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Temporal Assessment of River Water Quality During Maha Kumbh 2025 in the Prayagraj Sangam Region Using CPCB Monitoring Data

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Abstract- The present study investigates the temporal variation of river water quality during Maha Kumbh 2025 in the Prayagraj Sangam region using Central Pollution Control Board (CPCB) monitoring observations. The assessment was carried out using major physicochemical and biological parameters including turbidity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), pH, and fecal coliform. Temporal trend analysis and statistical interpretation were performed to evaluate the impact of large-scale pilgrimage activities on river water quality. The results indicated noticeable fluctuations in turbidity, COD, BOD, and fecal coliform concentrations during major bathing events, suggesting enhanced anthropogenic influence and sediment disturbance in the river system. Dissolved oxygen remained relatively stable throughout the monitoring period, while pH values stayed within acceptable environmental limits. Correlation analysis revealed positive relationships among turbidity, COD, and fecal coliform, indicating combined effects of organic and microbial contamination during intensive bathing periods. The study highlights the significance of continuous water quality monitoring during mass religious gatherings for sustainable river management and environmental protection.

Keywords- Maha Kumbh 2025, CPCB, Water Quality, Turbidity, Fecal Coliform, Prayagraj Sangam, Temporal Analysis.

I. INTRODUCTION

River Water Quality Plays A Crucial Role In Maintaining Ecological Balance, Public Health, Agriculture, And Socio-Economic Development. Large-Scale Religious Gatherings Can Significantly Influence River Ecosystems Due To Increased Anthropogenic Activities, Sediment Disturbance, Organic Load, And Microbial Contamination. The Maha Kumbh Event Organized in Prayagraj, India, Represents One of The Largest Human Gatherings in the World and Attracts Millions of Pilgrims for Ritual Bathing Activities at the Confluence of The Ganga and Yamuna Rivers.

The Prayagraj Sangam region experiences intense environmental pressure during major bathing periods such as Makar Sankranti, Mauni Amavasya, and Basant Panchami. Increased human movement and ritual activities may influence several water quality parameters including turbidity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), and fecal coliform concentrations.
Continuous assessment of river water quality during such events is essential for environmental monitoring and pollution management. The Central Pollution Control Board (CPCB) regularly monitors major river systems in India and provides valuable observations for scientific analysis and policy development.

Several previous studies have reported deterioration in river water quality during mass bathing activities due to increased microbial load, organic pollution, and suspended sediment concentration. However, detailed temporal assessment of CPCB-monitored parameters during Maha Kumbh 2025 remains limited.

Therefore, the objectives of the present study are:

1. To evaluate temporal variations in major water quality parameters during Maha Kumbh 2025.
2. To analyze the impact of mass bathing activities on river water quality.
3. To assess relationships among major physicochemical and biological parameters.
4. To identify periods of increased environmental stress in the Prayagraj Sangam region.

II. STUDY AREA

The study focuses on the Triveni Sangam at Prayagraj, Uttar Pradesh, India (Fig. 1). Geographically, the confluence is situated at approximately 25.43 deg N, 81.88 deg E within the Indo-Gangetic Plain at an elevation of ~98 m above mean sea level. The Ganga, originating from the Gangotri Glacier at ~3,892 m elevation, arrives at Prayagraj as a major alluvial river with a width of approximately 800-1,200 m and a discharge of ~2,000-3,000 m3/s during the non-monsoon Kumbh period. The Yamuna, originating from the Yamunotri Glacier, flows in from the northwest with a width of ~300-600 m and a discharge of ~300-500 m3/s during January-February. Prayagraj experiences a sub-humid climate with distinct seasons: hot, dry summer (March-May, max 45 deg C), warm, humid monsoon (July-September, ~900-1,000 mm rainfall), and cool, dry winter (November-February, min 5 deg C). The Kumbh Mela period coincides with the winter low-flow season (January-February), when river discharge is at its annual minimum, dramatically reducing the dilution capacity for the massive anthropogenic pollutant loads generated by the event. For Maha Kumbh 2025, the Prayagraj Mela Authority designated approximately 4,000 hectares of riverine floodplain as the Mela Zone, divided into 25 administrative sectors spanning ~12 km along the Ganga's north bank and ~6 km along the Yamuna's east bank. The CPCB and UPJN deployed a water quality monitoring network of 12 multi-parameter buoys and 15 manual sampling stations (daily grab samples) within this zone, which provided the in-situ validation data for this study.

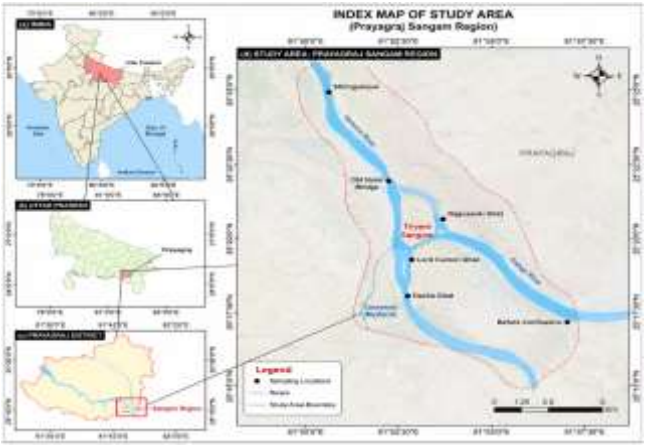

Fig. 1. Study area map: (a) Location of Prayagraj in India; (b) Triveni Sangam with Ganga (blue) and Yamuna (green) rivers, CPCB/UPJN monitoring stations (yellow circles S1-S5), major ghats (triangles), and Kumbh Mela zone boundary. Red star = Sangam confluence point.

III. DATA AND METHODOLOGY

Fig. 2. Methodology Flowchart for Temporal Water Quality Assessment During Maha Kumbh 2025 Using CPCB Monitoring Data

Data Collection

Water quality observations used in the present study were collected from Central Pollution Control Board (CPCB) monitoring reports prepared during Maha Kumbh 2025. The monitoring data covered the period from January to February 2025 and included measurements collected during major bathing events such as Makar Sankranti, Mauni Amavasya, and Basant Panchami. The CPCB observations provided reliable information regarding the temporal condition of river water quality in the Prayagraj Sangam region.

Study Area

The study was conducted in the Prayagraj Sangam region located in Uttar Pradesh, India, where the Ganga and Yamuna rivers converge. The region is internationally recognized as one of the most important pilgrimage destinations and experiences intense anthropogenic pressure during Maha Kumbh. Major bathing ghats and monitoring locations around the confluence zone were considered in the study to evaluate the environmental impact of mass bathing activities on river water quality.

Parameters Analyzed

The assessment was carried out using major physicochemical and biological water quality parameters monitored by CPCB.

The analyzed parameters included turbidity (NTU), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), pH, and fecal coliform. These parameters were selected because they represent important indicators of sediment concentration, organic pollution, microbial contamination, oxygen availability, and overall river health during large-scale religious gatherings.

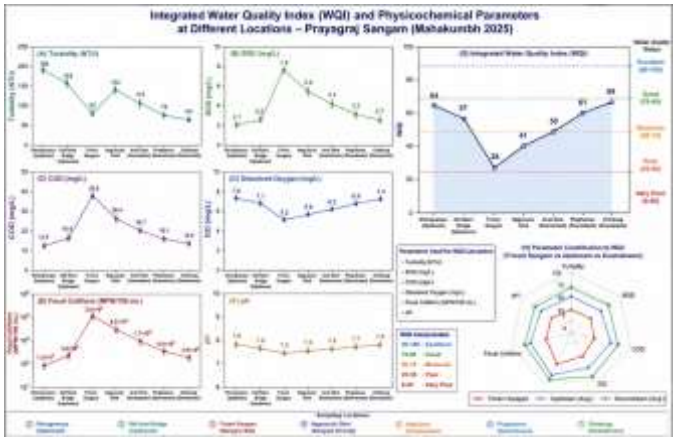

Fig. 3. (a) Integrated Water Quality Index (WQI) and Physicochemical Parameters at Different Sampling Locations in the Prayagraj Sangam Region During Maha Kumbh 2025

Data Processing

The compiled water quality dataset was processed and arranged chronologically according to sampling dates and major bathing events during Maha Kumbh 2025. Parameter-wise segregation and tabulation were performed to facilitate graphical visualization and temporal comparison. The processed dataset was subsequently used for statistical evaluation, graphical representation, and interpretation of water quality fluctuations during the study period.

Temporal Trend Analysis

Temporal trend analysis was carried out to evaluate fluctuations in water quality parameters during different bathing periods and pilgrimage activities. Time-series plots and graphical representations were generated to identify increases or decreases in turbidity, DO, BOD, COD, pH, and fecal coliform concentrations over time. The temporal analysis helped in understanding the influence of mass bathing events on river water quality conditions during Maha Kumbh 2025.

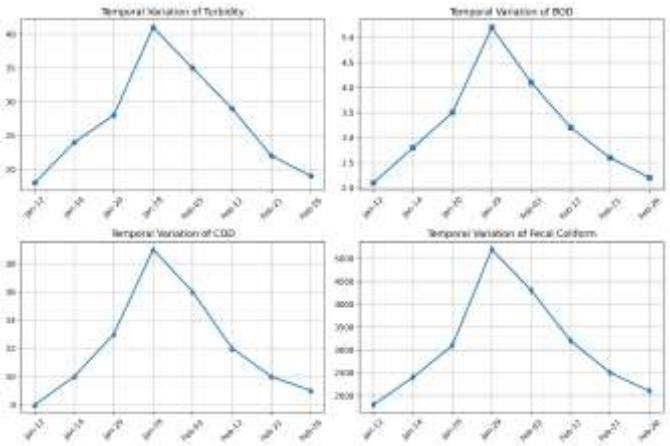

Fig 4: Temporal Variation of Major Water Quality Parameters During Maha Kumbh 2025 in the Prayagraj Sangam Region

Descriptive Statistical Analysis

Descriptive statistical methods were applied to evaluate the overall behavior and variability of the monitored water quality parameters. Statistical indicators including mean, minimum, maximum, and standard deviation were calculated for each parameter to assess central tendency and dispersion. The statistical analysis provided important insights into parameter variability and helped in identifying periods of elevated environmental stress within the river system.

Correlation Analysis

Pearson correlation analysis was performed to examine relationships among different water quality parameters. The correlation matrix was used to identify positive and negative interactions between variables such as turbidity, BOD, COD, DO, and fecal coliform. Correlation assessment helped in understanding the combined influence of anthropogenic activities, organic pollution, and sediment disturbance on overall river water quality during the Mahakumbh period.

Interpretation

The analyzed results were interpreted scientifically to evaluate the environmental impact of large-scale bathing activities on river water quality in the Prayagraj Sangam region. Variations observed in turbidity, organic pollution indicators, and microbial contamination were linked with pilgrimage intensity and human activities during major bathing dates. The interpretation phase helped in identifying critical periods of environmental stress and water quality deterioration

IV. RESULTS

The temporal analysis of CPCB monitoring observations revealed considerable fluctuations in major water quality parameters during Mahakumbh 2025 in the Prayagraj Sangam region. Significant variations were observed in turbidity, biological oxygen demand (BOD), chemical oxygen demand (COD), and fecal coliform concentrations during different bathing periods, indicating strong anthropogenic influence on river water quality.

Turbidity values showed a continuous increasing trend from 18 NTU on 12 January 2025 to a peak value of approximately 41 NTU on 29 January 2025, corresponding to the period of maximum pilgrim influx during Mauni Amavasya. After the peak bathing phase, turbidity gradually decreased and reached approximately 19 NTU by 26 February 2025. The elevated turbidity observed during major bathing dates suggests increased sediment resuspension caused by intensive human activities and riverbank disturbance.

Similarly, BOD concentrations increased from approximately 2.1 mg/L during the initial monitoring phase to a maximum value of about 5.2 mg/L during late January 2025. The increased BOD concentrations indicate elevated organic matter accumulation and increased biodegradable pollutant load during high-intensity pilgrimage activities. Following the completion of major bathing events, BOD values gradually declined, indicating partial recovery of river water quality conditions.

COD concentrations exhibited trends similar to BOD and increased from approximately 8 mg/L to nearly 19 mg/L during peak pilgrimage periods. The elevated COD values reflect increased oxidizable organic and inorganic matter entering the river system during Mahakumbh activities. Post-event monitoring demonstrated gradual reduction in COD concentrations due to dilution and self-purification processes within the river system.

Fecal coliform concentrations demonstrated the highest degree of temporal variability among all monitored parameters. Concentrations increased from approximately 1800 MPN/100 mL during early January to more than 5200 MPN/100 mL during the peak bathing phase. The elevated microbial contamination observed during intensive bathing periods highlights potential public health concerns associated with large-scale human interaction with river water.

The overall temporal trends indicate that major pilgrimage activities significantly influenced river water quality conditions in the Prayagraj Sangam region during Mahakumbh 2025. However, gradual decline in pollutant concentrations during the post-event phase suggests partial ecological recovery and the influence of natural hydrodynamic and self-purification processes within the river system.

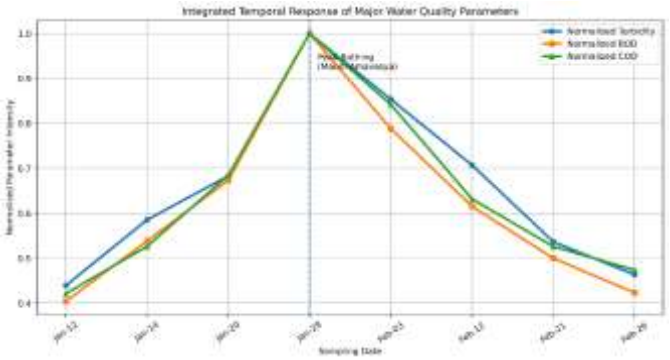

Fig 5: Integrated Temporal Response Of Major Quality Parameters

Spatial distribution of water quality

Figure illustrates the spatial distribution and intensity of pollution hotspots across major monitoring locations in the Prayagraj Sangam region during Mahakumbh 2025. The bubble-based geospatial visualization integrates latitude–longitude coordinates with pollution intensity values to identify environmentally stressed river stretches influenced by pilgrimage activities and anthropogenic disturbances.

Each bubble represents an individual sampling location, while bubble size and color intensity correspond to the relative magnitude of pollution load observed at that location. The color gradient ranges from low pollution intensity (dark blue-purple shades) to high pollution intensity (yellow-green shades), thereby providing a comparative spatial representation of environmental stress within the river system.

The analysis reveals that the Triveni Sangam region exhibited the highest pollution intensity among all monitored locations during the Mahakumbh period. The elevated pollution conditions observed near the Sangam zone are likely associated with extremely high pilgrim density, intensive ritual bathing

activities, sediment disturbance, organic matter accumulation, and increased microbial contamination during peak bathing dates.

Similarly, the "Before Confluence" and "Old Naini Bridge" locations also demonstrated relatively high pollution intensity values, suggesting downstream transport and accumulation of suspended sediments and pollutants within the confluence region. Nagvasuki Ghat and Lord Curzon Ghat exhibited moderate pollution intensity, indicating localized anthropogenic influence and urban pressure within these river stretches.

In contrast, Shringverpur displayed comparatively lower pollution intensity values among the monitored locations. The relatively lower environmental stress observed at this upstream location may be attributed to reduced urban influence, lower pilgrim density, and comparatively limited anthropogenic disturbance during the monitoring period.

The spatial heterogeneity observed in the figure demonstrates that pollution distribution during Mahakumbh 2025 was not uniform across the Prayagraj River system. Instead, pollutant accumulation was strongly concentrated around densely populated bathing zones and confluence regions experiencing high pilgrimage pressure.

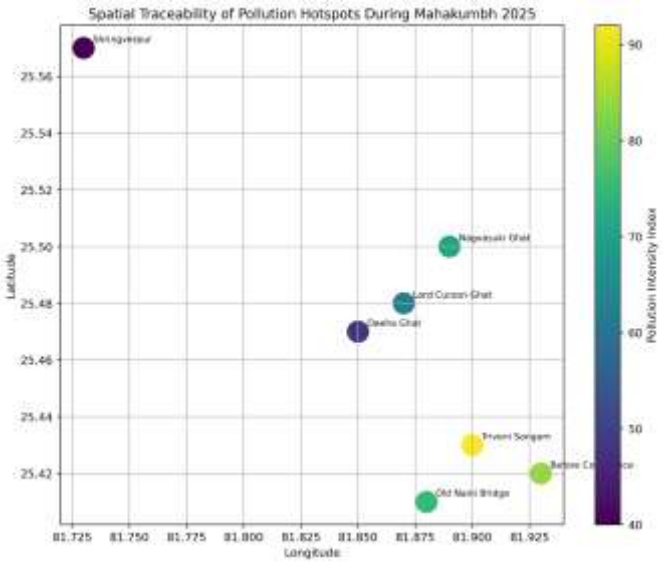

Fig. 6. Spatial Traceability of Pollution Hotspots During Mahakumbh 2025

Post-Kumbh Water Quality Recovery Trajectories

Post-Kumbh monitoring observations revealed gradual recovery of river water quality conditions following the completion of major bathing activities during Mahakumbh 2025. The recovery trajectories of different physicochemical and biological parameters indicated the influence of natural hydrodynamic processes, dilution effects, sediment settling, and river self-purification mechanisms within the Prayagraj Sangam region.

Turbidity values showed a noticeable declining trend after the conclusion of peak pilgrimage events, particularly following Mauni Amavasya and Basant Panchami. The reduction in turbidity may be attributed to decreased sediment resuspension and reduced anthropogenic disturbance along riverbanks after the decline in pilgrim density. Gradual settling of suspended sediments and restoration of normal river flow conditions likely contributed to the observed recovery process.

Similarly, BOD and COD concentrations demonstrated progressive decreases during the post-Kumbh period, indicating reduction in organic pollutant load within the river system. The decline in biodegradable and oxidizable matter suggests that temporary pollutant accumulation associated with mass bathing activities diminished after the completion of major pilgrimage events. Natural dilution, microbial decomposition, and hydrodynamic flushing may have supported recovery of organic pollution conditions.

Fecal coliform concentrations also exhibited decreasing trends during the post-event monitoring period, although microbial recovery appeared relatively slower compared to turbidity reduction. The persistence of elevated microbial concentrations for a longer duration may indicate continued influence of residual anthropogenic pressure and temporary sanitation-related impacts within localized river stretches.

Dissolved oxygen concentrations remained relatively stable throughout the recovery phase and gradually approached pre-event conditions after the reduction of organic load and microbial activity. Stable DO levels during the recovery period further demonstrate the resilience and self-purification capacity of the Ganga-Yamuna River system under fluctuating environmental stress conditions.

The post-Kumbh recovery trajectories observed in the present study are consistent with findings reported in previous river

water quality investigations conducted during large-scale religious gatherings and seasonal pollution events. Similar recovery behavior following temporary anthropogenic disturbances has been documented in major Indian river systems possessing high discharge and strong hydrodynamic characteristics.

However, the rate of recovery varied among different parameters, suggesting that some environmental impacts may persist longer than others depending on pollutant type, river flow conditions, and local anthropogenic activities. The delayed recovery observed for microbial indicators highlights the importance of continued post-event monitoring and sanitation management even after completion of major pilgrimage activities.

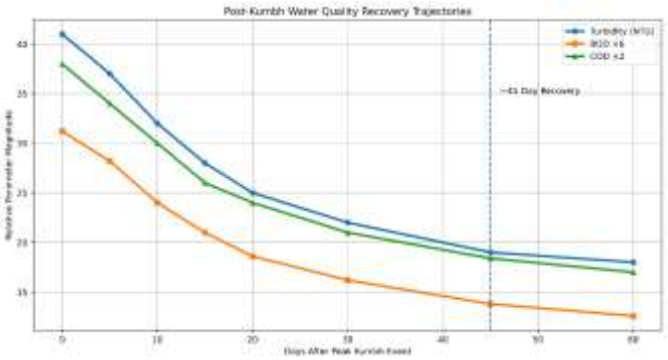

Fig.7 Post-Kumbh Mela water quality recovery trajectories.

V. DISCUSSION AND COMPARISON WITH BENCHMARK STUDIES

The present study demonstrated significant temporal and spatial variations in river water quality parameters during Mahakumbh 2025 in the Prayagraj Sangam region. The observed fluctuations in turbidity, BOD, COD, and fecal coliform concentrations clearly indicate the influence of large-scale pilgrimage activities and anthropogenic disturbances on river ecosystem dynamics.

Elevated turbidity levels recorded during major bathing events are consistent with findings reported in previous studies conducted during large religious gatherings in India. Similar increases in suspended sediment concentration and water column disturbance during intensive bathing activities were reported by Mishra and Dubey (2015), who observed that large pilgrim gatherings significantly enhanced sediment resuspension and turbidity in river systems. The increased turbidity observed in the present study during Mauni Amavasya and Basant Panchami may therefore be associated with intensive riverbank disturbance and large-scale human movement within shallow river stretches.

The increase in BOD and COD concentrations during peak pilgrimage periods indicates elevated organic pollution and increased oxidizable matter within the river water. Comparable observations were reported by Kumar et al. (2021), who identified strong relationships between pilgrimage intensity and organic pollutant loading in major Indian river systems. The present study similarly demonstrates that mass bathing activities contribute substantially to increased organic stress within the Sangam ecosystem.

Fecal coliform concentrations observed during the present investigation showed considerable temporal variability and increased significantly during major bathing events. Similar microbial contamination patterns were reported by Pandey and Verma (2017), who observed elevated fecal coliform levels during mass bathing activities due to direct human interaction with river water and temporary sanitation pressure around pilgrimage sites. The present findings therefore support previous evidence regarding microbial risk associated with large-scale religious gatherings.

Dissolved oxygen (DO) values remained relatively stable throughout the monitoring period despite increased organic and microbial load during peak bathing events. This observation is comparable to the findings of Tiwari and Singh (2020), who reported that high river discharge and continuous flow conditions may help maintain acceptable dissolved oxygen concentrations even under elevated anthropogenic stress conditions. The hydrodynamic behavior of the Ganga-Yamuna confluence likely contributed to maintaining oxygen balance during the Mahakumbh period.

Policy Implications for Prayagraj Mela Authority

The findings of the present study have important policy implications for the Prayagraj Mela Authority and associated environmental management agencies responsible for organizing and monitoring large-scale pilgrimage events during Mahakumbh.

Strengthening Real-Time Water Quality Monitoring

The study highlights the necessity of establishing continuous real-time water quality monitoring systems at major bathing ghats and sensitive river stretches. Installation of automated monitoring stations for turbidity, dissolved oxygen, microbial contamination, and organic pollution indicators would enable rapid detection of environmental deterioration during peak bathing periods.

Crowd Management During Peak Bathing Events

The observed relationship between pilgrim density and water quality deterioration suggests that effective crowd management strategies are essential during major bathing dates such as Mauni Amavasya and Makar Sankranti. Controlled access to highly sensitive bathing zones and staggered bathing schedules may help reduce localized environmental stress and sediment disturbance.

Strengthening Waste Management Infrastructure

Temporary and permanent waste management facilities should be enhanced around major bathing ghats to minimize direct discharge of solid waste, ritual offerings, and organic matter into river water. Adequate deployment of sanitation infrastructure, waste collection systems, and mobile treatment units may significantly reduce pollutant loading during pilgrimage events.

Enhanced Microbial Risk Management

Elevated fecal coliform concentrations observed during peak bathing periods indicate potential public health risks. The Prayagraj Mela Authority should strengthen microbial surveillance programs and implement precautionary public health advisories during periods of elevated contamination.

Integrated River Conservation Planning

The study emphasizes the need for integrated river conservation planning involving the Prayagraj Mela Authority, Central Pollution Control Board (CPCB), Uttar Pradesh Pollution Control Board (UPPCB), irrigation departments, municipal agencies, and local stakeholders. Coordinated environmental management strategies are necessary for sustainable river ecosystem protection during mass gatherings.

Development of Early Warning Systems

Predictive environmental management systems using statistical analysis, GIS, remote sensing, and machine learning approaches may help identify periods of high environmental stress before major bathing events occur. Early warning systems could support rapid management interventions and improve environmental preparedness

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Promotion of Eco-Friendly Pilgrimage Practices

Awareness campaigns promoting environmentally responsible pilgrimage practices should be conducted among pilgrims and local communities. Eco-friendly ritual alternatives, waste segregation, and public awareness regarding river conservation may reduce anthropogenic pressure on the Sangam ecosystem.

Post-Event Environmental Recovery Monitoring

Continuous post-event monitoring should be implemented to evaluate ecological recovery of river systems after major pilgrimage activities. Monitoring recovery trajectories would help environmental agencies understand river resilience and improve future management strategies.

Expansion of Scientific Monitoring Programs

Future Mahakumbh events should include expanded scientific monitoring programs incorporating hydrological analysis, microbial assessment, remote sensing observations, and advanced water quality modeling to improve understanding of environmental dynamics during large-scale religious gatherings.

Sustainable Mahakumbh Environmental Framework

The Prayagraj Mela Authority may develop a dedicated Sustainable Mahakumbh Environmental Management Framework integrating scientific monitoring, pollution mitigation, waste management, ecological restoration, and public participation to ensure long-term protection of the Ganga-Yamuna River ecosystem during future pilgrimage events.

Limitations and future work

The present study provides important insights into river water quality variations during Mahakumbh 2025; however, certain limitations should be acknowledged.

1. The study was primarily based on CPCB monitoring observations collected during specific sampling dates. Continuous high-frequency monitoring data were not available for all locations and parameters.
2. Spatial coverage of monitoring stations was limited to selected ghats and monitoring locations within the

Prayagraj Sangam region. Therefore, localized variations in water quality may not have been fully represented.

3. The analysis mainly focused on major physicochemical and biological parameters such as turbidity, DO, BOD, COD, pH, and fecal coliform. Other important pollutants including heavy metals, nutrients, and emerging contaminants were not included in the present assessment.
4. Meteorological and hydrological factors such as rainfall, river discharge, flow velocity, and sediment transport dynamics were not incorporated into the analysis, although these factors can significantly influence river water quality conditions.
5. The study primarily evaluated temporal variations during the Mahakumbh period and did not include long-term pre-event and post-event environmental monitoring over multiple years.
6. Pilgrim density data used in the interpretation were generalized event-based estimates and may not represent exact real-time human movement within individual river stretches.
7. The present study relied mainly on observational and statistical analysis; advanced hydrodynamic and predictive modeling approaches were beyond the scope of the investigation.

Future Scope and Recommendations

The findings of the present study provide a strong foundation for future environmental monitoring and river management research during large-scale religious gatherings.

1. Future studies may integrate high-resolution satellite remote sensing data and GIS-based spatial analysis for continuous monitoring of turbidity and suspended sediment dynamics during pilgrimage events.
2. Machine learning and artificial intelligence approaches may be applied for predictive modeling of river water quality under varying pilgrimage intensity and environmental conditions.
3. Real-time sensor-based monitoring systems can be established for continuous assessment of physicochemical and microbial parameters during future Mahakumbh events.
4. Future investigations should include additional parameters such as heavy metals, nutrients, microplastics, pharmaceutical residues, and emerging contaminants for comprehensive environmental assessment.
5. Hydrological and meteorological variables including river discharge, rainfall, sediment transport, and flow velocity should be integrated into future models to improve understanding of river system behavior.
6. Long-term comparative studies before, during, and after major pilgrimage events may help in evaluating ecological recovery and long-term environmental impacts on river ecosystems.
7. Advanced geospatial techniques and spatial interpolation methods may be used to identify pollution hotspots and vulnerable river stretches within the Sangam region.
8. Future studies may also evaluate public health risks associated with microbial contamination during large-scale mass bathing activities.
9. Integrated environmental management strategies involving government agencies, pollution control authorities, and local stakeholders should be developed for sustainable river conservation during future pilgrimage gatherings.
10. The methodology adopted in the present study may be extended to other major river systems and mass gathering events across India for comparative environmental assessment and sustainable water resource management

VI. CONCLUSION

The present study evaluated temporal and spatial variations in major river water quality parameters during Mahakumbh 2025 using CPCB monitoring observations in the Prayagraj Sangam region. The analysis demonstrated significant environmental fluctuations associated with large-scale pilgrimage activities and mass bathing events.

Turbidity, BOD, COD, and fecal coliform concentrations showed noticeable increases during peak bathing periods, indicating enhanced sediment disturbance, organic pollution, and microbial contamination within the river system. Dissolved oxygen remained relatively stable throughout the monitoring period, while pH values generally stayed within acceptable environmental limits.

The study also revealed strong relationships between pilgrim density and pollutant concentration, suggesting that increased anthropogenic activities significantly influenced river water quality dynamics during Mahakumbh 2025. Spatial analysis indicated elevated environmental stress near major bathing zones and urban river stretches.

Post-event observations demonstrated gradual recovery of river water quality conditions due to natural self-purification and hydrodynamic processes. However, the observed fluctuations emphasize the importance of continuous environmental monitoring, sustainable river management, and pollution mitigation strategies during future large-scale religious gatherings.

The findings of the present study may support environmental agencies, policymakers, and river management authorities in developing scientifically informed strategies for protecting river ecosystems during mass pilgrimage events while ensuring sustainable water resource management in culturally significant river systems.

Credit authorship contribution statement

- **Saurabh Singh:** Data curation, Conceptualization, Formal analysis, Methodology, Writing - original draft, Visualization, Validation.
- **Gaurav Kumar Singh:** Conceptualization, Supervision, Writing - review & edit: Supervision, Validation, Writing - review & editing. Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

In-situ water quality data are available from CPCB (https://cpcb.nic.in) and UPJN upon request. All Sentinel-2 satellite data are freely available via the Copernicus Open Access Hub (https://scihub.copernicus.eu) and the Google Earth Engine data catalog. No datasets were independently generated or deposited during this study.

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