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Effect of Idol Immersion Activities on the Water Quality of Urban Lakes in Bengaluru, Karnataak

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Abstract

Immersion of painted idols and dumping of organic wastes in the lakes, as a part of religious activities, are immensely adding to water quality deterioration. Incorporation of alkaline, alkali-earth metals and heavy metals through the idol making paints are likely to promote the hardness and heavy metal concentration of water in these surface water bodies, and therefore, deteriorate the water quality. In this purview, periodic analysis of Nagavara and Ulsoor lake water were carried out to investigate the effect of idol immersion activities on the lake water quality. Water samples were collected before and after immersion activities randomly from different points of these lakes. In Nagavara lake, the maximum concentrations of calcium and magnesium were recorded to be 6.6 and 3.02 ppm, respectively after one month of immersion. The maximum concentrations of Na and K were 19.3and 42.8 ppm, respectively after seven days of immersion. In Ulsoor lake water, the EC had increased from 0.36 dSm^{-1} before immersion to 1.22 dSm^{-1} after 14 days of immersion. The nitrate content of water before immersion was 1.51 ppm which increased to 4.7 ppm, after 14 days of immersion in Ulsoor lake water. Higher BOD and COD values were recorded in lake water seven days after immersion activities. The concentrations of different inorganic ions including heavy metals (Cr, Cd and Pb) were found to increase in the post immersion period. The water of these lakes is used for irrigation as well as other purposes. Thus, proper measures have to be adopted to restore and maintain water quality in these lakes.

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Introduction

Urban lakes are inland aquatic systems supporting ecosystem through biodiversity sustenance and acts as source of water in lean season. Recently, urban lakes are in the merge of extinction due to encroachments, siltation as well aseutrophication from domestic and industrial effluents.[1] The lakes in Bengaluru are also facing similar problems as indicated by satellite images and information available with Survey of India.[1,2] These are subjected to varying degrees of degradation and pollution. The water quality deterioration in these lakes is mainly due to discharge of untreated or partially treated sewage,organic, inorganic and toxic pollutants of industrial and domestic origin. Immersion of painted idols as a part of religious activities is reported to be an important source of heavy metal contamination in the lake water.[3,4,5]

The principal components in paints include pigments, vehicles and solvents. Pigments are color contributing insoluble solids, containing heavy metals as one of the main constituents. The major lead containing pigments include red lead, leaded zinc oxide, white lead, chrome green, chrome yellow and chrome orange. Lead is present in these pigments as oxides, carbonates, hydroxides and chromates. Vehiclesare the adhesives causing the pigment to adhere to a surface. They comprise of synthetic and phenolic resins. Solvents are used to adjust the consistency of the paint. Most commonly used solvents are naphtha, mineral spirits and turpentine. Generally, solvent - based paints contain 25% binders, 27.5% pigment and 47.5% organicsolvents.[6] These paints are used for colouring idols of Lord Ganesha and Goddess Durga which are later immersed in the lakes as a part of religious rituals. Further, addition of organic matter (leaves, flowers etc.), as a part of these activities, increases BOD and COD levels which in turn affect the aquatic environment adversely.[7]Addition of *Sindur* in these water bodies (reported to contain lead and chromium) is very toxic to human beings even at very low concentrations.[8]

These heavy metals subsequently get adsorbed on the charged surfaces of silt and clay or simply get dissolved in lake water. These heavy metal laden water and sediments, if used for irrigation or as amendment, can be translocated in the plant parts and enter the human system through food chain. The transfer factors of metals in the plant system vary not only with soil properties (pH, Eh, moisture, microbial diversity, organic matter content etc.) but also with the physiology of the crop. The content of heavy metals in edible plants follows the order: leafy vegetables > root crops > fruits. It was reported that the use of contaminated lake water for irrigation purpose has not only contaminated the vegetables and cereals but also animal milk9. Regular ingestion of heavy metal contaminated food and water cause bio magnifications in human and animal systems and may adversely affect the normal physiological functions. In this context, a study was conducted with the objective of determining the effect of idol immersion activities on the heavy metals contamination and lake water quality.

Table 1: Alkali and alkaline earth metals concentrations in Ulsoor lake water before and at different intervals after immersion of idols

Period of sampling	Ca (meqL^{-1})	Mg	K (ppm)	Na
T_1	3.5	1.8	28.5	19.10
T_2	4.7	1.6	35.3	21.50
T_3	9.63	3.2	36	26.20
T_4	7.33	2.8	33.5	27.50
T_5	11.51	3.6	29	23.75
T_6	9.33	3.4	28.4	22.50
mean	7.66	2.73	31.78	23.42
S.D.	3.08	0.84	3.55	3.08

T1: sampling before 30 days, T2, T3, T4, T5 and T6: sampling 1, 7, 14, 30 and 45 days after idol immersion activities, respectively
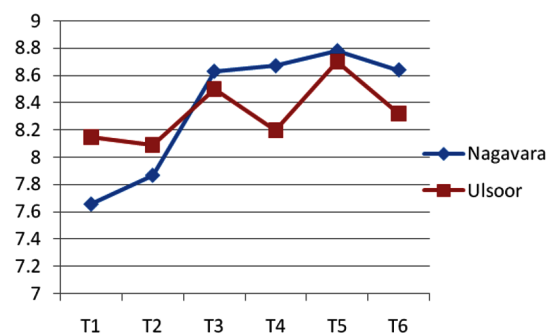

Fig. 1: Changes in pH due to idol immersion

Methodology
Location of the Lakes
Nagavara lake (13° 02' N, 77° 36' E) is one of the popular attractions of Bengaluru. The lake is situated in the outer ring road of Bengaluru and is spread across an area of 43.86 hectares. Ulsoor lake (12° 58' N, 77° 37' E) is located in central Bengaluru and begins roughly near the eastern terminus of MG Road. The lake has a catchment area of 1.5 km² fed by three drains at different locations. The surface area of the lake is 50 ha. These lakes are located in densely populated areas with possible chances of heavy metals contamination. Since they had the potential to cater to the water demand of the locality in the lean season through the conservation of large volume of water, these lakes were selected for the study.

Sampling of Lake Water
Water samples were collected from ffive randomly selected points within 20-30 feet from the immersion sites of two different lakes of Bengaluru *viz.* Nagavara

and Ulsoor, 30 days before immersion activities (T_1) and there after periodically at 1 (T_2), 7 (T_3), 14 (T_4), 30 (T_5) and 45 (T_6) days. The water samples were analysed for physico - chemical parameters viz. pH, EC, chemical constituents e.g. alkaline and alkali earth elements *viz.* Ca, Mg, K, Na and heavy metals *viz.* Fe, Pb, Cd and Cr.

Sample Preparation and Analysis
The analysis of physicochemical properties and estimation of the dissolved metal content were done after filtering the water samples (500 mL) using Whatman No 41 filter paper (0.45 µm pore size). The filtrates were preserved with 2 ml nitric acid to prevent the precipitation of metals. The samples were then concentrated on a water bath and subjected to nitric acid digestion prior to the estimation of metals using Atomic Absorption Spectrophotometer (Perkin Elmer Analyst,700). The physicochemical and biochemical water quality parameters were analysed using standard procedures.[10,11,12] The observed data were sere analyzed for the measures of central
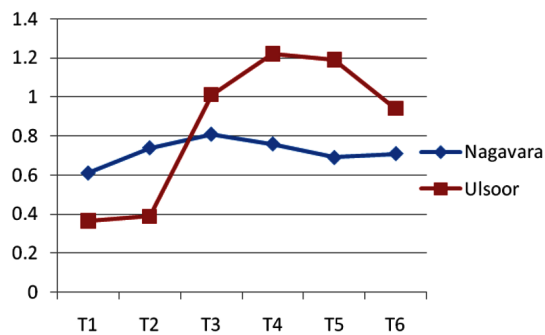

**Fig. 2: Changes in EC (dS m⁻¹)
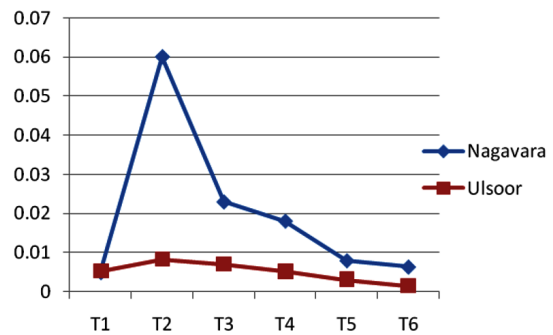due to idol immersion**

**Fig. 3: Changes in chromium concentration
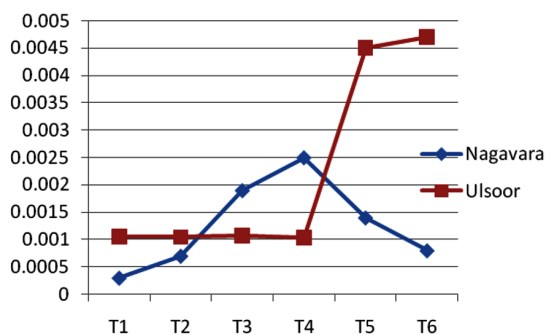(ppm) due to idol immersion**

**Fig. 4: Changes in cadmium concentration
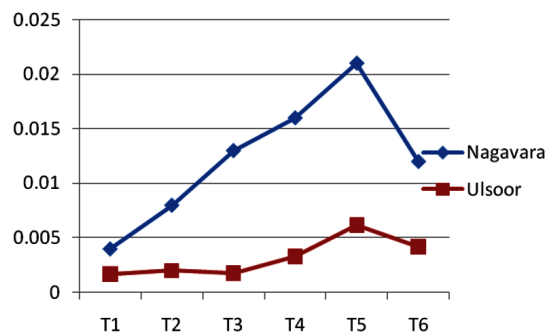(ppm) due to idol immersion**

**Fig. 5: Changes in lead concentration
(ppm) due to idol immersion**

tendency (mean) and measures of dispersion (standard deviation).

Results and Discussions

Changes in Physicochemical Properties of Lake Water Due to Idol Immersion

The EC of the Ulsoor lake water had increased from 0.36 dSm⁻¹ before immersion to1.22 dSm⁻¹ after 14 days of immersion (Fig. 2). The pH of the water increased from 8.15 to8.7, 30 days after immersion with a standard deviation of 0.23 (Fig. 1).The EC of Nagavara lake water increased from 0.61 dSm¹ to 0.81 dSm⁻¹ seven days after immersion. The average EC observed in the course of the study was 0.72 dSm⁻¹ with standard deviation of 0.06 dSm⁻¹ (Fig. 2). The pH of the water increased from 7.66 to 8.78 at 30ᵗʰ day after immersion with standard deviation of 0.48 (Fig. 1). The increase in EC of the lake waters (Fig. 1) in post-immersion period might be attributed to the incorporation of various salts during the immersion activities. Similar results were recorded in

Table 2: Alkali and alkaline earth metals concentrations inNagavara lake water before and at different intervals after immersion of idols

Period of sampling	Ca (meq l⁻¹)	Mg	K (ppm)	Na
T₁	4.6	1.9	39.8	13.5
T₂	5.3	2.6	41.4	15.5
T₃	6.6	2.9	42.8	19.3
T₄	4.7	2.6	40.7	17.86
T₅	6.3	3.02	38.4	14.7
T₆	5.4	1.79	37.84	15.4
mean	5.48	2.46	40.15	16.04
S.D.	0.81	0.51	1.86	2.13

T1: sampling before 30 days, T2, T3, T4, T5 and T6: sampling 1, 7, 14, 30 and 45 days after idol immersion activities, respectively
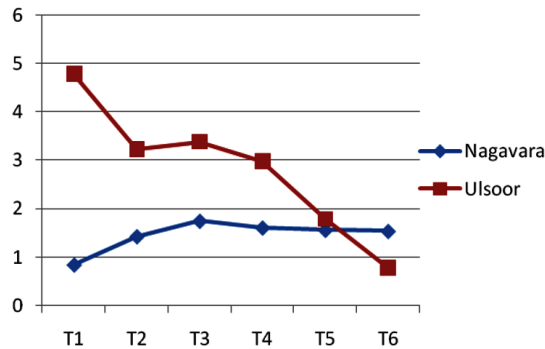

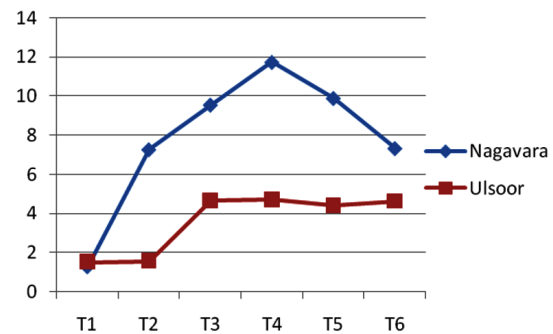**Fig. 6: Changes in iron concentration (ppm) due to idol immersion**

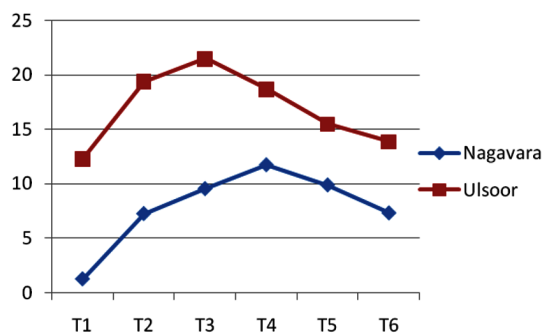**Fig. 7: Changes in nitrate concentration (ppm) due to idol immersion**

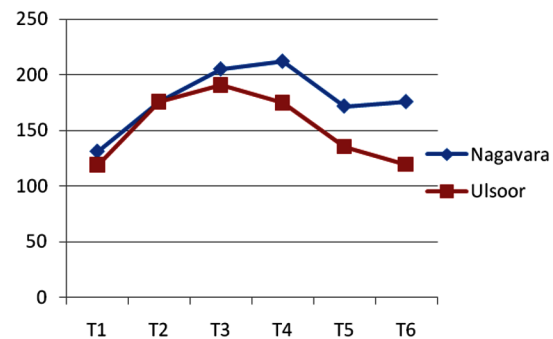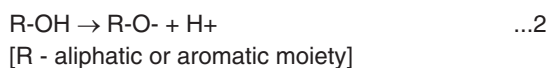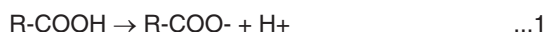**Fig. 8: Changes in BOD (mgL⁻¹) due to idol immersion**

Fig. 9: Changes in COD (mgL⁻¹) due to idol immersion

the Hebbal and Bellandur lakes of Bengaluru.[13] The difference in the mean electrical conductivity (EC) of the lake waters is a function of the degree of salt inclusion through sewage, sludge, domestic effluents and monsoonal runoff from adjoining agricultural fields along with the extent of idol immersion.[14,15,16] The decrease in pH was might be due to the decomposition of organic matter added during the idol immersion as well as from other domestic and industrial sources. The mechanism of pH reduction can be described by the following equations:

$$R\text{-}COOH \rightarrow R\text{-}COO\text{-} + H+ \qquad ...1$$

$$R\text{-}OH \rightarrow R\text{-}O\text{-} + H+ \qquad ...2$$
[R - aliphatic or aromatic moiety]

Contamination of Lake Waters with Heavy Metals and other Inorganic Ions

In Ulsoor lake, the nitrate content of water before immersion was 1.51 ppm which increased to 4.7 ppm after 14 days of immersion (Fig. 7). The concentration of Ca recorded, 30days after immersion was 11.51 meql[-1] and the mean was 7.66 meql[-1]. The average concentration of Mg, K and Na followed similar trends (Table 1). Higher BOD and COD values were recorded in lake water seven days after immersion activities. Due to the immersion of painted idols, the changes observed in the metal content of Ulsoor lake water are presented in Fig. 3,4,5 and 6. The mean concentration of Fe recorded was 2.82 ppm with corresponding standard deviation of 1.38 ppm, respectively. The Pb content was recorded to be 0.0016 ppm before immersion which increased to 0.0062 ppm 30 days after immersion. However, the mean Pb concentration of the lake water during the entire course of the study was 0.003 ppm with a standard deviation of 0.001 ppm. Similar trend in increase in the concentration of Cr, Ni and Cd were also observed. The average concentration of Cr and Cd in the lake was 0.005 and 0.002 ppm respectively (Fig 3 and 4).

In Nagavara lake, the concentration of Ca recorded was higher at seven days after immersion (6.6 meql[-1]). The average concentration of Mg, K and Na were 2.46 meql[-1], 40.15 ppm and16.04 ppm (Table 2). Similar results were observed in river and other fresh water bodies.[17,18] Higher BOD (23.6 mgL[-1]) and COD (211.8 mgL[-1]) values were recorded in lake

water 14 days after immersion activities (Fig. 8 and 9). Similar changes in BOD and COD were recorded in Madiwala and Lalbagh lakes of Bengaluru, Karnataka.[19] The Pb content recorded 0.004 ppm before immersion which increased to 0.021 ppm, 30 days post immersion. The mean Pb concentration of the lake water during the entire course of the study was 0.01 ppm with a standard deviation of 0.005 ppm (Fig. 5). Similar trend of increase in the concentration of Cr, Niand Cd were also observed. The mean concentration of Cr and Cd in the lake water was 0.02 and 0.001 ppm, respectively (Fig. 3 and 4). The different heavy metals showed diffential increase in concentrations with the period of immersion might be due to their different solubility rates as well as seasonal variations. Similar results were observed in both marine and freshwater systems.[17] The increase in these alkaline earth metals in the long run may increase the hardness of water thereby deteriorating the water quality.

Fluctuation in Biochemical Properties of Lake Waters due to Idol Immersion Activities

The Biochemical Oxygen Demand (BOD) of Ulsoor lake water, in the pre-immersion period was 12.3 mgL[-1] which after one week of immersion was recorded to be 21.5 mgL[-1] (Fig. 8). However, with time the BOD again decreased to13.9 mgL[-1]. The COD of Ulsoor lake showed a steep increase from 118.5 mgL[-1] in the pre-immersion period to 190.7 mgL[-1]in the post immersion period (Fig. 9). The fluctuation in BOD of the lake water might be attributed to the dilution of biodegradable organic matter in the large volume of lake water. The immersion of painted idols in the lake waters was accompanied by the addition of leaves, flowers and other organic materials used during the rituals. These materials upon decomposition increase the BOD and COD levels creating hypoxic conditions in the system.

Conclusions

The contamination in Nagavara and Ulsoor lakes through industrial, domestic effluents as well as religious activities like idol immersion is creating an uncongenial aquatic environment through water quality deterioration. The increase in BOD and COD levels in the lake water during the course of study reflect significant addition of biodegradable organic matter due to the idol immersion activities. The concentrations of Fe, Cr, Cd and Pb in the lake water

increased in the post immersion period. Since, heavy metals contamination is detrimental to animal system seven at very low concentration, public awareness regarding this problem should be generated.

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