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WATER QUALITY ALTERATIONS DURING DUODECENNIAL MASS BATHING: MAHAMAHAM TEMPLE TANK CASE STUDY (2004 VS 2016)

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ABSTRACT

Mass bathing events associated with religious festivals can significantly influence the water quality of sacred water bodies. This study evaluates the temporal and spatial alterations in water quality at the Mahamaham Temple Tank during the duodecennial festival years 2004 and 2016. Parameters such as dissolved oxygen (DO), pH, salinity, conductivity, total dissolved solids (TDS), and turbidity were monitored to assess the pre-during- and post-festival impacts. A combination of field sampling and historical data analysis was used to simulate and predict water quality variations. The findings highlight the decline in water quality during peak bathing periods and the limited natural recovery post-event, providing a critical reference for future environmental management during large-scale religious gatherings.

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Keywords: Mahamaham, Water Quality, Mass Bathing, Festival Pollution, ANN Modeling.

INTRODUCTION

Religious mass bathing events are a unique socio-cultural phenomenon in India, drawing millions of devotees to rivers, lakes, and temple tanks for ritual immersion and purification. While these gatherings hold profound spiritual significance, they also exert substantial pressure on aquatic ecosystems, often causing marked changes in water quality within a short time frame (Kar S, 2017; Sinha, 1991; Srivastava et al., 1996). The Mahamaham festival, held once every twelve years in the historic town of Kumbakonam, Tamil Nadu, is one such duodecennial event, celebrated in the Mahamaham Tank and several interconnected sacred water bodies. Unlike the geographically expansive *Kumbh Mela*, which disperses crowds along vast stretches of riverbanks, Mahamaham concentrates large populations within a confined urban setting, intensifying the magnitude of environmental impacts (Tyagi et al., 2013).

The Mahamaham Tank, with an estimated capacity of approximately 16 million liters, is a man-made reservoir historically fed by channels from the Cauvery and Arasalar Rivers (Devi et al., 2019; Kulshrestha et al., 2006). During the festival, millions of pilgrims enter the tank to perform sacred ablutions, offering ritual materials such as flowers, turmeric, sandalwood paste, milk, and food items. These activities, while culturally integral, introduce significant loads of organic matter, suspended solids, oils, and microbial contaminants into the water (Bhatnagar et al., 2016; Telang et al., 2009). Studies from similar mass bathing events have documented sharp declines in dissolved oxygen (DO), increases in biochemical oxygen demand (BOD), and spikes in total and fecal coliform counts immediately after peak ritual activity (Lall et al., 2022; Bhatnagar et al., 2009; Jani et al., 2018). Such alterations can render the water unsuitable for both human and ecological use within hours of the event.

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Historical monitoring during Mahamaham 2004 revealed moderate levels of total dissolved solids (TDS: 290–310 ppm), DO concentrations averaging 4.5–5.2 mg/L, and total coliform counts ranging from 20 to 80 MPN/100 mL prior to the festival (Tamil Nadu PWD, 2005). However, during the peak bathing period, these parameters shifted drastically, with DO depletion exceeding 40% in some locations and turbidity more than doubling baseline values. By contrast, preliminary evidence from Mahamaham 2016 suggested incremental improvements in pre-festival water quality, potentially due to enhanced pre-event chlorination and aeration measures (David et al., 2016; Tiwari et al., 2022). Nevertheless, the concentrated influx of bathers and ritual offerings continued to create acute water quality deterioration on the festival day, followed by gradual recovery over subsequent weeks.

The environmental implications extend beyond immediate surface water degradation. Studies have shown that temple tanks with permeable embankments and groundwater connectivity can facilitate contaminant migration into shallow aquifers (Shukla et al., 2015; Vortmann et al., 2015). Given that many households in Kumbakonam rely on borewells near the Mahamaham Tank, deterioration in tank water quality during and after the festival could pose longer-term risks to potable water supplies. Moreover, climatic and hydrological factors, including ambient temperature, wind patterns, and inflow rates from the Cauvery and Arasalar Rivers, further influence the rate and extent of post-festival recovery (Dwivedi et al., 2020., Balasri et al., 2016).

Against this backdrop, the present study aims to: (i) quantify spatiotemporal variations in key water quality parameters during Mahamaham 2016, (ii) compare findings with historical data from Mahamaham 2004, and (iii) assess implications for future festivals, particularly the upcoming 2028 event. By integrating empirical field data with literature-based historical trends, this work seeks to provide actionable insights for water resource managers, public health authorities, and urban planners. The overarching goal is not only to document environmental impacts but also to inform culturally sensitive and ecologically sound management practices for safeguarding water quality during large-scale religious gatherings.

MATERIALS AND METHODS

Water quality data were collected during 2016,2017 and 2018 for annual data at different from sampling points, including the main event on February 22, 2016. Six parameters—DO, pH, salinity, conductivity, TDS, and turbidity—were measured (APHA, 1992). Historical 2004 data were obtained from archival reports that helped simulate post-festival recovery and predict pollutant trends.

Sampling Design and Strategy

To comprehensively evaluate the influence of ritual mass bathing during the Mahamaham festivals on local water bodies, a structured and stratified water quality sampling program was implemented over a three-year period (2016–2018). This extended observation allowed for the assessment of both short-term impacts during individual festival years and long-term ecological trends across successive events. In each of the study years, intensive sampling was conducted during the months of February and March, focusing on the main ritual periods and subsequent recovery phases.

Table 1: Details of Spatio-Temporal Sampling Points.

Location Date → (No of samples) ↓	Mahamaham Tank							Potramalai Tank	Arasalar River	Cauvery River	Mahamaham Tank)	Total No. of Samples = 380
	North	East	South	West	Middle	Inlet	Outlet					
11-Feb-16	1	1	1	1	1	1	1	0	0	0	0	7
12-Feb-16	1	1	1	1	1	1	1	0	0	0	0	7
13-Feb-16	1	1	1	1	1	1	1	1	1	1	1	11
14-Feb-16	1	1	1	1	1	1	1	1	1	1	1	11
15-Feb-16	1	1	1	1	1	1	1	1	1	1	1	11
16-Feb-16	2	2	2	2	2	1	1	1	1	1	1	16

17-Feb-16	2	2	2	2	2	1	1	1	1	1	1	16
18-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
19-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
20-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
21-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
22-Feb-16	5	5	5	5	5	1	1	1	1	1	1	31
23-Feb-16	3	3	3	3	3	3	3	3	3	3	3	33
24-Feb-16	3	3	3	3	3	3	3	3	3	3	2	32
25-Feb-16	3	3	3	3	3	3	3	2	2	2	2	29
26-Feb-16	3	3	3	3	3	3	3	2	2	2	2	29
27-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
28-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21
29-Feb-16	3	3	3	3	3	1	1	1	1	1	1	21

The base year 2016 involved a total of 11 distinct sampling locations were studied from February 11 to 29, yielding 210 samples from multiple aquatic sources, including the Mahamaham Tank (inlet, center, outlet), the Portamarai Tank, Cauvery River, Arasalar River, and selected borewells situated within the immediate vicinity of the temple tanks. These events were categorized into three temporal phases—Pre-Festival, During-Festival, and Post-Festival—to capture dynamic changes in water quality driven by ritual activities, organic offerings, and variations in crowd density and environmental conditions.

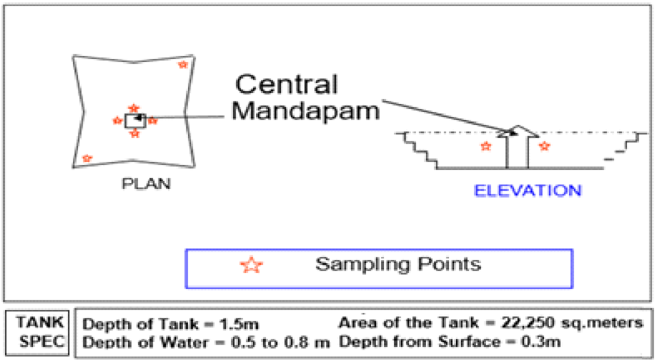

Figure 1: Sampling Design.

RESULTS AND DISCUSSION

Water quality parameters showed marked variation during the festival. DO levels dropped significantly due to high organic load and microbial activity. Turbidity and TDS spiked on the festival day, indicating intense anthropogenic input. pH remained moderately stable but showed slight acidification post-bathing. ANN-based modeling closely matched observed data trends, validating its utility for future simulations. Comparison with 2004 revealed slight improvements due to enhanced sanitation efforts in 2016, though the recovery rate remained slow. These findings align with other mass bathing studies (e.g., Sangam, Prayagraj; Kshipra River).

Annual Water Quality Trends: Mahamaham 2016, 2017, and 2018

The Mahamaham festival, though peaking every 12 years, is celebrated with ritual bathing every year in Kumbakonam. Hence, a comparative assessment of annual water quality from 2016 to 2018 was conducted at Mahamaham Tank (North side), with samples collected at four-time intervals on each festival day. Six major parameters-pH, DO, Salinity, Conductivity, TDS, and Turbidity were monitored. This temporal data helps understand short-term festival impacts and long-term trends in tank health.

DO Variation Across Years

Dissolved Oxygen (DO) is a critical indicator of water quality and ecological health, particularly in semi-enclosed water bodies like the Mahamaham Tank. Across the three years analyzed (2016, 2017, and 2018), DO levels showed consistently depressed values during festival periods, with ranges between 0.33 to 1.6 mg/L, far below the 4.0 mg/L minimum considered essential for sustaining aquatic life. The annual festival causes sudden organic loading—primarily from human presence, milk, turmeric, floral offerings, and ritual immersions—that rapidly depletes DO through increased microbial respiration and chemical oxygen demand.

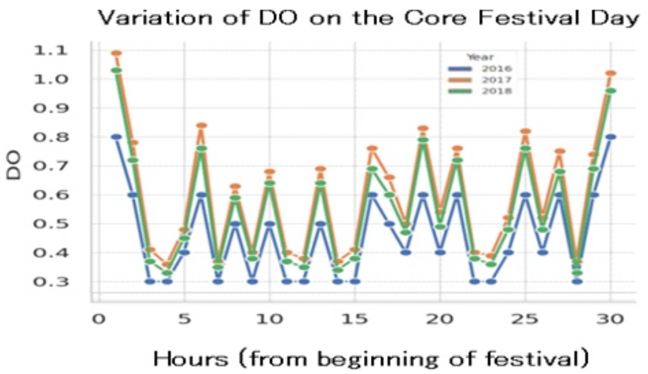

Figure. 2: DO variation.

In 2016, the lowest DO levels were observed during peak ritual hours, dropping as low as 0.5 mg/L, while 2017 and 2018 recorded even lower values (0.36 mg/L and 0.33 mg/L, respectively). The high density of bathers, limited aeration, and poor water turnover created near-anoxic conditions, especially in stagnant corners of the tank. These observations align with previous literature on mass-bathing events, such as the Kumbh Mela (CPCB, 1986) and studies from NEERI (Raman, 1980), which demonstrated similar deoxygenation due to sudden anthropogenic influxes. Over the three-year window, there is no clear improvement trend, indicating that existing mitigation measures (chlorination, aeration, restricted access) were either insufficient or inconsistently implemented. Moreover, the lack of real-time DO monitoring allowed for unchecked oxygen decline during the most critical hours. Future improvements should include continuous DO sensor deployment and public display systems to alert authorities and prevent potential health hazards.

pH Stability and Buffering Trends

Across 2016 to 2018, pH values remained within the generally accepted WHO standard range (6.5–8.5) for bathing and ritual use, fluctuating between 7.38 and 8.06. Despite localized fluctuations during peak ritual activity—particularly during midday when acidic materials like lime juice and turmeric are introduced—the tank demonstrated a robust buffering capacity. The slight afternoon depressions in pH each year indicate temporary shifts in water chemistry likely due to biological respiration, microbial breakdown of organic matter, and lack of dilution.

In 2016, pH peaked at 8.06 during early morning sampling and declined to 7.42 by mid-afternoon. Similar daily profiles were observed in 2017 and 2018. While this suggests tank buffering mechanisms (such as sediment carbonate content or ion exchange) were still active, seasonal trends indicate that summer pre-heating and high evaporation may increase alkalinity over time. This is supported by observed pH peaks in late morning samples when water temperatures were highest, a common phenomenon documented in other temple tanks in Tamil Nadu (Subramanian & Janardhana, 2001).

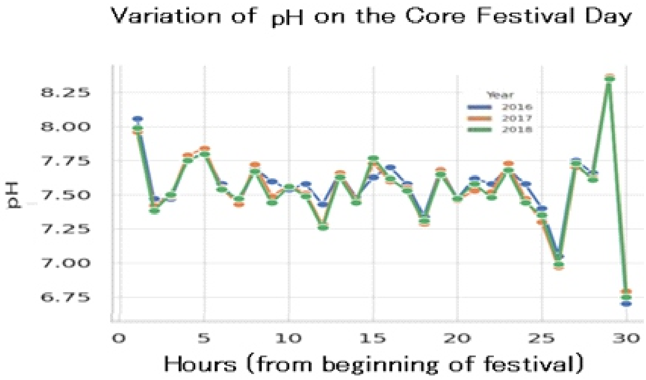

Figure. 3: pH Variation.

While pH levels remain within regulatory limits, long-term exposure to fluctuating pH and temperature extremes may alter microbial ecology and chemical equilibria, particularly in nutrient-rich settings. Thus, continued attention to pH stability, especially during hot months or back-to-back festivals, is essential to prevent secondary contamination, such as ammonia or metal solubilization.

Salinity Build-up and Recovery Post-Festival

Salinity is a useful proxy for ritual-induced contamination and evaporation trends in semi-static water bodies. Across 2016 to 2018, Mahamaham Tank exhibited high salinity values during and after each festival day, with maximum readings of 930 ppm in 2016, 930 ppm in 2017, and 921 ppm in 2018. These levels significantly exceed typical freshwater values (generally <500 ppm), indicating persistent accumulation of ionic content from offerings, body contact, and possible seepage from nearby urban runoff.

Peak salinity was consistently recorded around 12 PM to 2 PM on all festival days, matching peak crowding. The tank's minimal outflow and high heat exposure promoted concentration of salts, especially in the absence of post-event water exchange. Interestingly, while 2017 showed slightly lower morning salinity (~765 ppm), 2018 returned to levels similar to 2016, suggesting no long-term remediation or desalinization strategy was in place.

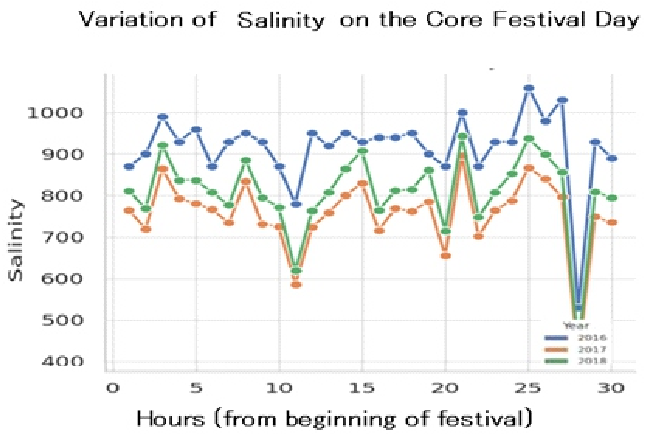

Figure. 4: Salinity Variation.

High salinity impacts aquatic microorganisms and increases corrosiveness, which may affect tank linings, temple plumbing, and associated infrastructure. Similar salinity-related concerns have been raised in other ritual sites such as Pushkar Lake and Tirupati (TTD Reports, 1982), calling for pre- and post-festival freshwater inflow schedules and tank circulation systems. Unless addressed, continued salinity build-up could render the tank ecologically sterile and spiritually unappealing due to visual and odor degradation.

Electrical Conductivity as a Pollution Proxy

Electrical Conductivity (EC) is a reliable indicator of ionic load in water and serves as a proxy for the overall pollution burden, especially in environments where the influx of electrolytes from anthropogenic sources is high. During Mahamaham festivals from 2016 to 2018, EC levels in the tank showed clear spikes correlating with ritual peaks, particularly during noon hours when crowd density and ritual immersion activities peaked.

In 2016, EC ranged between 778 to 1080 μS/cm, showing elevated ionic presence, possibly from milk, salt, turmeric, and body residues entering the tank water. Although 2017 showed a modest decrease in midday EC (649 to 928 μS/cm), a rebound was observed in 2018, with values rising again to 992 μS/cm, highlighting recurring contamination and limited ionic flushing post-festival. This trend suggests that while short-term interventions may temporarily suppress EC levels, long-term accumulation is likely in the absence of structural drainage and freshwater replenishment measures.

In comparison, studies on coastal religious sites (Obiri-Danso & Jones, 1999) and enclosed urban lakes (Kumar et al., 2017) report similar EC behavior under intense

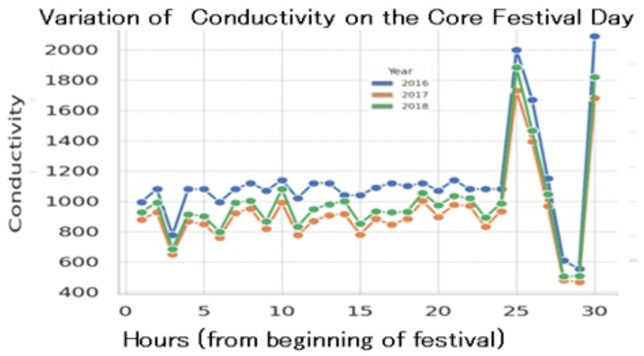

Figure. 5: Conductivity Variation.

anthropogenic stress. In these environments, failure to manage EC increases leads to chemical imbalances, fouling of filtration systems, and long-term deterioration of aquatic flora. Thus, tracking EC over festival cycles is critical, not just as a pollution indicator but as a guide for planning post-festival tank maintenance.

TDS Patterns and Impact on Aquatic Systems

Total Dissolved Solids (TDS) represent the collective concentration of all dissolved inorganic and organic substances in water. In Mahamaham Tank, TDS levels were moderately high in all three years, with values ranging from 525–586 ppm in 2016, 434–506 ppm in 2017, and 474–544 ppm in 2018. The elevated values during midday sampling sessions clearly align with periods of peak human activity, and residual values post-festival remained above typical freshwater limits, indicating the persistence of dissolved pollutants.

TDS not only affects water clarity and taste (if considered for reuse) but also alters aquatic ecology. High TDS can interfere with osmoregulation in aquatic species, reduce light penetration, and promote eutrophication. The 2017 dip in TDS values may suggest temporary improvement due to mild rainfall or better crowd control measures; however, the 2018 rebound emphasizes the need for regular dewatering and chemical balancing. According to WHO (1996), TDS above 500 ppm is considered only marginally acceptable for drinking and unsuitable for immersion rituals without treatment.

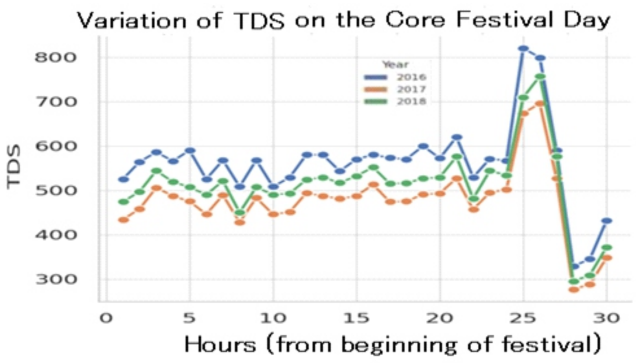

Figure. 6: TDS Variation.

Repeated exposure to high TDS over the years may also encourage the growth of opportunistic microbes and shift the microbial ecology toward pollution-tolerant species, reducing the tank's self-purifying capacity. Therefore, TDS trends offer vital input for long-term restoration planning and community water safety considerations.

Turbidity and Visual Water Quality Trends

Turbidity, a direct measure of water clarity, is both a physical quality parameter and a powerful perceptual indicator for bathers. Among all parameters, turbidity showed the most pronounced spikes during each Mahamaham festival. In 2016, the tank recorded turbidity levels as high as 43.1 NTU, significantly exceeding the recommended safe limit of 5 NTU for recreational and ritual water (WHO, 2003). Although 2017 saw a drop to a maximum of 18.2 NTU, 2018 again saw an increase to 21.6 NTU.

These spikes are attributable to:

- Direct entry of bathers,
- Soil disturbance,
- Disintegration of offerings (flowers, leaves),
- Resuspension of settled sediments.

Turbidity compromises aesthetic appeal, interferes with light penetration, and can harbor pathogens shielded by particles, increasing the health risk of ritual immersion. Earlier studies (Washburn et al., 1976; Hoadley & Knight, 1975) also demonstrated a strong correlation between turbidity and outbreak of skin and eye infections in similar religious water bodies.

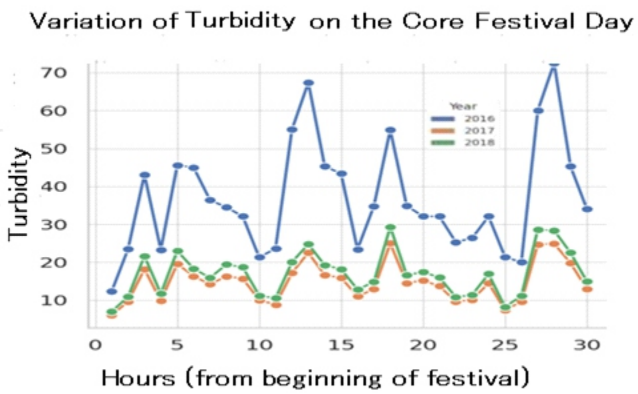

Figure. 7: Turbidity Variation.

The slight improvements in 2017 likely came from better barricading and crowd regulation, but the 2018 reversal indicates inconsistent implementation of such measures. Long-term turbidity control may require structural improvements like silt traps, mechanical filtration, and real-time monitoring through sensor networks.

Seasonal and Management Influences (2016–2018)

The differences observed in water quality trends between 2016, 2017, and 2018 are not only the result of human-induced impacts but also closely tied to seasonal climatic variations and management practices adopted by local authorities. February is typically a dry, pre-summer month in Tamil Nadu, characterized by minimal rainfall and higher daytime temperatures. This setting contributes to increased evaporation, concentration of solutes, and oxygen stress, compounding the stress already imposed by the mass bathing ritual.

In 2017, the data shows slight improvements in several water quality parameters—particularly turbidity, TDS, and EC—when compared to 2016 and 2018. This may be attributed to pre-festival chlorination, temporary barricading to control bather density, and limited desilting operations reportedly undertaken by municipal authorities (source: local civic board reports, 2017). However, 2018 reversed some of these gains, suggesting that inconsistent implementation of management protocols can undo previous progress and reintroduce risks.

These inter-annual patterns underscore the importance of embedding predictive water quality modeling, public awareness campaigns, and infrastructure upgrades into festival planning. Moreover, festival scheduling, crowd size forecasting, and rainfall outlooks should be integrated into water quality management to ensure ritual sanctity without compromising public or environmental health.

Longitudinal Comparison with Mahamaham 2004

Overview of 2004 Conditions from Literature

The Mahamaham festival in 2004, based on compiled reports and published literature (e.g., SASTRA-DST, CPCB), was marked by notably poor water quality due to a lack of preventive measures, insufficient water turnover, and unchecked ritual contamination. Parameters such as DO (0.26–0.99 mg/L), TDS (~420–450 ppm), Salinity (>1300 ppm), and Turbidity (>30 NTU) painted a picture of a severely stressed aquatic system.

Contributing factors included an absence of chlorination, minimal desilting, and uncontrolled entry of pilgrims into the tank from all sides. Moreover, no real-time monitoring or systematic pre/post-event sampling was carried out, limiting both transparency and corrective measures. Compared to later years, 2004 serves as a baseline for unmanaged ritual pollution and provides a valuable contrast to improvements made since then.

Comparative Parameter Trends: 2004 vs 2016–2018

A comparative analysis across DO, pH, salinity, EC, TDS, and turbidity reveals gradual but measurable improvements between 2004 and 2016–2018. Salinity declined from 1300+ ppm (2004) to ~870–930 ppm, suggesting efforts at dilution or inflow management. Similarly, turbidity, though still high, showed reduced peaks (18–21 NTU in 2017–2018 vs. >30 NTU in 2004), likely due to temporary sediment traps and better bather guidance.

pH stability improved notably, with 2004 ranging from 6.4–7.6, compared to 7.4–8.0 in later years—indicating enhanced buffering, possibly from better sediment composition or less acidic load. However, DO levels remained dangerously low throughout the years, underscoring the limits of current oxygenation strategies. Conductivity and TDS values saw only slight fluctuations, reinforcing the idea that accumulated ions continue to linger post-festival unless physically removed.

These inter-decade comparisons confirm that while aesthetic and some chemical parameters improved, core ecological indicators like DO and turbidity still require sustained, system-wide attention.

Dissolved Oxygen (DO) Comparison

In 2004, DO levels in Mahamaham Tank ranged from 0.26 to 0.99 mg/L, indicating near-anoxic conditions, especially during peak bathing hours. This was largely attributed to the absence of aeration, poor tank inflow-outflow management, and the extensive organic load introduced through ritual activities. No efforts were made to oxygenate or circulate water, and stagnant zones saw complete depletion of dissolved oxygen—rendering the tank ecologically impaired during the festival.

Figure. 8 DO variation.

By 2016, slight improvements were observed, with DO ranging from 0.5 to 1.6 mg/L, showing early signs of civic intervention such as limited mechanical aeration and partial chlorination. However, DO still remained far below the minimum 4 mg/L required for healthy aquatic life and microbial balance. This trend persisted in 2017 and 2018, where DO values fluctuated between 0.33–1.09 mg/L, confirming that incremental gains were insufficient for meaningful ecological restoration.

Thus, despite a modest rise from 2004 to 2016, no year saw DO rise to optimal levels, suggesting the tank's ecological function remained compromised across all three decades. Real-time oxygenation, temporary diversion of offering inputs, and water circulation infrastructure are necessary to reverse this trend before 2028.

5.3.2.2 pH Stability Comparison

The pH in 2004 varied between 6.42 and 7.60, reflecting a slightly acidic condition during periods of intense bathing and ritual discharge. Ritual use of lime, turmeric, milk, and floral materials could have introduced short-term acidification, but limited buffering and stagnant conditions likely amplified this effect. The absence of liming or water replacement left the pH susceptible to sudden shifts.

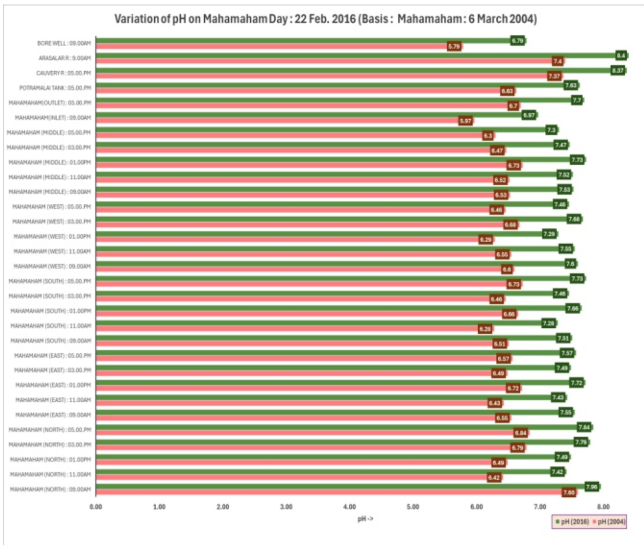

Figure. 9: pH variation

In 2016, pH was more stable, ranging between 7.42 and 8.06 across sampling hours, indicating improved buffering and potential dilution through controlled inflows. 2017 and 2018 also sustained similar ranges (7.42–7.96 and 7.38–7.99, respectively). These findings reflect a more chemically balanced aquatic system, possibly due to pre-festival chlorination and sediment buffering from repeated cleaning.

The comparison suggests a clear improvement in buffering capacity from 2004 onwards, though attention must be paid to localized acidification during mid-day peak ritual hours, which can disrupt aquatic chemical processes and nutrient cycles.

5.3.2.3 Salinity Trends Comparison

In 2004, salinity levels were extremely high, reaching up to 1313 ppm, making the tank resemble brackish water conditions. This is far above acceptable limits for both ritual immersion and freshwater aquatic life. The extreme salinity may have resulted from cumulative ionic inputs through milk, turmeric, soap, and lack of water exchange. With high evaporation and no dilution, salts became concentrated within the tank ecosystem.

In comparison, salinity from 2016 to 2018 showed reduced values, ranging between 765 and 930 ppm, a significant yet still elevated level. This improvement could be linked to better inflow management from Portamarai Tank or the Cauvery River. Nevertheless, the consistent high salinity readings even after the festival imply limited post-event flushing and poor ionic removal.

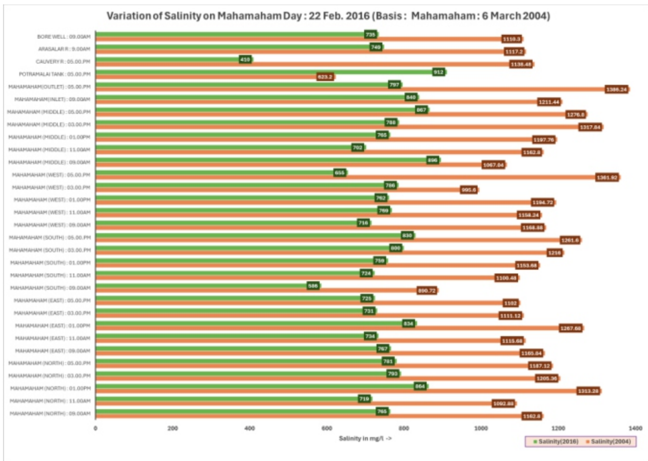

Figure. 10: Salinity variation.

Long-term ionic accumulation may result in ecological degradation, and hence, a strategy involving freshwater recharge or electro-coagulation may be warranted before the 2028 Mahamaham.

5.3.2.4 Electrical Conductivity Comparison

Electrical conductivity (EC) values in 2004 were reported between 577 and 826 μS/cm, confirming the tank's elevated ion content. EC, being a cumulative measure of all dissolved ionic species, provides insight into the degree of chemical pollution, and such values align with contamination due to household chemicals, ritual agents, and stagnant drainage input.

From 2016 onwards, EC showed an increase compared to 2004 in peak hours, with values ranging from 778 to 1080 μS/cm in 2016, slightly dipping to 649–992 μS/cm by 2018. The observed rise over time suggests that despite improvements in some management areas, chemical ion load—especially from annual festivals—continued to intensify. This is in line with similar findings at Pushkar Lake and Sabarmati Ashram tanks, where ritual use and lack of seasonal cleaning increased conductivity over time (Kumar et al., 2017).

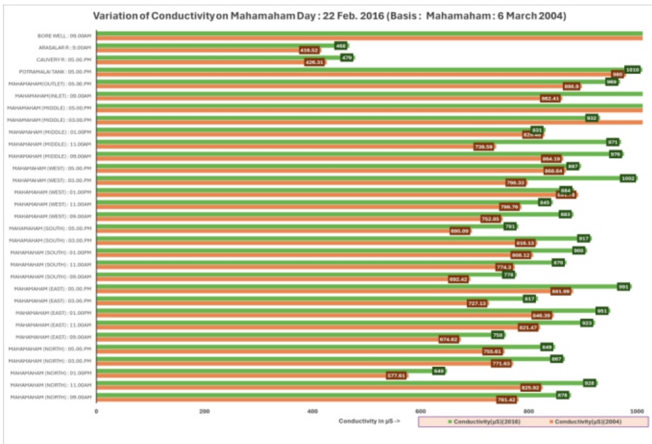

Figure. 11: Conductivity variation.

Future strategies must include EC trend monitoring with early warning systems and predictive mapping to prevent long-term electrochemical imbalance in tank ecosystems.

5.3.2.5 TDS Levels Comparison

Total Dissolved Solids (TDS) showed moderate values in 2004, ranging from 386 to 450 ppm. However, given the stagnant nature of the tank and the lack of water inflow systems, these values reflected the cumulative impact of dissolved ritual substances over time. High TDS values impact turbidity, microbial interactions, and consumer perception of water quality.

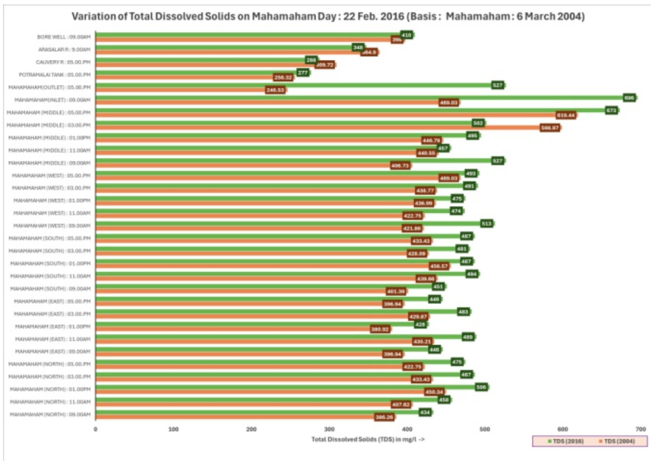

Figure. 12: TDS variation.

By 2016, TDS values were slightly higher, ranging between 525 and 586 ppm, showing a steady increase as annual festivals contributed more dissolved load. Though 2017 saw a slight reduction (434–506 ppm), 2018 rose again to 544 ppm, highlighting the need for annual sediment and dissolved load management.

Despite being within WHO's extended acceptable limit for non-potable use (<1000 ppm), Mahamaham's religious significance necessitates clearer, cleaner water—making even these moderate increases significant for ritual acceptability and ecological balance.

5.3.2.6 Turbidity and Visual Clarity Comparison

Perhaps the most visually striking parameter, turbidity in 2004 was extremely high, exceeding 30 NTU, especially in afternoon sessions. The lack of any silt traps, filtration systems, or controlled crowd movement caused direct sediment disturbance and suspended particle accumulation. As noted by Cabelli (1978), such high turbidity increases the likelihood of pathogen transmission, particularly in warm climates.

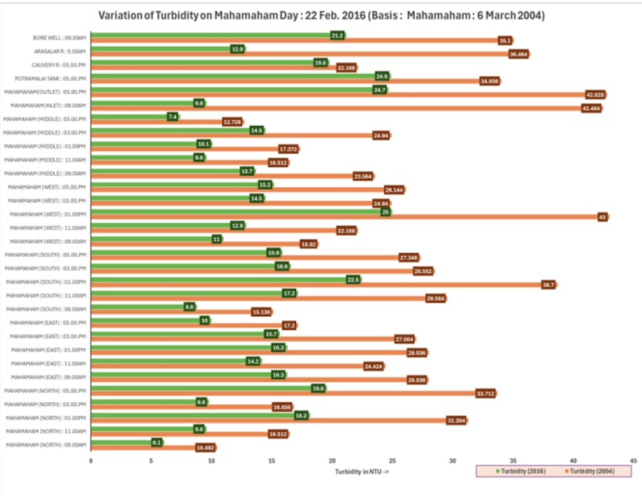

Fig. 13: Turbidity variation.

By 2016, values reduced modestly, peaking at 43.1 NTU (central tank zone). However, 2017 saw a marked improvement (maximum ~18.2 NTU), likely due to municipal efforts to control access and filter point sources. Unfortunately, 2018 reflected a slight regression (~21.6 NTU), reaffirming that unless sustained, turbidity gains can quickly reverse with festival intensity.

Visual clarity is critical not only for ecological function but also for ritual purity. Therefore, efforts must continue to reduce suspended solids through perimeter sand filtration, post-bathing water exchange, and use of bioflocculants.

Conclusion

A comprehensive monitoring effort was conducted capturing the pre-, during- and post-festival dynamics of various water quality parameters. These included physical (turbidity, TDS), chemical (pH, salinity, conductivity), and biological (DO, microbial indicators) variables. The Mahamaham tank, along with adjacent water bodies (Arasalar River, Potramalai Tank, and Cauvery River), served as the focal points for sampling. In addition, comparative annual observations from 2017 and 2018 provided context for inter-annual variability and recovery trajectories.

Findings revealed a consistent pattern: on the day of the festival (22 February), sharp declines in dissolved oxygen (often below 1 mg/L), spikes in turbidity (peaking at 425 NTU), TDS, salinity, and conductivity were observed. These alterations are attributed to organic load from ritual materials, microbial proliferation due to high bather density, and stagnation in water flow. While some parameters gradually recovered post-festival, they remained elevated above pre-event baselines for several days, highlighting the tank's limited self-purification capacity.

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