas that are not well ventilated. The hazards are significantly worse for people who paint regularly. Natural solvents such as citrus thinners and natural turpentine are preferable, but they can still emit low levels of VOCs [11].

Additives: Commercial paint manufacturers frequently include several additives in their products, but they aren't required to list them on the can. Additives include plasticizers, foaming and antifoaming agents, driers, biocides that inhibit the growth of mold, and ingredients that improve water resistance or opacity [11]**.** Figure 3 shows the half made idols and 4 shows a painter is painting an idol.

Figure 3. Half made idol before festival.

Figure 4. A painter is painting an Idol.

3. ADVERSE EFFECTS OF HEAVY METALS USED IN PAINTS

When Idol immersed in water bodies then lots of paints which are used making of idol, those paints are also add into water bodies. These paints do not dissolve easily in the water bodies. Also these paints are contains of various heavy metals such as Mercury, Lead, Arsenic, Cadmium, Chromium and Zinc etc. Through food chain these heavy metals get into human bodies. These heavy metals have lots of adverse effect on human bodies. Here are some effects of some heavy metals are mentioned below.

Mercury (Hg): Mercury pollution can be a serious health threat, especially for children and pregnant women. Humans risk ingesting dangerous levels of mercury when they eat contaminated fish. Since mercury is odourless, invisible and accumulates in the meat of the fish, it is not easy to detect and can't be avoided by trimming off the skin or other parts. Even in low doses, mercury may affect a child's development, delaying walking and talking, shortening attention span and causing learning disabilities. Less frequent, high dose prenatal and infant exposures to mercury can cause mental retardation, cerebral palsy, deafness and blindness. In adults, mercury poisoning can adversely affect fertility and blood pressure regulation and can cause memory loss, tremors, vision loss and numbness of the fingers and toes. A growing body of evidence suggests that exposure to mercury may also lead to heart disease [12].

Cadmium (Cd): A by-product of zinc production is Cadmium. Cadmium is primarily toxic to the kidney; especially to the proximal tubular cells are the main sites of accumulation. Cadmium can also cause bone demineralization, either through direct bone damage or indirectly as a result of renal dysfunction. Cadmium is primarily toxic to the kidney, especially to the proximal tubular cells, the main site of accumulation [13]. Drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhoea, and sometimes death. Eating lower levels of cadmium over a long period of time

can lead to a build-up of cadmium in the kidneys. If the levels reach a high enough level, the cadmium in the kidney will cause kidney damage, and also causes bones to become fragile and break easily [14].

Arsenic (As): Arsenic is one of the most toxic elements. Exposure to inorganic arsenic can cause various health effects, such as irritation of the stomach and intestines, decreased production of red and white blood cells, skin changes and lung irritation. It is suggested that the uptake of significant amounts of inorganic arsenic can intensify the chances of cancer development, especially the chances of development of skin cancer, lung cancer, liver cancer and lymphatic cancer. A very high exposure to inorganic arsenic can cause infertility and miscarriages with women, and it can cause skin disturbances, declined resistance to infections, heart disruptions and brain damage with both men and women. Inorganic arsenic can damage DNA [15]. Ingestion of large amounts can lead to gastrointestinal symptoms such as severe vomiting, damage to the nervous system, and eventually death [16].

Zinc (Zn): Excess amounts of zinc lead can lead to heavy metal poisoning. The National Institutes of Health cites that gastrointestinal complaints are usually the most common side effects of zinc toxicity. Upset stomach, vomiting and diarrhoea are most common. These effects, especially nausea and vomiting, can start as soon as a half hour after ingesting large quantities of zinc. High doses of zinc have also been associated with decreased urine output, which is the number one reason for hospitalization associated with zinc toxicity. Aside from vomiting and nausea, this can lead to doziness, a metallic taste in the mouth, low blood pressure, convulsions, shortness of breath and even shock. Emergency treatment for heavy metal zinc poisoning involves fluids like water or milk to flush out the body, medications that counteract the effects of zinc and sometimes removal of the stomach contents [17].

Lead (Pb): Lead is a toxic substance that poses a variety of dangers for humans. Lead damages the central and peripheral nervous system, the kidneys and the body's ability to regulate vitamin D. Lead negatively affects the formation of red blood cells. Very high levels of lead can cause seizures, coma and death. At lower levels of exposure, a child can suffer from developmental delay, lower IQ, hyperactivity, learning disabilities, behavioural problems, impaired hearing and stunted growth [18]. Lead can cause several unwanted effects, such as- Disruption of the biosynthesis of haemoglobin and anaemia, arising blood pressure, Kidney damage, Miscarriages and subtle abortions, Disruption of nervous systems, Brain damage, Declined fertility of men through sperm damage, Diminished learning abilities of children, Behavioural disruptions of children, such as aggression, impulsive behaviour and hyperactivity. Lead can enter a foetus through the placenta of the mother. Because of this it can cause serious damage to the nervous system [19].

4. EFFECTS OF IDOL IMMERSION ON THE WATER QUALITY OF INDIAN RIVERS AND LAKES

Water pollution occurs due to the discharge of municipal sewage both domestic and industrial without any treatment which brings considerable changes in the river water quality in addition to many religious activities now became a threat to the ecosystem [20,21].

Traditionally, idol immersion activities are going on in our country. After idol immersion, materials which are used in idol making that do not dissolve easily in water, thereby reducing the oxygen level and psychochemical characters are become changed in the

water bodies. The changes in the water quality parameters in the major water bodies in India due to idol immersion are discussed below:

4. 1. Saryu River

The Saryu River flows through the Indian states of Uttarakhand and Uttar Pradesh. The Sarayu forms at the confluence of the Karnali (or Ghaghara) and Mahakali (or Sharda) in Bahraich District [22]. The immersion of idols of Lord *Ganesh* and *Durga* during *Ganesh Ustav* and *Navratris* festivals is a major source of contamination and sedimentation to the river. The festivals of *Ganesha Chaturthi* and *Durga Puja* witness a massive community involvement. To match the contemporary ethos, new materials are being used for modernising the representation of these idols without much thought being given to the issue of toxicity and its impact on the environment [23].

Most of freshwater bodies all over the world are becoming polluted, thus decreasing the portability of the water. An investigation was carried out to find out the effects of immersion of idols on water quality of the river by collecting and analysing the water samples from the immersion site of the river. The sampling was done one week before the immersion, on the day of immersion and after ten days of the event [26]. After analysing the river water samples, it was found that before the immersion of idols the dissolved oxygen level was 15 mg/l which decreased during immersion (10 mg/l) and after the immersion activity, D.O was 11 mg/l. BOD was observed (9 mg/l) before immersion, maximum during (14 mg/l) immersion and after (11 mg/l) the immersion activity.

The average values of DO and BOD indicate the presence of organic pollution sources [23]. Earlier studies reported the high values between 23.0-56.4 mg/l and indicated the high organic pollution in river [28]. The hardness of water is not a pollution parameter but indicates water quality. The BIS recommend the limit of total hardness for drinking water purpose to be 300 mg/l and WHO has set 100 mg/l. Hardness was reported between 94.0 and 167.3 mg/l in Hanuman Taal, Jabalpur [29]. The results of total hardness were 35 mg/l (before immersion), 41 mg/l (during immersion) and 50 mg/l (after immersion). Turbidity was recorded 30 NTU, 60 NTU and 55 NTU during the three stages of the activity respectively [23]. The water column is disturbed completely during idol immersion causing higher turbidity [3].

Though magnesium is non-poisonous, it increases the hardness of water. The concentration of Calcium, Magnesium, and Cadmium in the river water was 38.14 mg/l, 8.78 mg/l, 0.003 mg/l before the immersion which increased to 51.57mg/l, 11.58 mg/l, 0.012 mg/l during the immersion and was 60.93 mg/l, 15.75 mg/l, 0.03 after the immersion respectively. Manganese, Lead, Iron, Mercury were found 0.091 mg/l , 0.192 mg/l,0.123 mg/l, 0.575 mg/l before the immersion and 0.182 mg/l, 0.219 mg/l, 0.311 mg/l, 0.617 during immersion and 0.299 mg/l, 0.411 mg/l, 0.521 mg/l, 0.811 after the immersion [23].

So, the findings of the study revealed that the water quality degraded after the immersion of idols as some of the parameters were above the permissible limit and also reveals a clear picture of the status of water quality at different stages which shows in Figure 5. The higher concentration of some parameters is probably due to heavy pollution load due to the immersions, resulting in the deterioration of the natural water body. Therefore, it is suggested that the authorities should conduct environmental awareness programmes, particularly before the festival to educate the public of the city and make them aware of the harmful environmental effects of immersion of idols. By doing that pollution can be reduce [23].

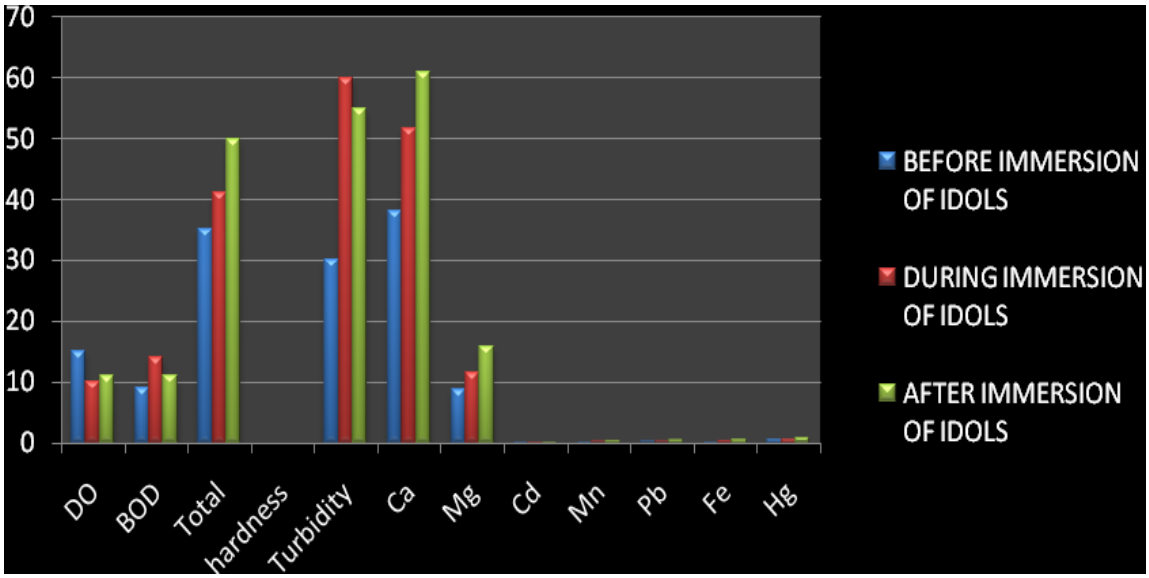

Figure 5. Shows Changes in concentration of some water quality parameters in Saryu river before, during and after the immersion of idols.

4. 2. Kolar River

The Kolar River (Kolhar River) is a river of Nagpur district, Maharashtra, India, flowing southeast from above the town of Saoner to its juncture with the Kanhan River. It is in the Godavari river basin [32]. In Kolar River, after Ganesh and Durga puja thousands of idols were immersed. An investigation was carried out to find the changes of some water quality parameters, after idol immersion in Kolar river. For this investigation two sampling stations have been selected. Station 1 was near Shiv Temple, Pahlepar and station 2 was near Borujwada, Saoner.

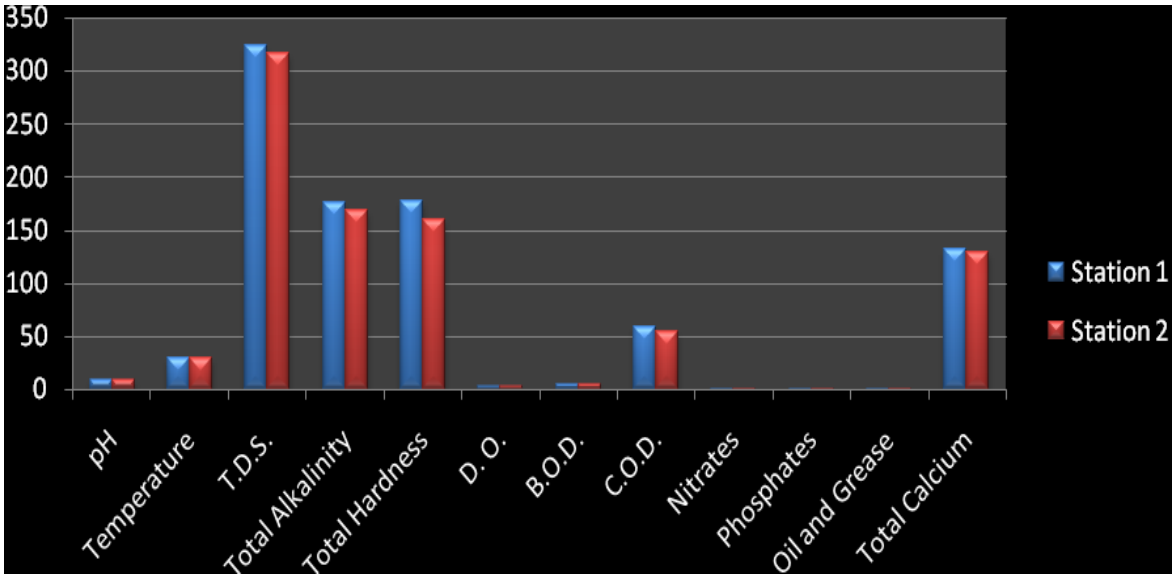

Figure 6. Shows Physico-chemical parameters of Kolar river at Station 1 and Station 2.

Samples were collected and preserved from both the stations as per standard methods. Samples were collected during idol immersion successive three days of immersion activities from both the stations. pH of river at two stations were found to be 8.6 and 8.3 respectively.

In present study, water temperature, T.D.S, Total alkalinity, Total hardness, D.O, BOD, COD, Nitrates, Phosphates, Oil and Grease, Total calcium were found to be 30 and 29, 324 mg/l and 31 6mg/l, 176 mg/l and 168 mg/l, 177 mg/l and 159 mg/l, 2.4 mg/l and 2.6 mg/l, 4.1 mg/l and 4.4 mg/l, 59.14 and 54.12, 0.025 mg/l and 0.019 mg/l, 0.043 mg/l and 0.040 mg/l, 0.54 and 0.49, 132 mg/l and 129 mg/l station wise respectively (Figure 6). The present study on assessment of idol immersion on water quality of Kolar river shows that the idol immersion has negative impact on physical and chemical properties of water.

4. 3. Budhabalanga river

Budhabalanga River is a river of Eastern India and North east Odisha with a length around 175 km. This river plays important and major role in economic and social growth and development in Balasore. The people of Balasore are always excided for celebration of festivals. The immersion of idol of Lord *Ganesh* (Figure 7), Lord *Viswakarma* and Goddess *Durga* during month of August to October is a major source of contamination and sedimentation to the River Budhabalanga. About 500 or more Ganesh idols and about 150 Durga idols were immersed during 2011 in Balighat immersion point. Balighat point was selected as sampling station [37]. Water samples were collected at morning hours a week before of immersion, during immersion and ten days after immersion.

Figure 7. Shows an immersion of Ganesh idol.

After analysing the river water samples, it was found that Calcium, Magnesium, Cadmium, Chromium, Mercury, Manganese, Lead, Iron and Arsenic were 24.05 mg/l, 17.56 mg/l, 0.019 mg/l,0.018 mg/l, 0.058 mg/l, 0.2 mg/l, 0.13 mg/l, 0.87 mg/l, 0.124 mg/l respectively before the immersion and during immersion 56.11 mg/l, 21.70 mg/l, 0.024 mg/l, 0.020 mg/l, 0.0592 mg/l, 0.44 mg/l, 0.25 mg/l, 1.35 mg/l, 0.169 mg/l respectively. After 10 days of idol immersion Ca, Mg, Cd, Cr, Hg, Mn, Pb, Fe, As were found 68.16 mg/l, 35.18

mg/l, 0.036 mg/l, 0.029 mg/l, 0.067 mg/l, 0.65 mg/l, 0.291 mg/l, 1.75 mg/l, 0.173 respectively and 45 days of idol immersion 35.27 mg/l, 19.71 mg/l, 0.022 mg/l, 0.019 mg/l, 0.059 mg/l, 0.23 mg/l, 0.205 mg/l, 0.94 mg/l, 0.134 mg/l respectively. These data revealed that the water of River Budhabalanga is deteriorated due to the immersion of different idols [37]. The study also made a clear picture of the status of water quality at different stages in Budhabalanga River, which shows in Figure 8.

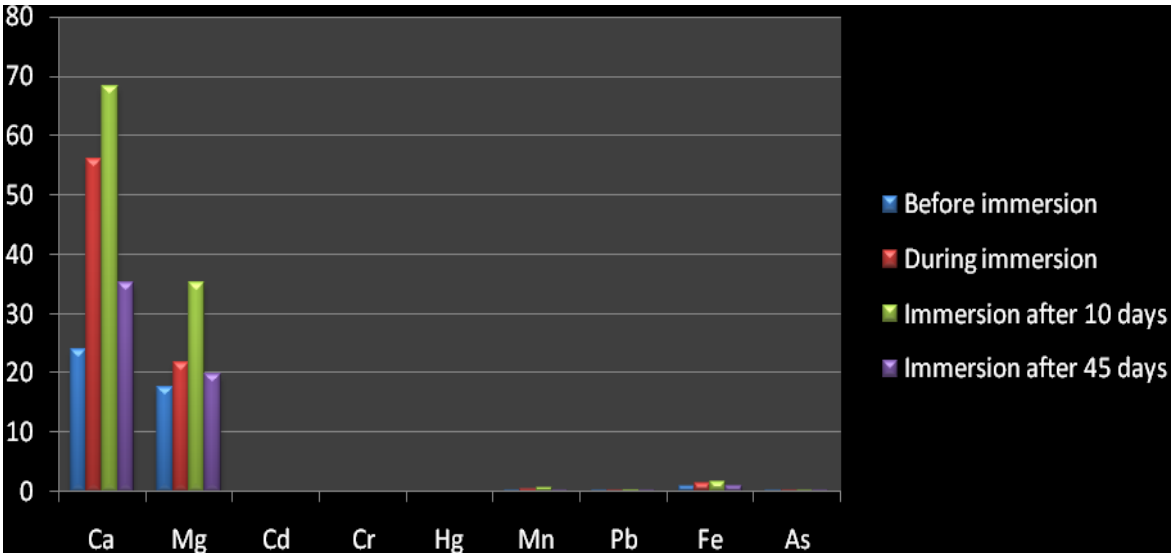

Figure 8. Shows changes in concentration (mg/l) of some chemical pollutants in Balighat Immersion Point of Budhabalanga River before, during and after immersion of idols.

4. 4. Ganga river

The Ganges or Ganga is a 2525 km. long trans-boundary river of Asia which flows through India and Bangladesh that empties into the Bay of Bengal and it is the third largest river by discharge [38]. The Ganges was ranked as the fifth most polluted river of the world in 2007. Pollution threatens not only humans, but also more than 140 fish species, 90 amphibian species and the endangered Ganges river dolphin [39]. The Ganga Action Plan, an environmental initiative to clean up the river and for the proper management of water pollution [40,41].

After worshipped, a huge number of *Jagadhatri* idols are immersed every year in the holy river Ganga at Ranighat, Chandernagore, West Bengal. A study highlighted the water quality status in Ganga river during *Jagadhatri* festival. The study mainly emphasized on the changes of water quality parameters during pre-immersion, immersion and post-immersion periods of idols into the river Ganga. After idol immersion the temperature of river water was 33.0 °C recorded during pre-immersion period, 30.4 during immersion and 31.2 °C in post-immersion periods. After idol immersion, pH ranges between 7.26 (pre-immersion) to 7.91(during immersion) and after immersion pH was 7.65 [42]. From the study, Transparency and Conductivity was found 32.90cm and 210.30 µS/cm respectively before immersion. During immersion and after immersion Transparency and Conductivity was 14.57cm, 283.96 µS/cm and 21.30cm, 265.48 µS/cm respectively. DO, BOD, COD, Total alkalinity, Chloride, Total hardness, Phosphate were found 5.67 mg/l, 2.25 mg/l, 11.10 mg/l, 95.67 mg/l, 14.77 mg/l, 116.33 mg/l, 0.38 mg/l respectively before the immersion and 8.29 mg/l, 3.41 mg/l,

21.77 mg/l, 167.24 mg/l, 47.77 mg/l, 136.74 mg/l, 0.94 mg/l respectively found during immersion and 6.17 mg/l, 3.18 mg/l, 17.91 mg/l, 133.01 mg/l, 25.06 mg/l, 123.27 mg/l, 0.78 mg/l respectively found after immersion of idols. From the investigation it was cleared that in Ganga river, there was marked variations in different parameters which shows in Figure 9. And also it was found that the values of these parameters significantly increased during the period of immersion and declined in the post-immersion period [42].

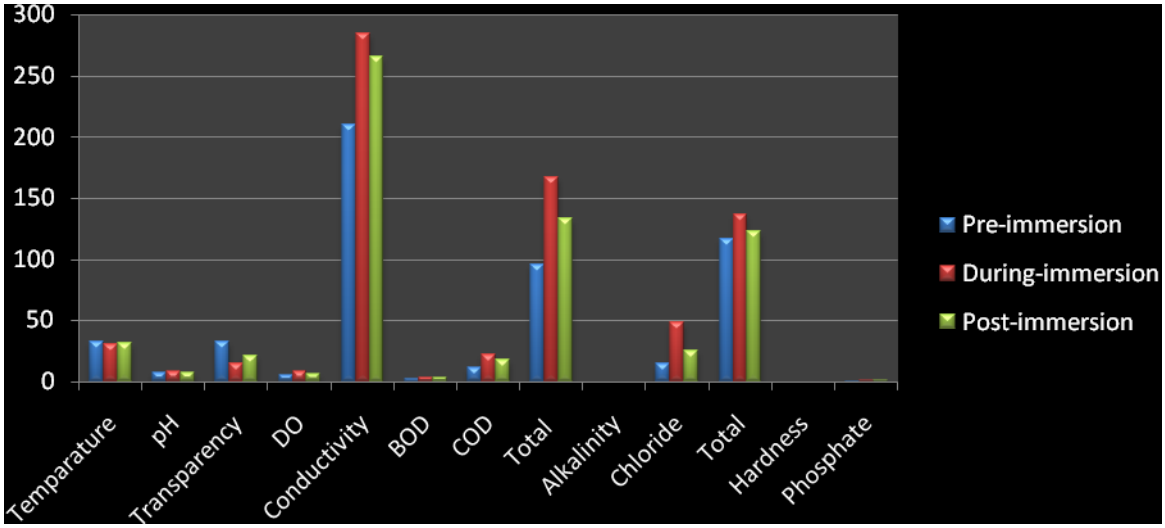

Figure 9. Shows Analysis of water quality parameters in Ranighat immersion point of River Ganga at different phases of immersion.

4. 5. Hussainsagar Lake

Hussain Sagar, is a lake in Hyderabad, Andhra Pradesh, India, built by Hazrat Hussain Shah Wali in 1562, which spread across an area of 5.7 square kilometers and this lake was the main source of water supply to Hyderabad [44]. The lake is constructed across Kalvaleru stream, one of the tributaries of Musi River passing through Hyderabad city. It is 3.2 km long and 2.8 km wide and its depth ranging from 2.5 to 12.5 m with a surface area of 446 hectares. Thousands of Ganesh idols of various sizes reaching heights up to 45 to 50 feet and goddess Durga are also immersed in the Hussainsagar Lake [2]. In 2001, an investigation carried out to find out the effects of immersion of Ganesh idols on water quality of Hussainsagar lake, by collecting and analysing the water samples from the immersion sites of the lake before and after ten days of immersion activities, following the standard methods [45]. After analysing the river eater samples, it was found before the immersion of idols Calcium, Magnesium, Molybdenum and silicon were 6.590 mg/l, 0.149 mg/l and 2.954 mg/l respectively which increased after the immersion activity 68.4 mg/l, 10.02 mg/l, 0.354 mg/l and 3.826 mg/l respectively. Over the years, the average concentration of heavy metals, especially arsenic, lead and mercury has also increased considerably in the lake water. The concentration of arsenic which is a noxious trace element, has increased nine-fold, lead and mercury which are potentially obnoxious heavy metals, had increased many-fold in the lake water after the idol immersion. After the immersion of the idols, mercury concentration increased further, to more than seven-hundred fifty times in the water. So, the investigation reveals that a huge changes in water quality in Hussainsagar lake after idol immersion which shows in Figure 10 [2].

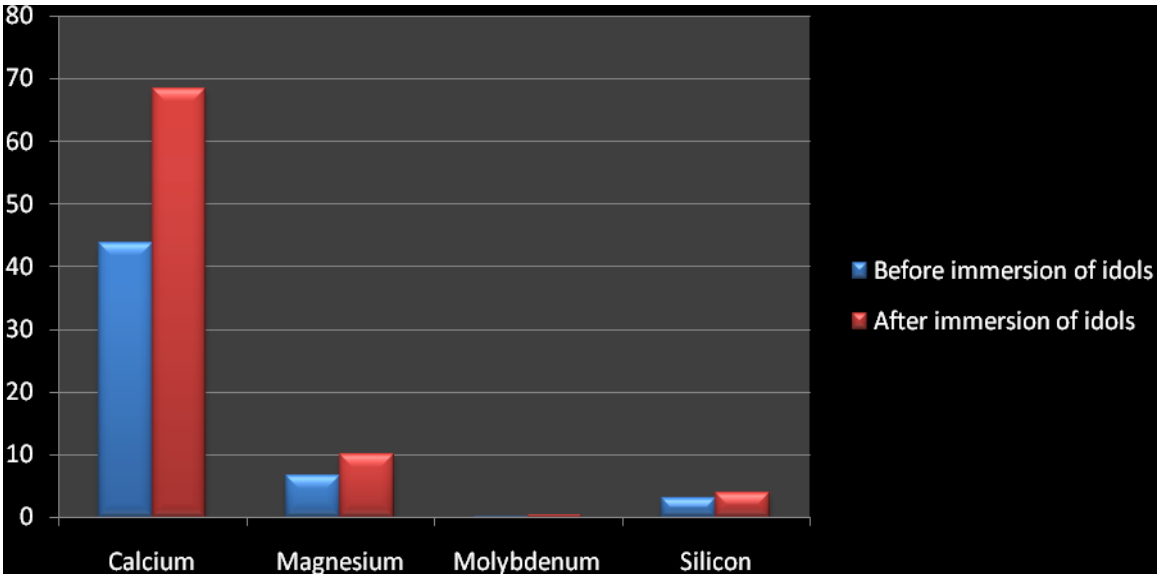

Figure 10. Shows Changes in concentration (mg/l) of some chemical pollutants in Hussainsagar Lake water before and after the immersion of Ganesh idols.

4. 6. Chhatri Lake

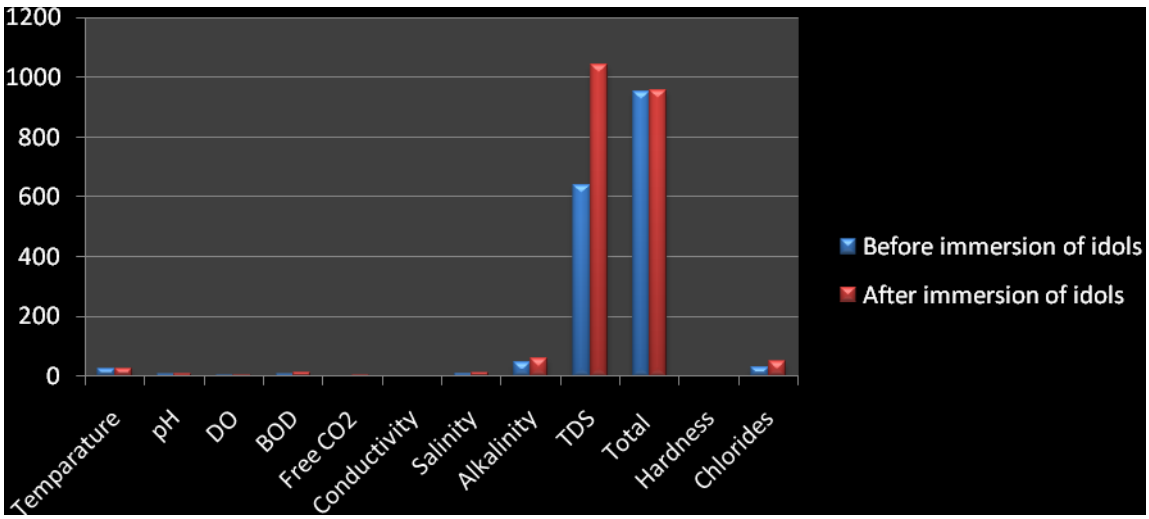

Figure 11. Shows Physicochemical analysis of water before and after Idol Immersion in Chhatri lake.

Chhatri Lake located outskirt of Amravati city, Maharashtra. In every year, after Ganesh and Durga Utsav, 3000-5000 idols of Lord Ganesh of various shapes and sizes were immersed in Chhatri Lake. Due to these religious activities, the physiochemical characteristics of water quality of Chhatri lake was changed. The present investigation study was the basis of data collected before and after immersion of idols in August 2009 Ganesh festival.

Analysis of composite water sample of Chhatri Lake shows that the water quality parameters are Temperature, pH, Dissolved Oxygen, BOD, Dissolved CO_2, Conductivity,

Salinity, Alkalinity, TDS, Total Hardness, Chlorides. Analysis of composite water sample of Chhatri Lake shows that the Temperature (26 °C), pH (8.01), D.O (3.039 mg/l) and BOD (8.0 mg/ltr.) before immersion of idol and it was directly change after immersion Temperature (27 °C), pH (8.35), D.O. (2.43 mg/l) and BOD (12.5 mg/l) respectively.

The low value of D.O. was due to increase in amount of decomposition of organic matter and effluent of sewage, respectively. Before the idol immersion, the conductivity (1.54 $x10^4$ μ mho/cm), concentration of free CO2 (1.32 mg/l), chlorides (31.95mg/l), TDS (640 mg/l), Salinity (9.2 %), total hardness (950 mg/l), alkalinity (48.8 mg/l) respectively.

After the immersion of idols, it was found that the conductivity (1.65×10^4 μ mho/cm), concentration of free CO_2 (2.112 mg/ltr.), chlorides (49.7 mg/ltr.), TDS (1040 mg/ltr.), Salinity (11.5%), total hardness (958 mg/ltr.), alkalinity (61.00 mg/ltr.) respectively. This result (Figure 11) Indicates serious environmental issue and in order to protect water bodies. This study reveals that physicochemical changes in lake water quality after immersion of idols [46].

4. 7. Yamuna River

The Yamuna, sometimes called Jamuna, is the largest tributary river of the Ganges (Ganga) in northern India [47]. Total length of the River Yamuna from its origin near Yamunotri Glacier at a height of 6,387 metres to its confluence with Ganga River at Allahabad is 1376 kilometre [48]. The total basin area of the river is 366223 km^2 which covers part of geographical area in the states of Uttaranchal, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh & NCT – Delhi [49]. The 22 km stretch in Delhi, once described as the life line of the city, today has become one of the dirtiest rivers in the country [50]. River Yamuna, the main source of water supply to national capital-Delhi, plays a crucial role in its growth [51]. Idol immersion is one cause of water pollution in the river Yamuna as it is widely worshipped by devotees in India. The immersion of idol of Lord Durga during Navratris festival is a major source of contamination and sedimentation to the lake water. During the immersion ceremony, puja articles such as polythene bags, foam cut-outs, flowers, food offerings, decorations, metal polish, plastic sheets, cosmetic items, all of which are highly polluting, are also thrown into the water. A study was carried out for assessment of water quality of River Yamuna after idol immersion. The sampling was done in three phases; pre idol immersion sampling, during idol immersion and post immersion sampling. The samples were collected from 13 different locations such as Thokar No. 8, Thokar No. 12, Ram Ghat u/s of Wazirabad, Sonia Vihar U/S of Wazirabad, D/S of Wazirabad, Garhi Mandoo, Majnu Ka Tila, Khudesia Ghat, Geeta Colony, Haathi Ghat, Nizamuddin , Kalindi kunj and Okhla Barrage of the Yamuna along the Delhi stretch, primary sites for practicing idol immersion. The composed data was analyzed for the year 2011, to understand deterioration in the water quality of the river due to idol immersion practices. From the analysis, it was found that among from all sampling station, minimum concentration (Figure 12) of some chemical parameters such as pH, BOD, COD, Total Suspended Solids (TSS) were 6.9, 1.4 mg/l, 16 mg/l, 294 mg/l respectively before the immersion and during immersion 7.3, 4.0 mg/l, 32 mg/l, 494 mg/l respectively and after immersion 7.3, 3.3 mg/l, 28 mg/l, 430 mg/l respectively. Also it was found that among from all sampling station, maximum concentration (Figure 13) of some chemical parameters such as pH, BOD, COD, Total Suspended Solids (TSS) were 7.8, 35 mg/l, 124 mg/l, 1366 mg/l respectively before the immersion and during immersion 7.9, 55.0 mg/l, 188 mg/l, 1264 mg/l and after immersion of idols all chemical parameters were becomes 7.9, 38.0 mg/l, 136 mg/l, 1268 mg/l respectively.

The low levels of DO and high BOD and Total solids levels at different sites indicate the poor water quality due to idol immersion [48].

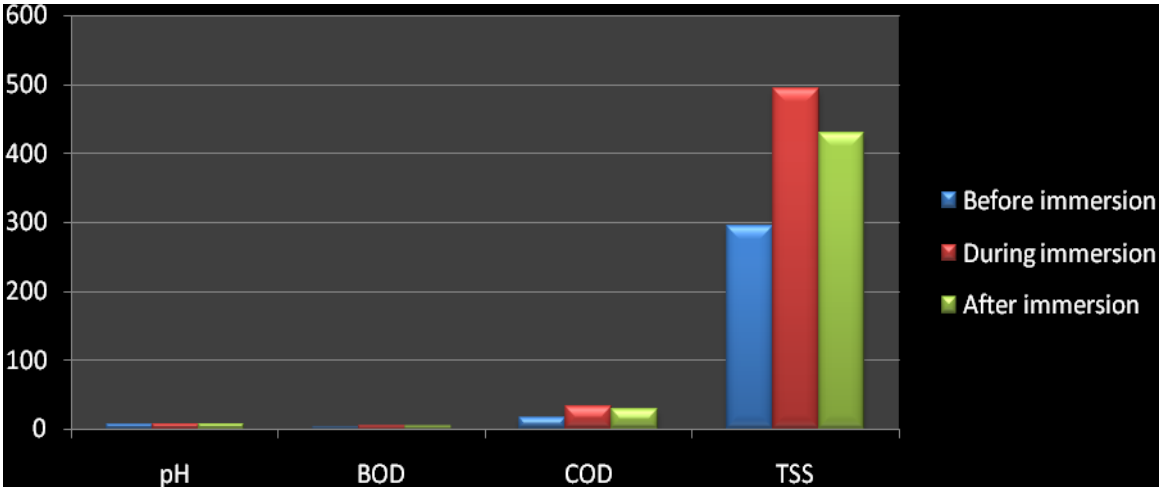

Figure 12. Shows minimum concentration of some chemical parameters Among from all the sampling station in Yamuna river.

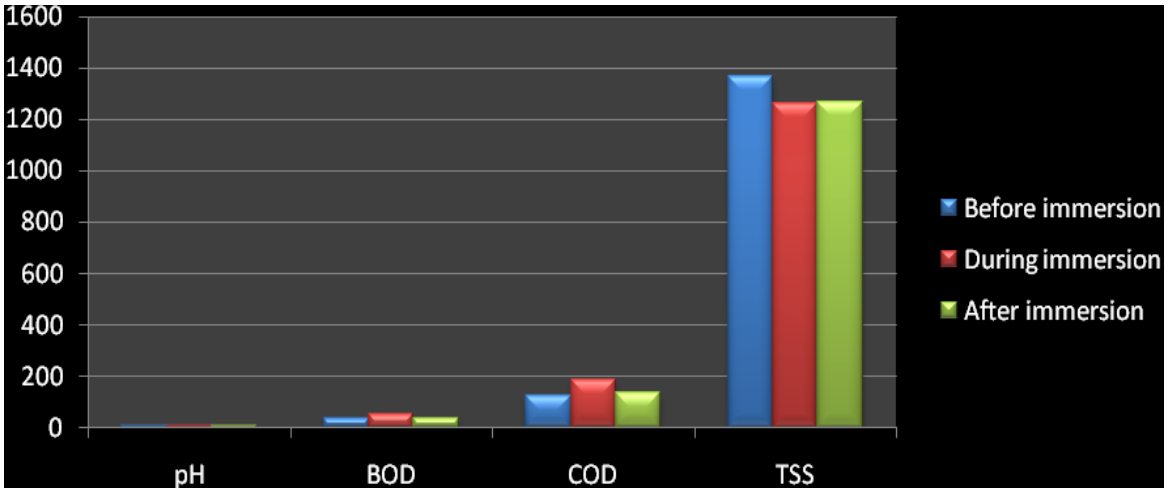

Figure 13. Shows maximum concentration of some chemical parameters among from all the sampling station in Yamuna river.

4. 8. Marine (Shivaji Park or Dadar Chowpatty beach) and fresh water bodies (Masunda lake)

Shivaji Park or Dadar Chowpatty beach is located in Mumbai, India. The beach is mainly used for walking and jogging purpose but is unfit for bathing as the faecal coliform concentration & BOD values are 6-8 times higher than the permissible levels. On designated days of immersion, devotees assemble to immersion spots at Shivaji Park and have to wait for

long hours for immersion of Ganesha idols. Due to heavy immersions in its water, the condition of Dadar beach has further deteriorated.

Masunda lake also called as Talao Pali is one of the prominent lakes in the heart of Thane city. The lake is mainly used for fishing & boating and also serves as a tourist spot. Every year thousands of Ganesha devotees gather on the lake to perform Visarjan ceremony on 2nd, 5th & 11th day of Ganapati festival. Idol immersion activities have deteriorated the water quality and negatively affected the recreational activities in the lake.

Idol immersion activities during certain festive occasions are adding to the pollution load of the Marine and Fresh water- bodies. The present work is concern about the water quality assessment to evaluate the nature and the extent of pollution in marine and fresh water body. For this purpose, two prominent idol immersing sites in Mumbai: one marine- Sea at Shivaji Park or Dadar beach and other freshwater-Masunda lake, Thane were selected as sampling site. Water samples were collected a week before of immersion, during immersion and three weeks after the completion of immersion activities and analyzed for various water quality parameters. From the assessment it was found that in Fresh water samples pH, TSS were 7.8, 13mg/l in pre immersion, 7.5, 28 mg/l in immersion and 7.6, 20 mg/l in post immersion period whereas in marine water samples pH and TSS were 7.8 and 44 mg/l, 7.4 and 78 mg/l, 7.7 and 65 in the pre immersion, immersion, post immersion period respectively. Also it was observed that in Fresh water samples (Figure 14), TDS, Total Solids, Turbidity, Conductivity, Hardness, DO, COD were found 180 mg/l, 193 mg/l, 3.9 NTU, 200 µS, 106 mg/l, 4.5 mg/l, 24 mg/l respectively before the immersion, 252 mg/l, 280 mg/l, 5.1 NTU, 275 µS, 149 mg/l, 4.3 mg/l, 28 mg/l respectively during immersion and after immersion 207 mg/l, 227 mg/l, 4.2 NTU, 268 µS, 136 mg/l, 4.4 mg/l, 26 mg/l respectively. In Marine water samples (Figure 15), TDS, Total Solids, Turbidity, Conductivity, Hardness, DO, COD were found 42420 mg/l, 42464 mg/l, 4.2 NTU, 55600 µS, 3680 mg/l, 4.2 mg/l, 79 mg/l respectively before the immersion, 45710 mg/l, 45788 mg/l, 5.4 NTU, 58600 µS, 4230 mg/l, 4.3 mg/l, 84 mg/l respectively during immersion and after immersion 44110 mg/l, 44175 mg/l, 4.8 NTU, 56700 µS, 4010 mg/l, 4.1 mg/l , 81 mg/l respectively. The current research indicates that the pollution load on water bodies has increased significantly during idol immersion period [52].

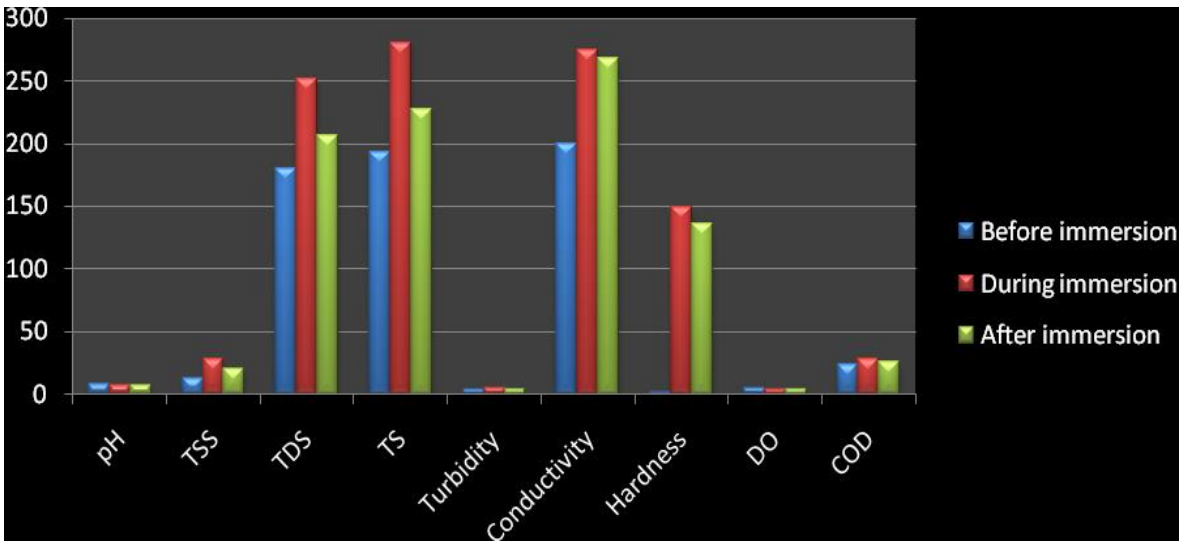

Figure 14. Shows analysis of water quality parameters of Fresh water bodies (Masunda lake) at different phases of immersion.

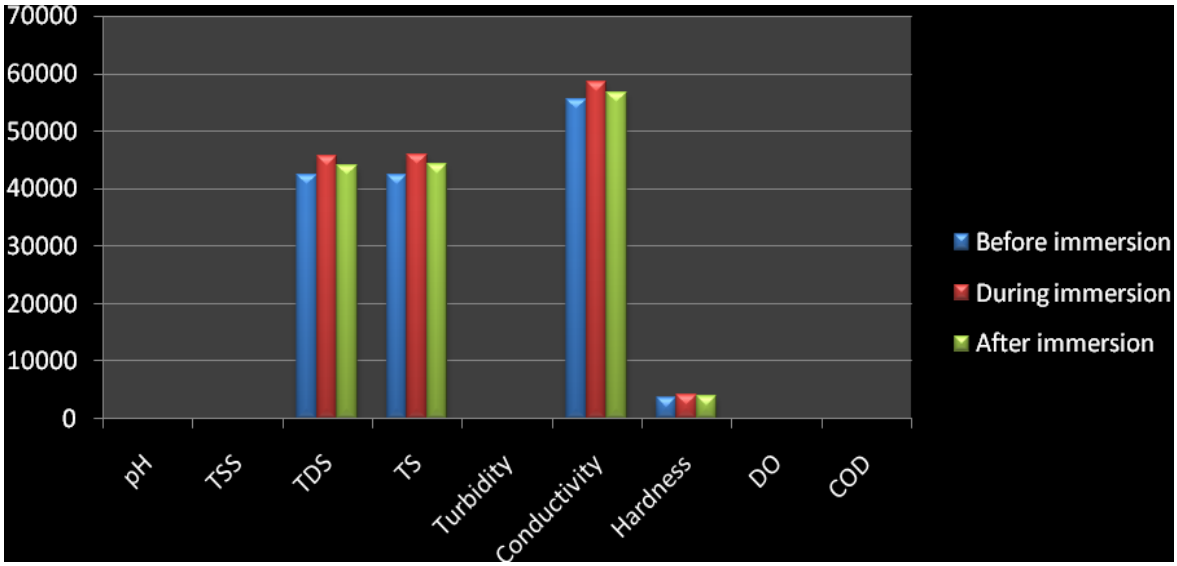

Figure 15. Shows analysis of water quality parameters of Marine water bodies (Shivaji Park or Dadar beach) at different phases of immersion.

4. 9. Lakes of Bangalore

Bangalore city is located at Latitude of 12.58° North and Longitude of 77.36°. The mean annual temperature being 24 °C with extremes ranging from 15 °C in winter to 37 °C in summer. The average annual rainfall is 900 millimetres. Bangalore, the capital city of the southern Indian State of Karnataka is the third largest city in India. The biological wealth of a lake is mainly dependent on its water quality.

This study highlights the quality of water analysed with reference to various physico-chemical parameters in selected lakes of Bengaluru North, of Karnataka state before and after the immersion of Ganesha idols. These selected lakes are Yelahanka lake, Dasarahalli lake, Machohalli lake, Gangodanahalli lake, Herohalli lake, Mallathali lake, Ullala lake and Komagatta lake.

Where, thousands of painted Ganesha idol were immersed in a day, estimated that more than a lakh idols were immersed in a week per lake. The major ions present in the lake water have been analysed. The lakes are found to be under the influence of parameters like turbidity, temperature, pH, chloride, Total dissolved solids (TDS), total hardness, alkalinity, potassium, sodium, calcium and magnesium [53].

From the samples of Yelahanka lake (Figure 16) of Bangalore, it was found that before the immersion salinity, turbidity, temperature, pH, chloride, Total dissolved solids (TDS), total hardness, alkalinity, potassium, sodium, calcium and magnesium were 3012 mg/l, 5.3NTU, 24.8 °C, 6.56, 126 mg/l, 3090 mg/l, 452 mg/l, 140 mg/l, 32 mg/l, 70 mg/l, 126 mg/l, 64 mg/l respectively. After the immersion period salinity, turbidity, temperature, pH, chloride, Total dissolved solids (TDS), total hardness, alkalinity, potassium, sodium, calcium and magnesium were 2010 mg/l ,2.3 NTU, 23.6 °C, 6.75, 177mg/l, 2750 mg/l, 559 mg/l, 72 mg/l, 32 mg/l, 36 mg/l, 183 mg/l, 25 mg/l respectively [53].

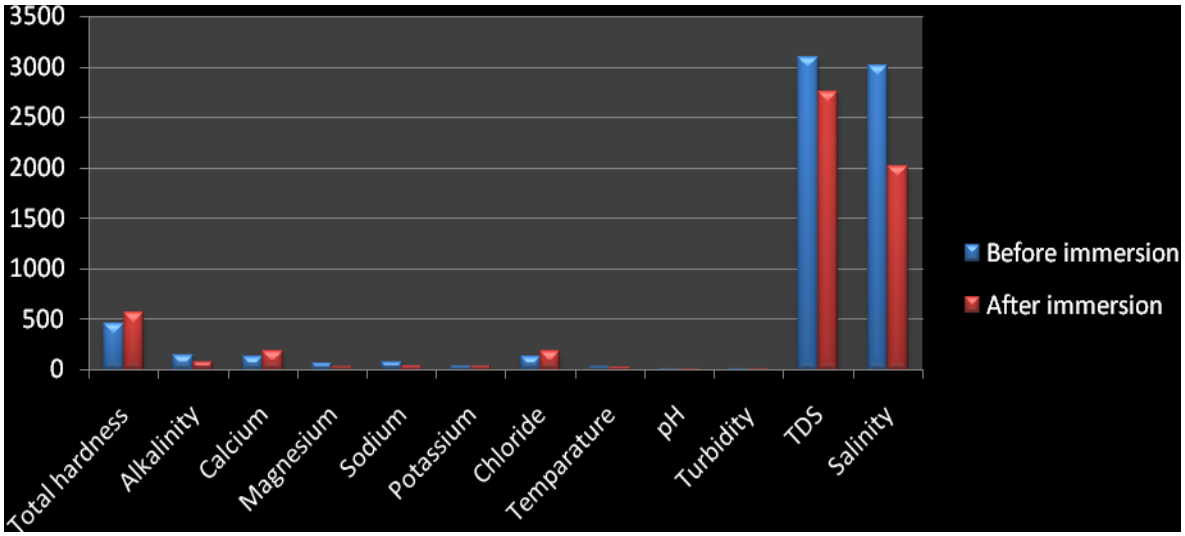

Figure 16. Shows Physico-chemical parameters of Yelahanka lake(Bangalore) before and after Idol Immersion.

From the samples of Dasarahalli lake (Figure 17) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 25.8 °C, 6.98, 4.3 NTU, 2600 mg/l, 2360 mg/l, 361 mg/l, 76 mg/l, 82 mg/l, 23 mg/l, 84 mg/l, 24 mg/l and 82 mg/l respectively. After the immersion period Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 24.5 °C, 6.98, 2.7 NTU, 2175 mg/l, 2360 mg/l, 570 mg/l, 128 mg/l, 71 mg/l, 95 mg/l, 114 mg/l, 12 mg/l and 128 mg/l respectively [53].

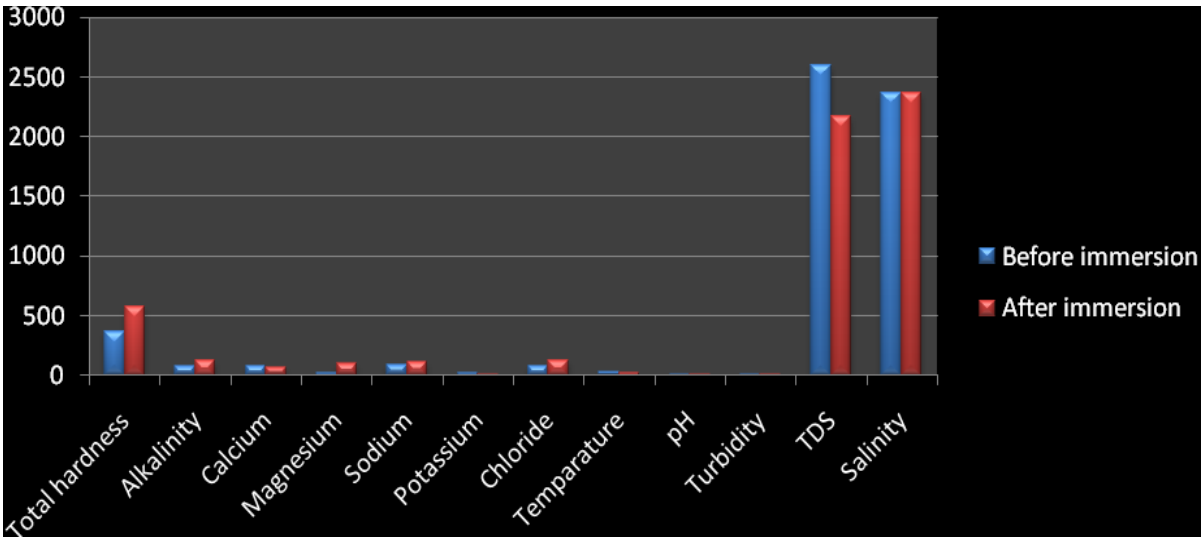

Figure 17. Shows Physico-chemical parameters of Dasarahalli lake (Bangalore) before and after Idol Immersion.

From the samples of Machohalli lake (Figure 18) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 24.8 °C, 6.21, 0.78 NTU, 13000 mg/l, 12120 mg/l, 791 mg/l, 204 mg/l, 522 mg/l, 122 mg/l, 48 mg/l, 20 mg/l and 522 mg/l respectively. After the immersion period Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 23.0 °C, 6.89, 1.5 NTU, 6750 mg/l, 6780 mg/l, 634 mg/l, 92 mg/l, 120 mg/l, 81 mg/l, 113 mg/l, 42 mg/l and 648 mg/l respectively [53].

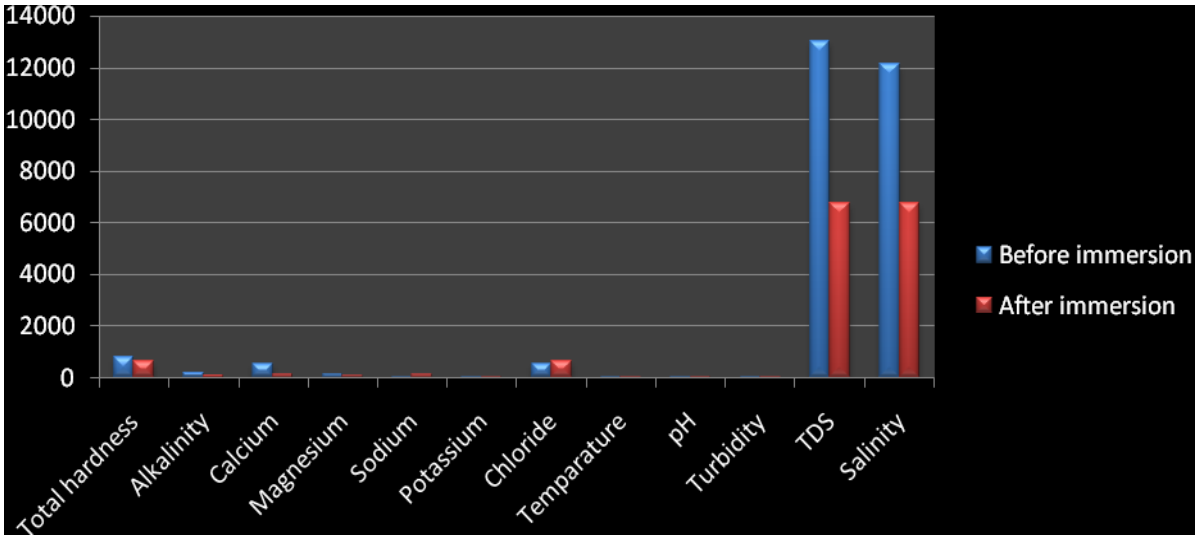

Figure 18. Shows Physico-chemical parameters of Machohalli lake (Bangalore) before and after Idol Immersion.

From the samples of Komagatta lake (Figure 19) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 21.9 °C, 6.99, 6.3 NTU, 1390 mg/l, 1012 mg/l, 224 mg/l, 32 mg/l, 137 mg/l, 41 mg/l, 45 mg/l, 24 mg/l and 137 mg/l respectively. After the immersion period Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 24.9 °C, 6.06, 64 NTU, 742 mg/l, 701 mg/l, 3763 mg/l, 32 mg/l, 803 mg/l, 428 mg/l, 54 mg/l, 40 mg/l and 589 mg/l respectively [53].

From the samples of Ullala lake (Figure 20) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Chloride were 24.9 °C, 7.36, 4 NTU, 6260 mg/l, 6010 mg/l, 542 mg/l, 228 mg/l, 106 mg/l, 75 mg/l, 30 mg/l, 9 mg/l, 106 mg/l respectively and 25.9 °C, 6.92, 52 NTU, 3210 mg/l, 3120 mg/l, 914 mg/l, 52 mg/l, 223 mg/l, 87 mg/l, 23 mg/l, 9 mg/l, 98 mg/l respectively after the immersion period [53].

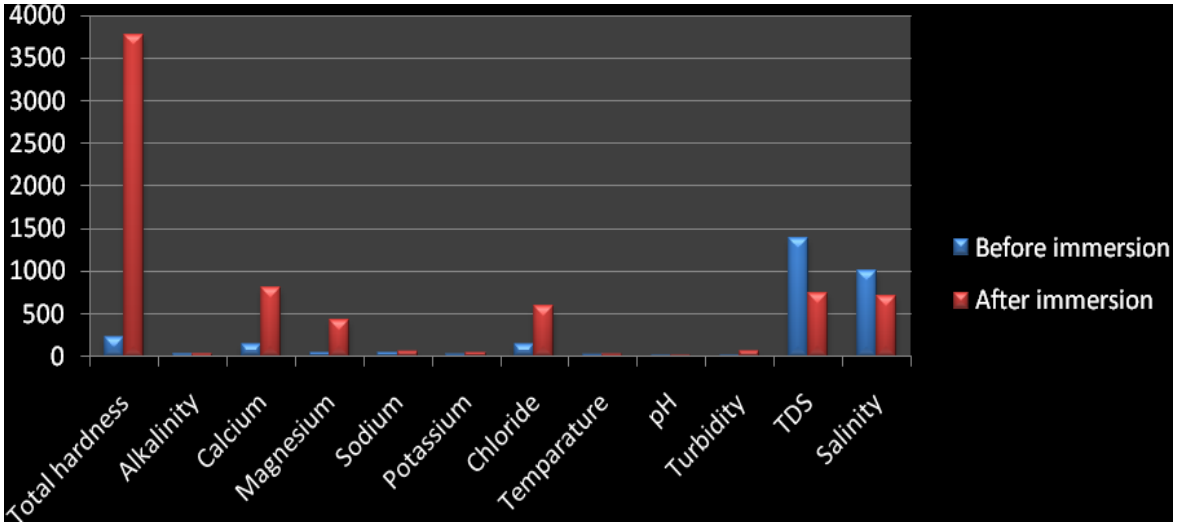

Figure 19. Shows Physico-chemical parameters of Komagatta lake (Bangalore) before and after Idol Immersion.

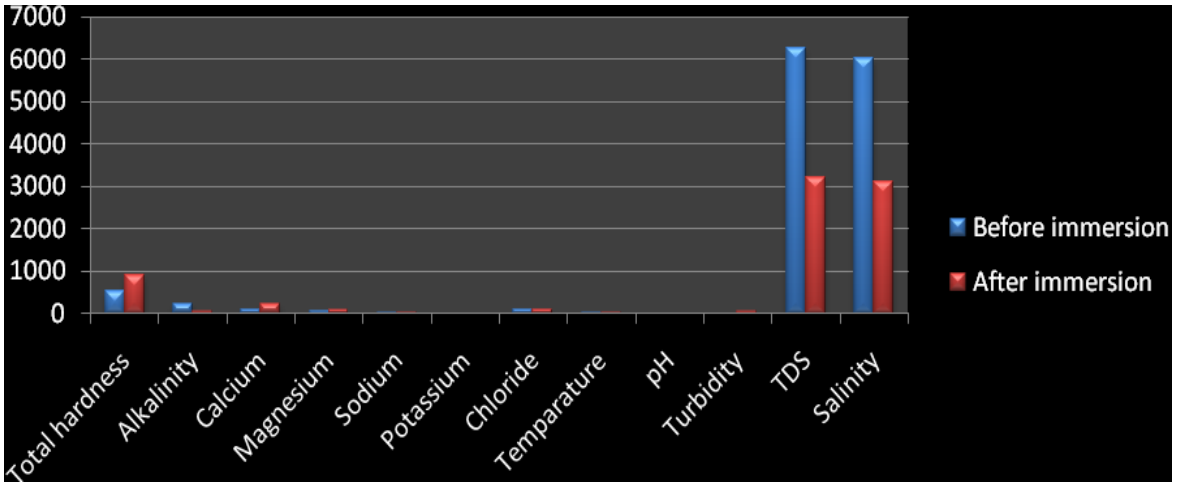

Figure 20. Shows Physico-chemical parameters of Ullala lake (Bangalore) before and after Idol Immersion.

From the samples of Gangodanahalli lake (Figure 21) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 23.0 °C, 6.65, 1.9 NTU, 13200 mg/l, 12900 mg/l, 718 mg/l, 192 mg/l, 534 mg/l, 88 mg/l, 11 mg/l, 12 mg/l and 534 mg/l respectively. After the immersion period Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 22.5 °C, 9.4, 25 NTU, 7010 mg/l, 7589 mg/l, 581 mg/l, 88 mg/l, 76 mg/l, 95 mg/l, 20 mg/l, 40 mg/l and 609 mg/l respectively [53].

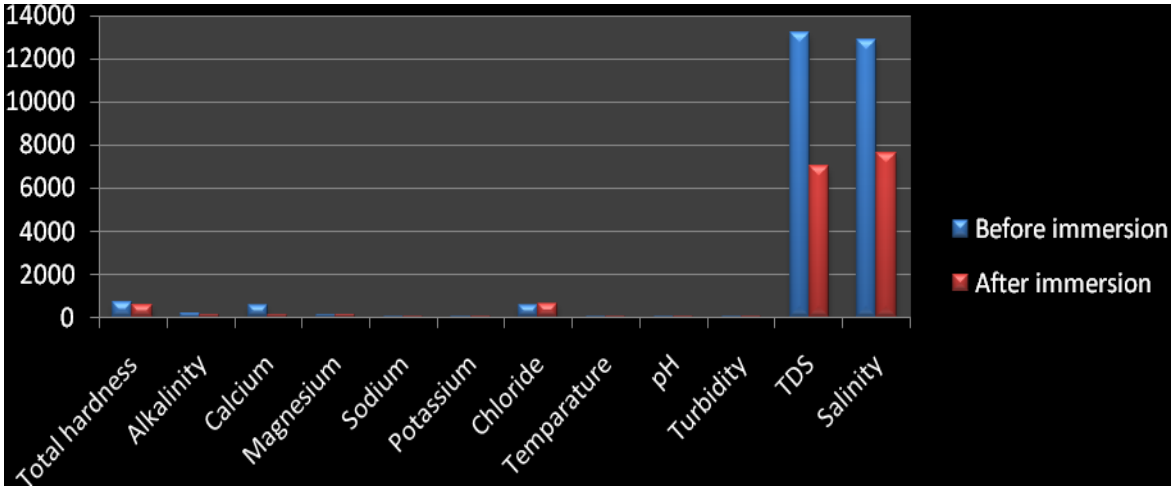

Figure 21. Shows Physico-chemical parameters of Gangodanahalli lake (Bangalore) before and after Idol Immersion.

From the samples of Herohalli lake (Figure 22) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Chloride were 20.9 °C, 7.22, 7.9 NTU, 1760 mg/l, 1250 mg/l, 348 mg/l, 96 mg/l, 43 mg/l, 61 mg/l, 107 mg/l, 36 mg/l, 43 mg/l and 21.2 °C, 6.74, 4.3 NTU, 858 mg/l, 980 mg/l, 387 mg/l, 48 mg/l, 49 mg/l, 65 mg/l, 113 mg/l, 15 mg/l, 49 mg/l respectively after the immersion period [53].

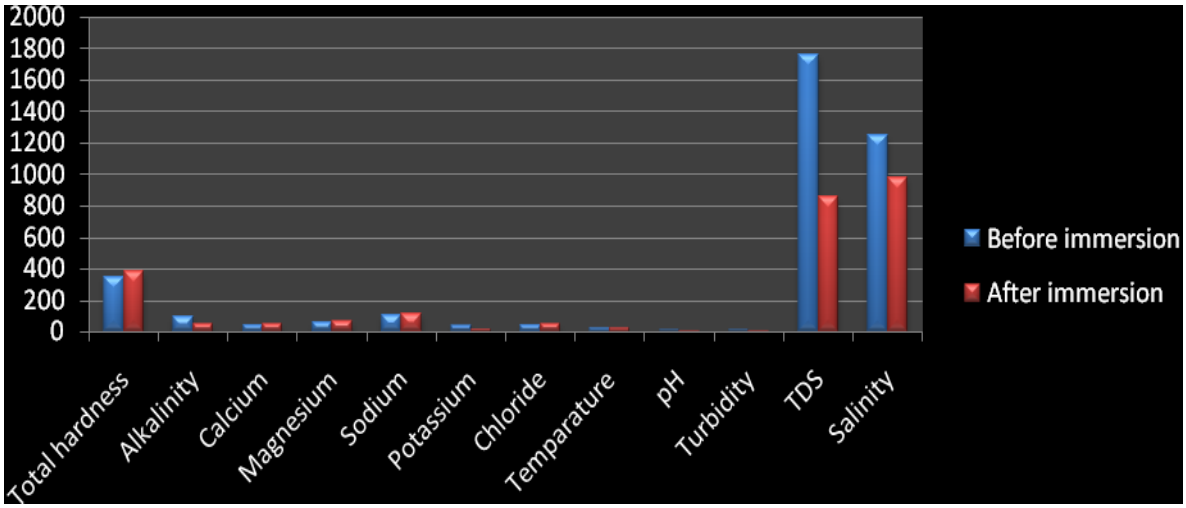

Figure 22. Shows Physico-chemical parameters of Herohalli lake (Bangalore) before and after Idol Immersion.

From the samples of Mallathali lake (Figure 23) of Bangalore, it was found that before the immersion Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 20.1 °C, 7.66, 0.33 NTU, 4350

mg/l, 3250 mg/l, 520 mg/l, 236 mg/l, 20 mg/l, 59 mg/l, 104 mg/l, 36 mg/l and 20 mg/l respectively. After the immersion period Temperature, pH, Turbidity, TDS, Salinity, Total hardness, Alkalinity, Calcium, Magnesium, Sodium, Potassium and Chloride were 22.5 °C, 6.49, 14 NTU, 2354 mg/l, 3250 mg/l, 387 mg/l, 148 mg/l, 94 mg/l, 37 mg/l, 55 mg/l, 36 mg/l and 157 mg/l respectively [53].

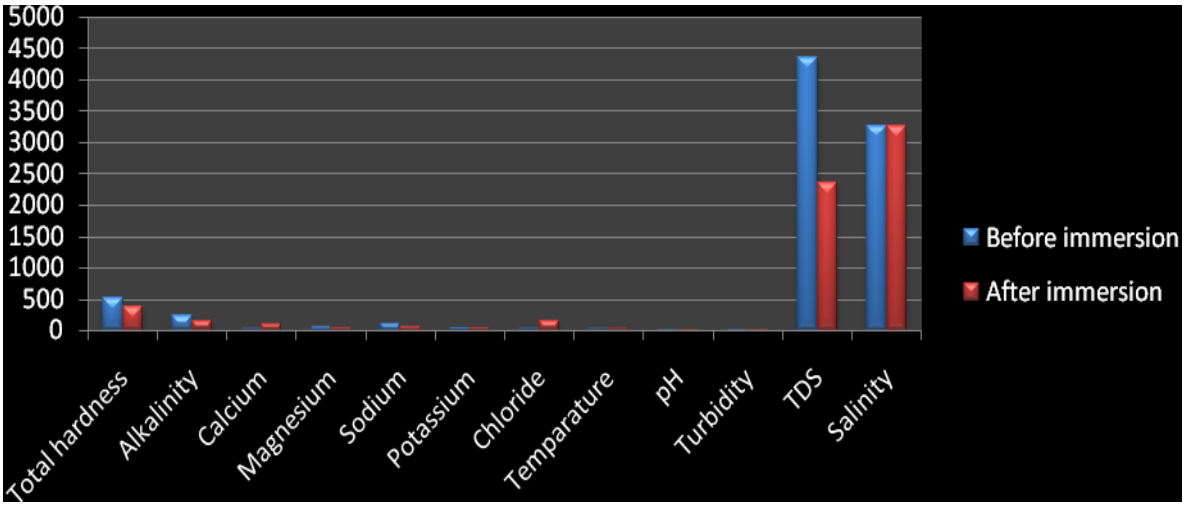

Figure 23. Shows Physico-chemical parameters of Mallathali lake (Bangalore) before and after Idol Immersion.

The significance of immersion of painted Ganesha idols is the rise in physiochemical parameters of all the above mentioned lakes. Thus the present study was concluded that different lakes water of the study areas were polluted in respect to rituals practiced in Ganesha festival and due to immersion [53].

4. 10. Upper and lower lakes of Bhopal

Upper lake situated in Bhopal is arguably the oldest man-made lake in India, and was created by Raja Bhoj in the 10th century AD by constructing an earthen dam across the Kolans River. The Upper lake (Lat 23°16'N and Long 77°18' – 77°23' E, with a catchment area of 361 sq. km. and presently having a water spread area of 31 sq.km.)has many direct and indirect uses [4]. The Lower lake (Lat 23°16’ N and long $72^0$25’ E) situated in Bhopal is an artificial lake created in 1794 AD. Lower lake situated towards the east end of the Upper lake and is an integral part of the latter. Lower lake has a small catchment area of 9.60 sq. km and water spread of 1.29 sq.km [54].

This upper lake of Bhoj wetland is a major source of potable water, a recreational hub – with boating, a cruise ship, walkways, restaurants, a tourist destination, a bird habitat and a Ramsar Site, a source of livelihood (fishing, boating, chestnut farming etc), a cultural landmark and a micro-climatic influence on the city. The upper lake is one of the most productive and resourceful, with a wide range of economic social and ecological benefits. Idol immersion is one of the pressures the wetland is facing during the festival seasons [4]. The quality of water in Lower Lake has far more deteriorated than that in the Upper Lake due io idol immersion activities [55].

The Lower Lake receives a large amount of raw sewage from its densely populated habitation. The water body is an urban eutrophic lake where the amount of nutrient is very high and O_2 depletion is very prominent [56].

In 2012, an investigation was carried out by Bhat *et. al* , to find the physico-chemical changes in water quality after idol immersion in upper lake Bhoj wetland. The physico-chemical parameters of water quality were analysed. Prempura Ghat and Sheetal Das ki Bagiya are selected as sampling station because maximum immersions take place in this station.

Pre-idol immersion samples were collected three days before the immersion activities and post-idol immersion samples were collected 15 days after the completion of immersion activities. Samples from Prempura Ghat (Figure 24), it was found that DO, BOD, COD, Conductivity, Turbidity, TDS , Zinc were 6.8 mg/l, 2.4 mg/l, 16 mg/l, 350 µS/cm, 3 NTU, 240 mg/l, 0.013 µg/l respectively before the immersion and 3.6 mg/l, 13.5 mg/l, 71 mg/l, 780 µS/cm, 26 NTU, 590 mg/l, 0.202 µg/l respectively after idol immersion activities. Samples from Sheetal Das ki Bagiya (Figure 25), it was found that DO, BOD, COD, Conductivity, Turbidity, TDS were 7.2 mg/l, 2.9 mg/l, 14 mg/l, 180 µS/cm, 5 NTU, 130 mg/l respectively before the immersion and 5.4 mg/l, 4.1 mg/l, 22 mg/l, 270 µS/cm, 7 NTU, 190 mg/l respectively were found after idol immersion activities [4].

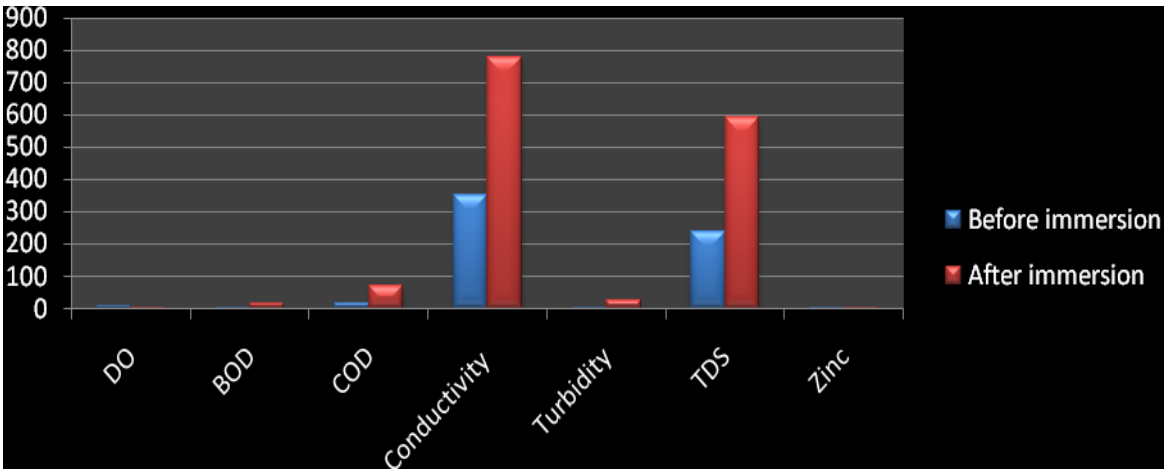

Figure 24. Shows some physico-chemical parameters of Prempura Ghat before and after Idol Immersion in upper lake of Bhoj wetland.

In 2006,Vyas *et.al* have done a research to found the water quality status in upper and lower lake of Bhopal. For that reason, samplings was done from two sites of Upper lake namely Prempura as U-1 and Kamla Park as U-2 two sites of Lower lake namely Kali mandir as S-1 and Khatlapura as S-2. Pre-immersion samples are collected 7days before the immersion activities, during idol immersion samples were collected in during immersion activities. Post-idol immersion samples were collected 15 days after the completion of immersion activities. The parameters namely Turbidity, Total Hardness, BOD, COD and Oil and Grease were analyzed. Turbidity was comparatively higher during the period at the stations S-1. Turbidity was found in the range of 30-82 FAU in pre-, while 45-154 FAU and 35-100 FAU during and post-samples, respectively, for both the stations.

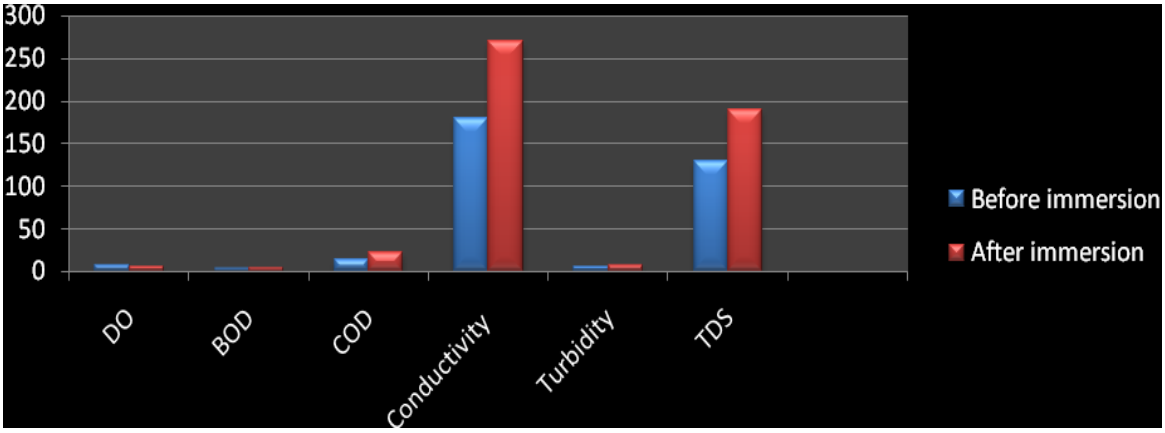

Figure 25. Shows some physico-chemical parameters of Sheetal Das ki Bagiya before and after Idol Immersion in upper lake of Bhoj wetland.

Total Hardness was found in the range of 32 – 96 mg/l in pre-, while 56 – 156 mg/l and 96 – 198 mg/l. during and post samples, respectively, for both the stations.

DO was noticed comparatively higher in during period at the station U-1. It was found in the range of 6.1 – 9.6 mg/l. In pre-, while 7.2 – 9.4 mg/l. and 7.1 – 8.4 mg/l. during and post samples, respectively, for both the stations [54]. For drinking water limit is 6.0 mg/l accordingly [57].

BOD was found in the range of 5 – 15 mg/l. in pre, while 8 – 26 mg/l. and 12.2-39 mg/l. during and post samples respectively for both the Stations. During the study higher values that cross the permissible limits. COD was found in the range of 42 – 65 mg/l. in pre, while 55- 92 mg/l. and 62 – 115mg/l during and post samples at both the station. Maximum limit for drinking water is 150 mg/l [58].Oil and grease was noticed comparatively higher in during and post period at the station S-1 [54].

In 2007, Vyas *et. al.* was done an another research work on heavy metal contamination cause of idol immersion activities in urban lake Bhopal, India. For this purpose, Samplings was done from three sites of Upper lake.

The water samples were collected from surface layer and the site of idol immersion at different intervals a week before of immersion, during immersion and 15 days after of post immersion. The samples were subjected to analysis heavy metals. It was observed that before the idol immersion the concentration of calcium, magnesium, cadmium and chromium were found 39.64 mg/l, 9.98 mg/l, 0.003 mg/l and 0.009 mg/l respectively.

During immersion activities and post immersion calcium, magnesium, cadmium and chromium were found 53.21 mg/l, 12.34 mg/l. 0.013 mg/l, 0.015 mg/l and 66.97 mg/l, 16.52 mg/l, 0.021 mg/l, 0.028 respectively. It was also found that before the immersion of idol, Manganese, Lead, Arsenic and Mercury were 0.084 mg/l, 0.243 mg/l, 0.132 mg/l and 0.689 mg/l respectively. During immersion Manganese, Lead, Arsenic , Mercury were found Manganese, Lead, Arsenic and Mercury were 0.146 mg/l, 0.364 mg/l, 0.125 mg/l, .552 mg/l respectively and after the immersion period 0.328 mg/l, 0.609 mg/l, 0.145 mg/l, 0.954 respectively (Figure 26) [59].

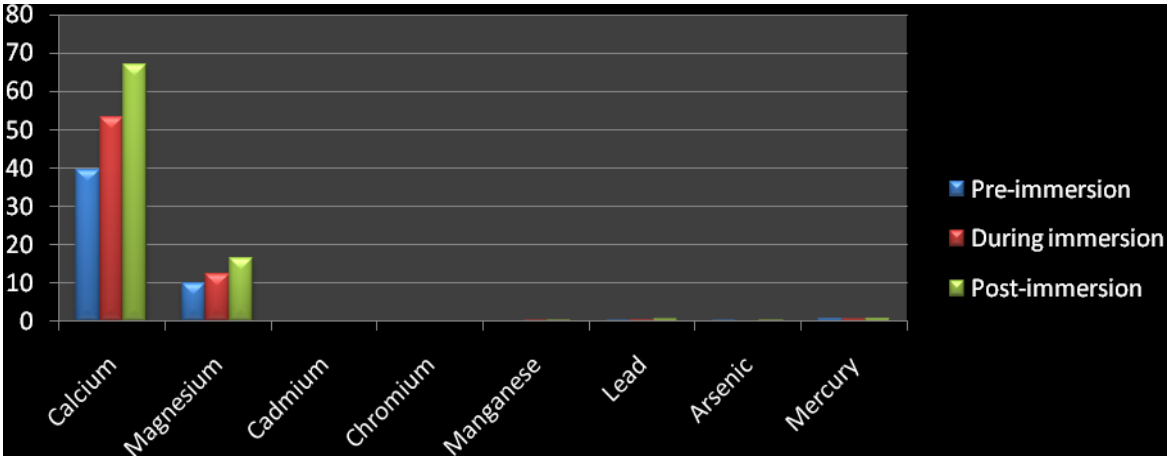

Figure 26. Shows concentration of some chemical parameters in upper lake of Bhopal before, during and after the immersion of idols.

From all the research, effect on upper and lower lake of Bhopal by different scientist which are mentioned above, revealed that idol immersion activities have negative effect on water quality of lakes. From the results of water samples study also it was found that the water quality of lake was not suitable for the drinking [4].

4. 11. Tapi River

Surat is situated on the bank of Tapi River that plays important and crucial role in its economic growth and development. Tapi River is a river of western India. It is one of the major rivers of west coast river system of India with a length around 724 km. Tapi river originates from the Satpura range of hills, Betul district of Madhya Pradesh. The flow of Tapi River covers Maharashtra, Madhya Pradesh and Gujarat state and empty into the Arabian Sea. The people of Surat city are always excited for celebration of festivals. Ganesh Chaturathy is one of the important festivals of them [21]. In this festival number of Ganesh idols in different sizes are immersed in Tapi River after worship of 10 days. In Tapi river, about 2700 idols were immersed during 2010 [60].

In 2011,a study has been done by Ujjania and Multani, to found the impact of Ganesh idol immersion on water quality of Tapi River. For this purpose Ashwanikumar immersion point (Ovara) was selected as sampling station because large number of Ganesh idols immersed on this Ghat of Tapi River. Water samples were collected at morning hours during pre immersion, during immersion and post immersion periods of Ganesh idols. After analysis of samples, it was observed that after idol immersion, Temperature of the river water was 29.8-30.5 °C. But 29.0-31.0 °C, 28.0-31.0 °C recorded during immersion and pre-immersion respectively. The minimum pH (6.9) was observed at pre- immersion while acidic pH (7.6) was observed during immersion period of idols.

The free CO_2 released by microbial activity is important for algal growth, as it is required for the photosynthesis. Low free CO_2 (17.2 mg/L and 17.6 mg/L) was found during pre immersion and post immersion period while high free CO_2 (18.8 mg/L) was found during immersion period. Before immersion of idols D.O, BOD and COD of river water was observed 6.4-6.8 mg/L, 3.2-4.8 mg/L and 19.4-41.7 mg/L respectively. During immersion and post immersion of idols D.O, BOD and COD of river water were found 6.0-7.6 mg/L, 3.6-5.6

mg/L, 40.6-44.0 mg/L and 5.6-6.8 mg/L, 2.4-2.8 mg/L, 36.6-38.3 mg/L respectively. Pre-immersion of idols to during immersion the total hardness, total alkalinity and total calcium of river water varied from 110-174 mg/L, 220-350 mg/L and 60.0-96.0 mg/L respectively. Before immersion of idol the oil and grease content found in the river water was 0.43-0.69 mg/L. But 0.9-1.3 mg/L and 0.7-0.8 mg/L was recorded during immersion and post immersion respectively [21].

In 2012, Ujjania and Mistry have done a research work to present the environmental impact of Ganesh idol immersion on water quality of Tapi River. For this purpose Pal idol immersion point (Ovara) was selected for sampling purpose because this is one of the important idol immersion point of Tapi River. Water samples were collected in morning at different intervals like pre-immersion, immersion and post-immersion. These samples were subjected to analyze the physico-chemical parameters. The environmental impact of Ganesh idol immersion activity on water quality of Tapi River was assessed and significant changes in physico-chemical properties of water were observed. In the present study pH, temperature, DO, free CO_2, Total hardness, total alkalinity, BOD, COD, oil and grease and total calcium were varied from 6.9 -7.4, 27.0 °C – 31.0 °C, 4.8 mg/l – 6.8 mg/l, 7.04 mg/l – 15.84 mg/l, 110.0 mg/l – 120.0 mg/l, 230.0 mg/l – 270.0 mg/l, 3.6 mg/l – 4.8 mg/l, 21.14 mg/l – 35.42 mg/l, 0.33 mg/l – 0.65 mg/l and 72.0 mg/l – 100.0 mg/l respectively. During immersion period pH, temperature, DO, free CO_2, Total hardness, total alkalinity, BOD, COD, oil and grease and total calcium were found 7.5 – 7.9, 28.0 °C – 31.0 °C, 2.8 mg/l – 4.4 mg/l, 12.32 mg/l – 14.08 mg/l, 166.0 mg/l – 178.0 mg/l, 310.0 mg/l – 360.0 mg/l, 3.2 mg/l– 6.0 mg/l, 42.28 mg/l – 49.14 mg/l, 0.69 mg/l – 1.20 mg/l, 126.0 mg/l – 134.0 mg/l and 7.6 – 7.7, 28.0 °C – 30.0 °C, 2.8 mg/l – 5.2 mg/l, 8.8 mg/l – 14.08 mg/l, 120.0 mg/l – 166.0 mg/l, 230.0 mg/l – 310.0 mg/l, 3.2 mg/l – 4.0 mg/l, 14.00 mg/l – 35.42 mg/l, 0.53 mg/l – 0.80 mg/l, 80.0 mg/l – 124.0 mg/l after the immersion period respectively [61].

In 2010, Desai and Tank was carried out a investigation to study deterioration of water quality of River Tapi at Surat. Sampling was done from two sites of river namely Navdi Ovara and Ramnath Ghela [62]. According to officials of civic body like Surat Municipal Corporation (SMC), nearly 20000 to 25000 idols of various sizes are immersed in the river [63]. The water samples were collected from the site of idol immersion at different intervals a day before immersion, during-immersion and a day after immersion. From the river water samples analysis, it was found that before idol immersion P^H, Temperature, Total hardness, Conductivity, Alkalinity, DO, BOD, COD, TDS, Lead and zinc were 8.5, 28.5 °C, 188 mg/l, 514μmho/cm, 8mg/l, 405 mg/l, 600 mg/l, 2165.12 mg/l, 360 mg/l, 0.153 mg/l and 0.043 mg/l respectively for both sites.

But in Navdi Ovara (Figure 27) samples pH, Temperature, Total hardness, Conductivity, Alkalinity, DO, BOD, COD, TDS, Lead , Zinc, Copper were found 7.5, 29.5 °C, 172 mg/l, 406 μmho/cm, 164 mg/l, 3 mg/l, 46.66 mg/l, 172.22 mg/l, 280 mg/l, 0.384 mg/l, 0.726 mg/l, 1.730 mg/l respectively during immersion and 8.5, 30 °C, 144 mg/l, 338 μmho/cm, 84 mg/l, 4 mg/l, 68.0 mg/l, 262.08 mg/l, 240 mg/l, 0.307 mg/l, 0.654 mg/l, 1.58 mg/l respectively in post immersion period whereas in Ramnath Ghela (Figure-28) samples pH, Temperature, Total hardness, Conductivity, Alkalinity, DO, BOD, COD, TDS, Lead, zinc, copper were found 7, 30 °C, 440 mg/l, 1739 μmho/cm, 320 mg/l, 3.5 mg/l, 350 mg/l, 1325.37 mg/l, 1200 mg/l, 0.538 mg/l, 1.35 mg/l, 1.66 mg/l respectively during immersion period and 8, 28.5 °C, 180 mg/l, 557 μmho/cm, 204 mg/l, 3 mg/l, 12.0 mg/l, 44.92 mg/l, 390 mg/l, 0.153 mg/l, 0.10 mg/l , 0.77 mg/l post immersion period respectively [62].

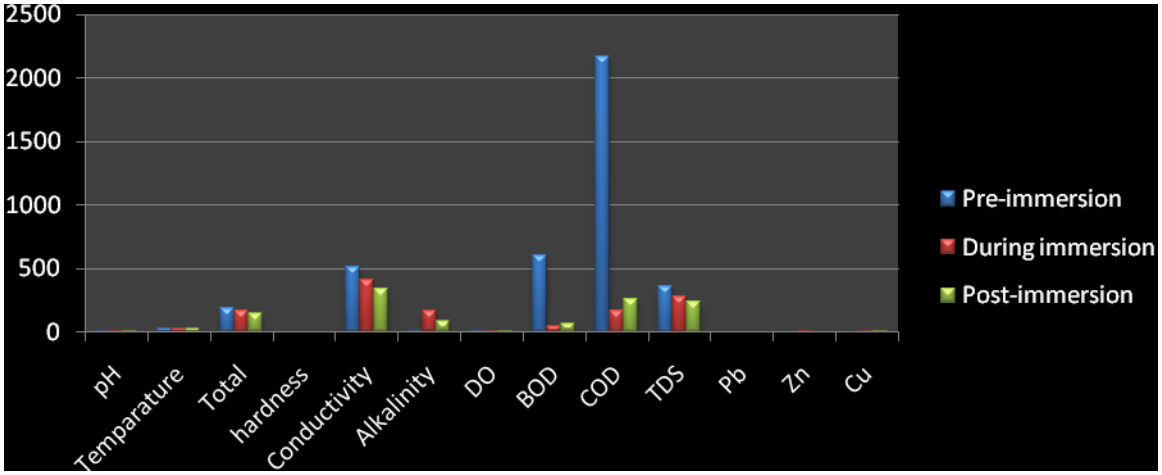

Figure 27. Shows Physico-chemical results of water samples (Navdi Ovara) of Tapi River, Surat.

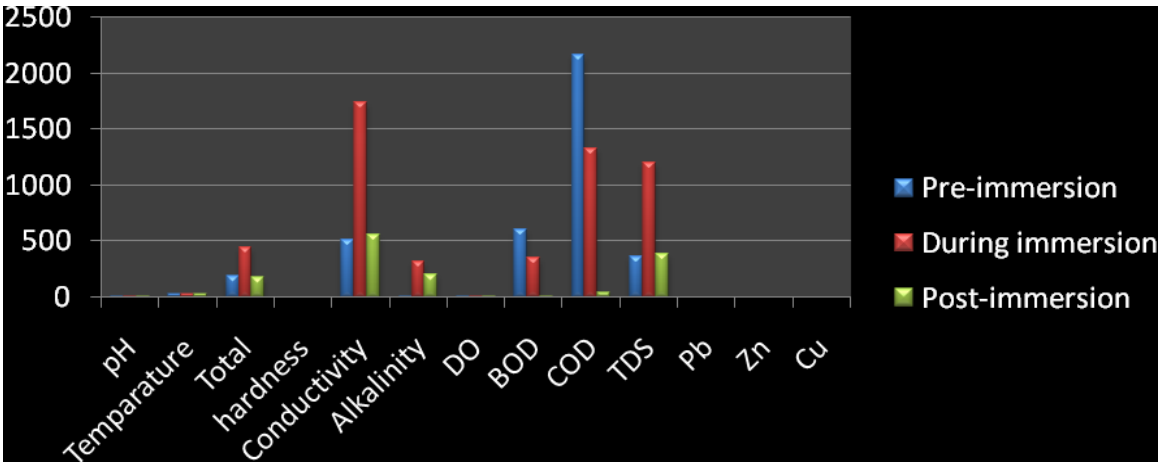

Figure 28. Shows Physico-chemical results of water sample (Ramnath Ghela) of Tapi River, Surat.

5. DISCUSSIONS AND CONCLUSIONS

In this paper, changes of physio-chemical characteristics after idol immersion on different water bodies are discussed. This discussion make a clear picture is that idol immersion activity has negative impact on water quality of all water bodies. The main reason of the deterioration of water quality in different water bodies is various religious activities such as idol immersion. Traditionally, year by year, this idol immersion activities going on. From the mythological point of view, the water bodies are related to religious sentiments but from the scientific point of view, these water bodies like ponds, lakes and rivers are not suitable for human uses [21]. After idol immersion, the water bodies were polluted especially with heavy metals. It is worrisome because due to deterioration of potable water, these water resources is harmful for domestic and drinking purpose. The cumulative effect of this usage can be disastrous because many of these metals are poisonous. During the Hindu festive season, hundreds of idols of God and Goddess are immersed in the different water bodies.

The possible ways of dealing with this grave problem is by creating awareness among the masses. The lack of awareness among our people is the main reason behind such an environmental pollution. Environmental awareness campaigns and meetings should be organized to make public aware of environmental damage caused due to immersion of idols into the river system. Different communication media may serve as a useful tool for such a campaign. A Co-ordinated Committee comprising Police, Non-Government Organization, Local Authorities, State Pollution Control Boards, representatives of puja committees and stakeholders should be set up for guiding the public in carrying out the immersion with minimal impact on water bodies [48]. Central Pollution Control Board has formulated a comprehensive set of guidelines on the practice of idol immersion in lakes, rivers and seas [64]. According to CPCB, general guideline for idol immersion mentioned below.

- Idols should be made from natural materials as described in the holy scripts. Use of traditional clay for idol making rather than baked clay, plaster of paris, etc. may be encouraged, allowed and promoted.
- Painting of Idols should be discouraged. In case idols are to be painted, water soluble and nontoxic natural dyes should be used. Use of toxic and nonbiodegradable chemical dyes for painting idols should be strictly prohibited.
- Worship material like flowers, *vastras* (clothes), decorating material (made of paper and plastic) etc. should be removed before immersion of idols. Biodegradable materials should be collected separately for recycling or composting. Non-biodegradable materials should be collected separately for disposal in sanitary landfills. Clothes may be sent to local orphan house(s).
- Public should be educated on ill effects of immersion in the holy water bodies through mass awareness programme.
- The 'Idol Immersion Points' shall be cordoned and barricaded. Synthetic liner may be placed in the bottom, well in advance. The said liner shall be removed on completion of immersion ceremony so that remains of idols would be brought to the bank. Bamboo and wooden logs, if any would be reused. Clay, etc may be taken to sanitary land fill for disposal [64].

These guidelines if followed and acted upon can help in bringing tremendous change in the water quality of water bodies post idol immersion. Debris flowing through in water bodies can be collected and treated with technical measures that can prevent the further deterioration of the river during immersion period [48]. Some other alternatives should be taken for reducing the water pollution. These alternatives are mentioned below.

- Immersing the idols in a water tank or in a bucket of water at home.
- Avoid the use of different decorative material (Thermocol sheets, polythene bags, etc.)
- Selective plantation may do at the immersion site because some has an ability to absorb heavy metals.
- Use of a permanent icons made of stones and brass, used every year [46].

Even though some cities have now provided water tanks for Ganesh immersion, they still need to ensure that the water in these tanks is properly treated before it is put back into rivers or the sea. Plaster of Paris idols with chemical paints that get immersed into such tanks are collected and have to be disposed off in an eco-sensitive manner. Companies who

specialize in water treatment should be invited to provide solutions to ensure that the water in these tanks does not pose a hazard [11].

Actually no one can change the problem. Only awareness among the masses can reduce the pollution gradually.

References

[1] Idol. Accessed on 29/5/2014, accessed from http://dictionary.reference.com/browse/idol.

[2] Reddy V.M., Kumar V.A. Effect of ganesh idol immersion on some water quality parameter of Hussain Sagar. *Current Science*, 1412-1413.

[3] Dhote S., Varghese B., Mishra S.M. 2001. Impact of idol immersion on water quality of twin lakes of Bhopal. *Indian Journal of Environment Protection* 21, pp. 998-1005.

[4] Bhat N.A., Wanganeo R., Wanganeo A. 2012. Pollution Status of Bhoj Wetland before and after Immersion of Idols. 5(1), 154-156.

[5] The times of india. Idols' immersion adds to Ganga's pollution. Accessed on 30/05/2014, accessed from http://timesofindia.indiatimes.com/city/patna/Idols-immersion-adds-to-Gangas-pollution/articleshow/16964313.cms.

[6] Bibicz, M. 1982. Heavy metal in the aquatic environment of some water bodies of the Lublin basin, *Actuatic Hydrobiology*, 24, 125-138.

[7] Handy R.D. 1993. The accumulation of dietary aluminium by rainbow trout oncorhynchus mykiss at high exposure concentrations. *Journal of Fish Biology* 42(4), 603-606.

[8] Leland, H.V. 1991. Transport and distribution of trace elements in a watershed ecosystem in environment. Boggess, W.R., and Wixsion, B.G. Eds. Castle House Publication, pp. 105-134.

[9] Gupta, P. and N. Srivastava. 2006 Effects of sub- lethal concentrations of zinc on histological changes and bioaccumulation of zinc by kidney of fish Channa punctatus (Bloch). *J. Environ. Biol.*, 27, 211-215.

[10] Singh S.P., Pathak D. and Singh R.2002. Hydrobiological studies of two ponds of Satna (MP), India, *Eco. Evn. And Cons.*, 8(3), 289-292.

[11] Ecoeist. Water pollution caused by toxic chemical paints. Accessed on 28/05/2014, accessed from http://e-coexist.com/products/ganesh-chaturthi/ganesh-2010/water-pollution-caused-by-toxic-chemical-paints.

[12] Natural resources defence council. Accessed on 30/05/2014, accessed from http://www.nrdc.org/health/effects/mercury/effects.asp.

[13] Cadmium & its adverse effects on human health. Accessed on 30/05/2014, accessed from http://www.ncbi.nlm.nih.gov/pubmed/19106447.

[14] The encyclopaedia of earth. Accessed on 30/05/2014, accessed from http://www.eoearth.org/view/article/153344/.

[15] Lenntech. Accessedon30/05/2014, accessed from http:// www.lenntech.com/ periodic /elements/as.htm

[16] Bhattacharya, S., Gupta, K., Debnath, S., Ghosh, U.C., Dhrubajyoti Chattopadhyay, Aniruddha Mukhopadhyay, *Toxicolology and Environmental Chemistry* 94(3) (2012) 429-441.

[17] The effect of too much Zinc. Accessed on 31/05/2014, accessed from http://www.livestrong.com/article/29333-effects-much-zinc/.

[18] Health Effects of Lead Exposure. Accessed on 01/06/2014, accessed from https://public.health.oregon.gov/HealthyEnvironments/HealthyNeighborhoods/LeadPoisoning/MedicalProvidersLaboratories/Documents/introhealtheffectsmedicalprovider.pdf.

[19] Lenntech. Accessed on 01/06/2014, accessed from http: //www.lenntech.com/periodic /elements/pb.htm.

[20] Bajpai A., Pani S., Jain R.K., Mishra S.M. 2003. Heavy metal concentration through idol immersion in a tropical lake, *Eco. Env. And Cons.*, 8(2), 157-159.

[21] Ujjain N.C., Azhar A.M. 2011. Impact of Ganesh Idol Immersion Activities on the Water Quality of Tapi River, Surat (Gujarat) India, *Research Journal of Biology*, 01(01), 11-15.

[22] Sarayu. Accessed on 02/06/2014,accessed from http://en.wikipedia.org/wiki/Sarayu.

[23] Shahenshah, Bhat, M.M., Andrabi, A. Z. S, Shukla, S. 2011. Effect of Idol Immersions on some Water Quality Parameters of Saryu River. *European Journal of Experimental Biology*, 1(3), 97-100.

[24] Vyas A., Bajpai A., Verma N. *Environ. Monit. Assess.* 145 (2008) 437-443.

[25] Peter W.P., William A.W., *Aquaculture* 172 (1999) 275-280.

[26] APHA, Standard methods for the examination of water and waste water. 21st edition. American Public Health Association DC, USA, 2005.

[27] ICMR, Manual of standards of quality for drinking water supplies. Special report series No.44, 2nd edition, 1975.

[28] Hostetti B.B., Kul Karni A.R., Patil H.S., *India Journal Environmental Health* 36(2) (1994) 124-127.

[29] Dhamaji S.K., Jain Y., *Pollution Research* 14(3) (1995) 341-346.

[30] Bhat M.M., Yazdani T., Narain K., Yunus M., Shukla R.N. 2009. *Journal of Wetlands Ecology*, 2, 67-73.

[31] Sen I., Shandil A., Shrivastava V.S., *Adv. Appl. Sci. Res*. 2(2) (2011) 161-166.

[32] Kolar River (Maharashtra). Accessed on 03/06/2014, accessed from http://en.wikipedia. org/wiki/Kolar_River(Maharashtra).

[33] Shukla S.S. 2004. Effect of public awareness campaign in mitigating impact of religious activities on Bhopal lakes, Abstract in image of water in religion, myths, literature, Switzerland, *Global Biodiversity Forum*, 17(2).

[34] Gupta A.K., Mishra K., Pramod Kumar, Singh C.S. and Srivastava S. 2011. Impact of religious activities on the water characteristics of prominent ponds at Varanasi (UP) India, *Plant Archives*, 11(1), 297-300.

[35] Watkar A.M., Barbate M.P. 2014. Impact of Idol Immersion on Water Quality of Kolar River in Saoner, Dist. Nagpur, India. *International Research Journal of Environment Sciences.* 3(3), 39-42.

[36] Trivedy P.K. and Goel R.K. 1986. Chemical and Biological methods water pollution studies, Environmental publication Karad India.

[37] Das K.K., Panigrahi.T., Panda R.B. 2012. Idol Immersion Activities Cause Heavy Metal Contamination in River Budhabalanga, Balasore, Odisha, India. *International Journal of Modern Engineering Research*, 2(6), 4540-4542.

[38] Ganges. accessed on 03/06/2014, accessed from http://en.wikipedia.org/wiki/Ganges.

[39] ^ a b kalpana 1 April 2007 (1 April 2007). "Ganga is dying, pollution the killer". Greendiary.com. Retrieved 4 July 2012.

[40] ^ a b Gardner, Gary, "Engaging Religion in the Quest for a Sustainable World", in Bright, Chris, et al, State of the World: 2003, W. W. Norton & Company. Pp. 256, pp. 152–176,ISBN 0-393-32386-2 Quote: "The Ganges, also known as the Ganga, is one of the world's major rivers, running for more than 2,500 kilometres from the Himalayas to the Bay of Bengal. It is also one of the most polluted, primarily from sewage, but also from animal carcasses, human corpses, and soap and other pollutants from bathers. Indeed, scientists measure fecal coliform levels at thousands of times what is permissible and levels of oxygen in the water are similarly unhealthy. Renewal efforts have centred primarily on the government-sponsored Ganga Action Plan (GAP), started in 1985 with the goal of cleaning up the river by 1993. Several western-style sewage treatment plants were built along the river, but they were poorly designed, poorly maintained and prone to shut down during the region's frequent power outages. The GAP has been a colossal failure, and many argue that the river is more polluted now than it was in 1985. (page 166)".

[41] ^ a b c d "Clean Up Or Perish", The Times of India, 19 March 2010.

[42] Sarkar R. 2013. Study on the impact of idol immersion on water quality of river ganga at Ranighat, Chandernagore (W.B.). *International Journal of Geology, Earth & Environmental Sciences.* 3(3), 24-29.

[43] Jhingran A.G. 1977. Optical appearance and interpretation of annuli on scales of Gadusia chapra (Ham.). *Journal of the Inland Fisheries Society of India* 9, 138-153.

[44] Hussain Sagar. Acceseed on 04/06/2014, accessed from http://en.wikipedia.org/wiki/ HussainSagar.

[45] APHA, AWWA, and WPCP, Standard Methods for the Examination of Water and Waste Water, American Public Health Association, Washington D.C., 1985, 16th edn, p. 1268.

[46] Shirbhate, Nayana S., Malode S.N., Wadankar G.D., Shelke P.B. *International Journal of Innovations in Bio-Sciences* 2(1) (2012) 51-54.

[47] Yamuna. Accessed on 04/06/2014, accessed from http://en.wikipedia.org/wiki/Yamuna.

[48] Kaur B.J., George. M.P., Mishra S. 2013. Water quality assessment of river Yamuna in Delhi stretch during Idol immersion. *International Journal of Environmental Sciences*. 3(6), 2122-2130.

[49] CPCB Report, (2006), Water quality status of Yamuna river http://www.cpcb.nic.in/ newitems/11.pdf, accessed on 15th March, 2012.

[50] Mishra A.K. 2010. A river about to Die: Yamuna, *Journal of water resource and protection,* 2, 489-500.

[51] Goel V and Grad IE, Quantitative Study on Microbial Pollution of River Yamuna at Delhi, http://gangapedia.iitk.ac.in/sites/default/files/Quantitative%20Study%20on%20 Microbial%20Pollution%20of%20River%20Yamuna%20at%20Delhi.pdf ,accessed on 10th March, 2012.

[52] Kaur R., *Advances in Applied Science Research* 3(4) (2012) 1905-1909.

[53] Sripathy L., Raju M.H., Renuka C., Thuppil V. *International Journal of Innovative Research in Science, Engineering and Technology* 1(1) (2012) 113-120.

[54] Vyas A., Mishra D. D., Bajpai A., Dixit S., Verma N., *Asian J. Exp. Sci.* 20(2) (2006) 289-296.

[55] Pani S. and Mishra S.M. 2000. Impact of hydraulic detention on water quality Characteristics of a tropical wetland (Lower Lake) Environmental pollution and its management. Pankaj Shrivastava, Ed. ABS Publication, New Delhi, pp. 286.

[56] Varughese B., Dhote S., Pani S. and Mishra S.M. (2004) : Impact of artificial aeration and ozonization on pathogenic bacteria of a tropical sewage fed lake, *Poll. Res.,* 23(1), pp. 199-203.

[57] WHO (1968): World Health Organization Tech. Report Sr. No. 406. Vyas A. et al. (2006) *Asian J. Exp. Sci.* 20(2), 289-296

[58] ISI. (1991): Indian Standard Specification for drinking water, IS 10500.ISI, New Delhi.

[59] Vyas A., Bajpai A., Verma N., Dixit S., *J. Appl. Sci. Environ. Manage.* 11(4) (2007) 37-39.

[60] Anonymous. Ganesh Idol Immersion Peaceful in City. Times of India, 23 September, 2010.

[61] Ujjania N.C.,Mistry C.A.2012. Environmental impact of idol immersion on Tapi river (India). *International Journal of Geology, Earth and Environmental Sciences,* 2(3), 11-16.

[62] Desai J., Tank S.K., *Journal of Environmental Research And Development* 4(4) (2010) 999-1007.

[63] SMC: The "Surat Municipal corporation" Ganesh Utsav Samiti, (2008).

[64] CPCB, Guidelines for Idol Immersion, 2006. Accessed from http://www.cpcb.nic.in/upload/NewItems/NewItem_159_Guideline_for_Idol_Imersion. pdf, accessed on 20th March, 2012.

(Received 22 September 2013; accepted 07 October 2014)