जल शक्ति मंत्रालय
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Seasonal Water Quality and Pollution Assessment at the Tunga Bhadra Confluence, Kudli, Karnataka, India

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DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION, MINISTRY OF JAL SHAKTI, GOVERNMENT OF INDIA

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National Institute of Technology Karnataka, Surathkal



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River Tungabhadra

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Introduction

- Rivers are vital for **human needs, ecosystems and biodiversity**
- Increasing **urbanization** and **untreated wastewater** are degrading river water quality
- Water quality varies with **pollution sources, river flow and seasonal conditions**.
- **River confluences** are critical zones where different water qualities and pollutant loads interact.
- The **Tunga–Bhadra confluence at Kuudli** is an important location to assess pollution sources, seasonal water-quality changes and the influence of urban sewage.
- Study combines **water-quality monitoring, FTIR and ICP-MS** to better understand pollution characteristics and their implications for river health



Priority Class I

> 30.1 mg/L

Priority Class II

20.1 – 30.0

Priority Class III

10.1 – 20.0

Priority Class IV

6.1 – 10.0

Priority Class V

3.1 – 6.0

Objectives of the Research Work

- To assess the seasonal variation in water quality at the Tunga–Bhadra confluence during the pre and post – monsoon seasons, and to evaluate the influence of seasonal changes, on key water quality parameters.

- To investigate the impact of urban wastewater discharge on the Tunga–Bhadra confluence by evaluating pollutant dilution before and after mixing with river water and characterizing the wastewater using FTIR and ICP-MS analyses.

Literature

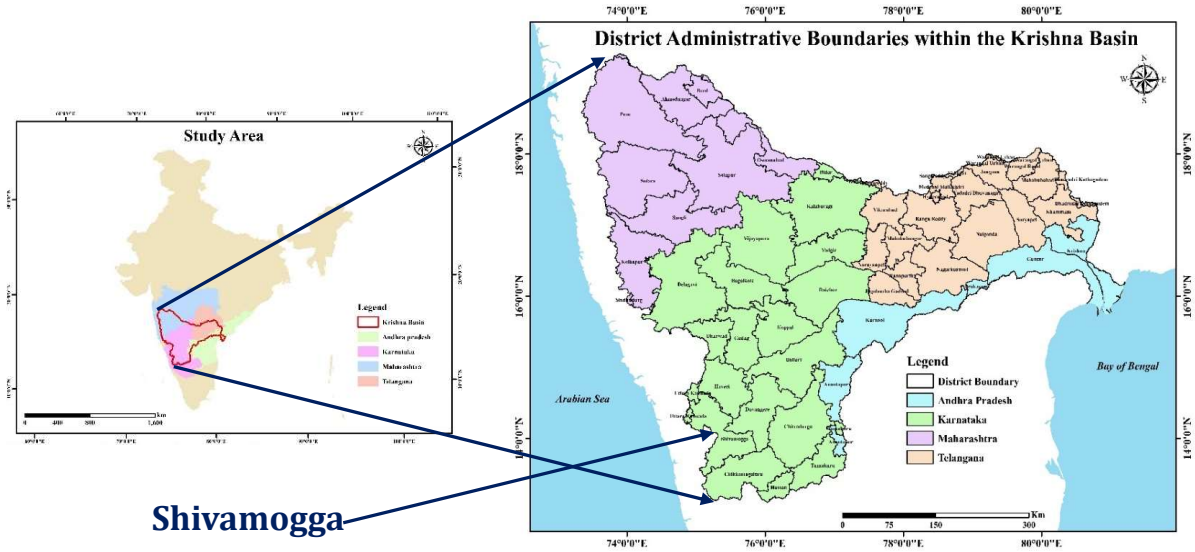
Sl.No	Title /Year/Authors	Focus / Scope of Study	Key Outcomes	Relevance to Present Work
1.	Water Quality Assessment of River Tungabhadra (2020)	Physico-chemical + biological, seasonal comparison	• BOD exceeded permissible limits (>3 mg/L) at most stations • Physico-chemical parameters showed clear increasing trend toward downstream. • Total & Fecal Coliform count high (up to 4950 MPN/100mL), • TDS increasing downstream indicates contamination inflow. • Seasonal variation observed — higher pollution load during pre-monsoon compared to post-monsoon. • Seasonal variation observed — higher pollution load during pre-monsoon compared to post-monsoon.	• Strongly related to your WQ study at Kudli stretch • Kudli is located upstream of Harihara region studied in this paper • same river system, similar pollution context & geography. • Uses same parameters in study — pH, TDS, BOD, COD, DO, Hardness, Turbidity, Coliform. • Supports integration of seasonal/temporal variation analysis similar to my 15-day dataset
2.	Comparative study of physico-chemical parameters and water quality index of river (2022) — N. Jain, R. Yevatikar & T. S. Raxamwar	• Physico-chemical analysis + WQI of Mula-Mutha River (Pune, India) across 4 sampling sites. • Comparative trend analysis over ~5 years (2013–2018).	• Observed large variations in pH, DO, BOD, COD, hardness, turbidity, TDS/EC — indicating water quality degradation over time. • WQI results show that river water is unsuitable for drinking — due to high pollution load (organic + inorganic + sewage/effluent discharge). • Identified that industrial effluents + municipal/domestic sewage + agricultural runoff are major pollution sources	• Their long-term dataset supports my approach of analysing temporal variation in water quality (15-day monitoring). • Identifies industrial effluents, sewage discharge, and agricultural runoff as major pollution sources — helps frame probable pollution origins in Kudli stretch.

Study Area

Tunga–Bhadra Confluence, Kuudli

Location:

- Kuudli, Shivamogga District, Karnataka, India
- Approximately 14 km east of Shivamogga city
- Coordinates: 13.99° N, 75.67° E
- **Tunga River + Bhadra River → Tungabhadra River**
- Tungabhadra is a major tributary of the Krishna River

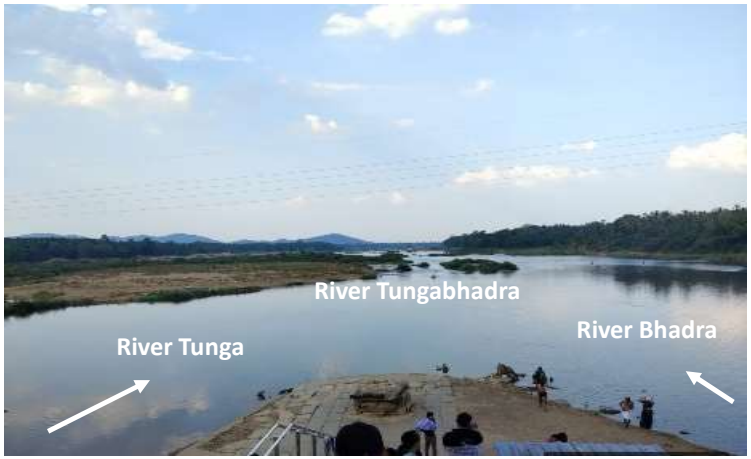


Climate & Hydrological Setting

- Tropical monsoon climate
- **Southwest monsoon:** June–September
- Lower pre-monsoon flows can result in **higher pollutant concentrations**

Why Kuudli?

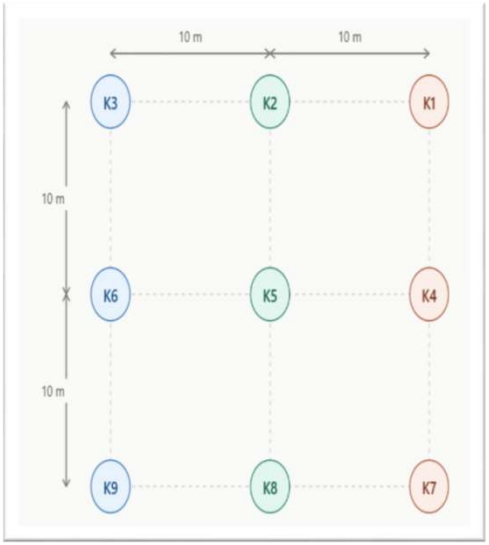
- Important river confluence and downstream transition zone
- Seasonal variation in flow and water quality
- Suitable location for assessing **spatial and seasonal water-quality dynamics**



Sampling Stations and Spatial Framework

Sampling Stations:

Parameter	Details
Monitoring Stations	9 (S1 – S9)/(K1-K9)
Sampling frequency	Fortnightly
Study period	October 2025 – April 2026
Hydrological periods	Post Monsoon and Pre monsoon
Sampling Type	Grab Sampling









Urban Drain and Sewage Source Assessment

Sampling Stations:

• An urban drain carrying **untreated municipal/domestic sewage from Shivamogga** discharges into the Tunga–Bhadra confluence.
• Two representative samples were collected to assess the pollution contribution:

1. Raw Sewage Sample
• Collected **directly from the drain**
• Represents the untreated point-source discharge

2. Mixed River Sample
• Collected **immediately downstream of the sewage–river mixing point**
• Represents water quality after initial mixing





Analysis

In-situ & Laboratory Analysis APHA standardized procedures for pH, EC, DO, BOD (5-day), COD, Sulphate, Nitrate, Total hardness,etc.

Advanced Molecular Mapping FTIR Spectroscopy utilized to do the characterization of major organic and inorganic constituents in sewage and mixed samples

Trace Metal Profiling ICP-MS analysis for quantitative detection of Zn, Cu, Pb, Cd and Cr.

Comparison of raw sewage and mixed samples was used to understand the **effect of river mixing and dilution on pollutant characteristics**.

BOD	pH
COD	EC
Sulphate	Nitrate
Turbidity	Total Hardness
Chloride	TDS
Temperature	DO

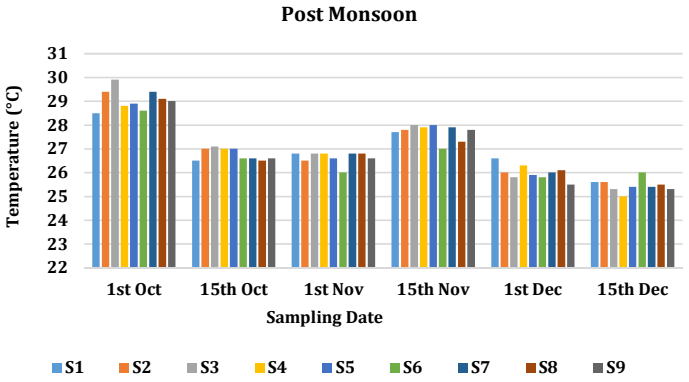
COLIFORM TEST

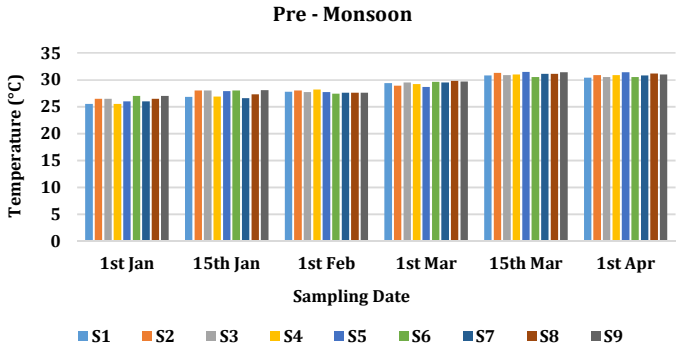
Microbiological Assessment Coliform presence verified using HI Media dip slides for rapid cultivation.



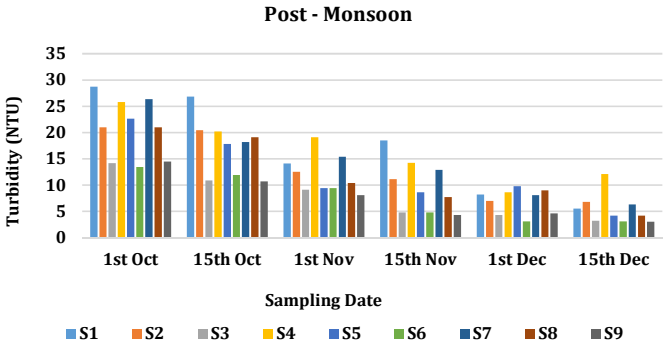
Findings

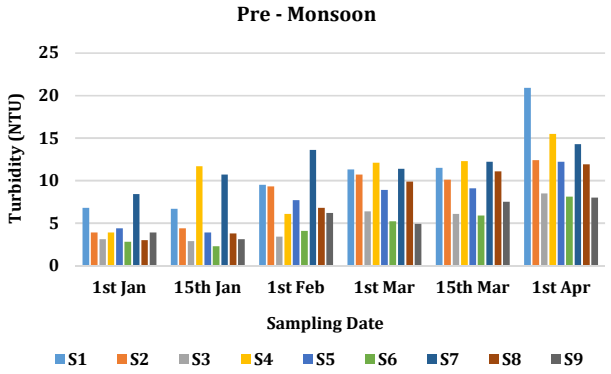
Temperature



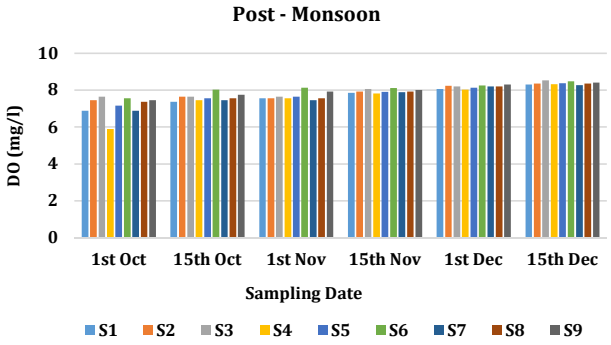


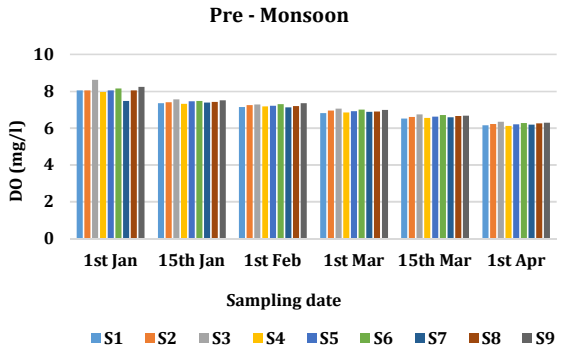
Turbidity



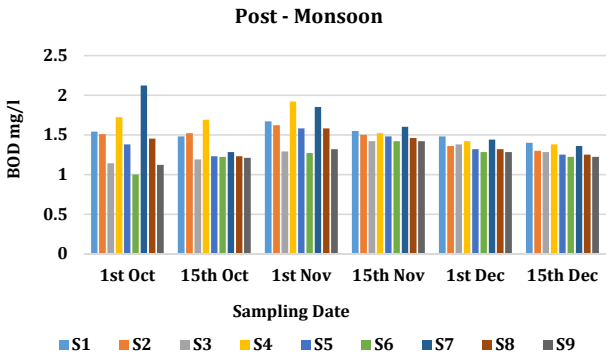


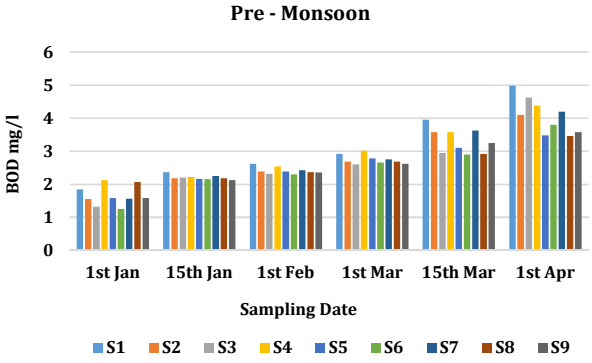
Dissolved Oxygen



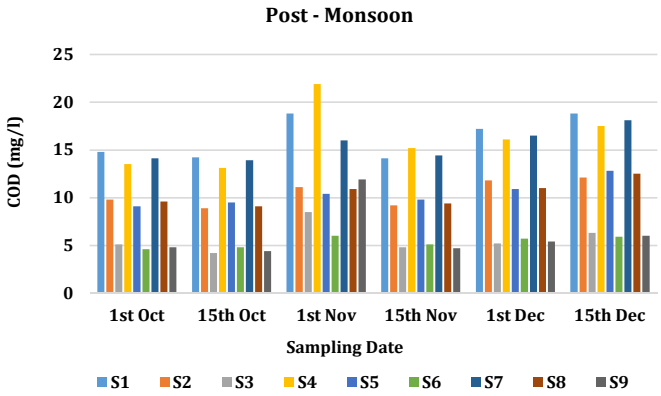


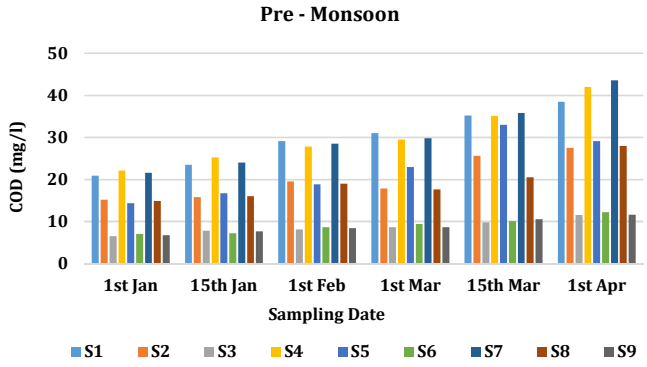
Biological Oxygen Demand



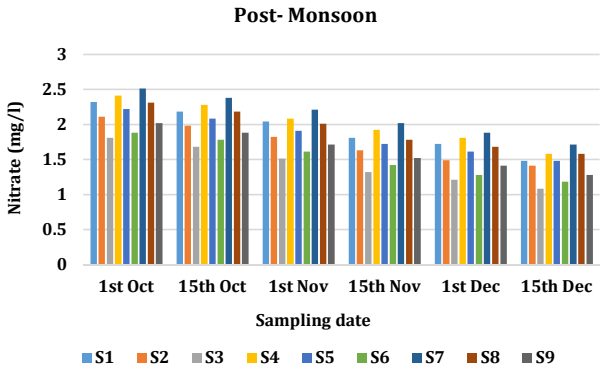


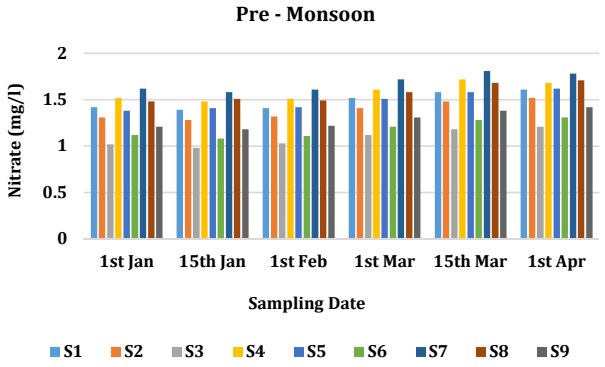
Chemical Oxygen Demand



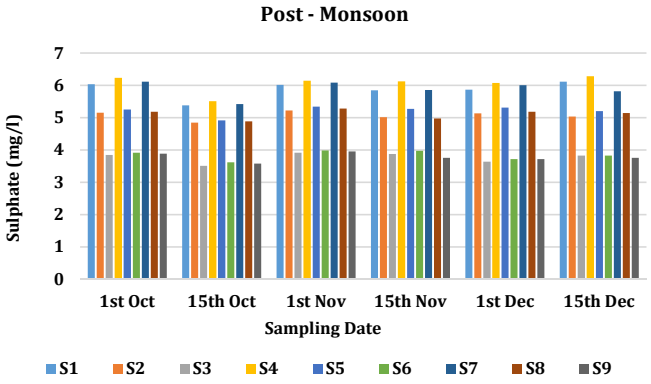


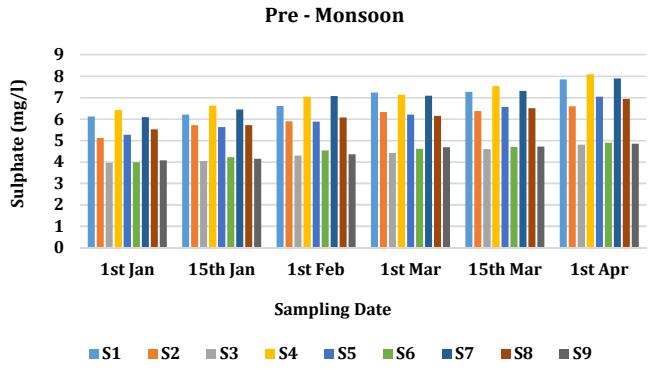
Nitrate



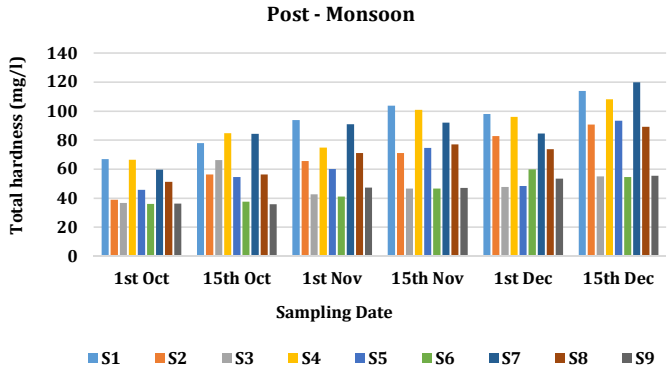


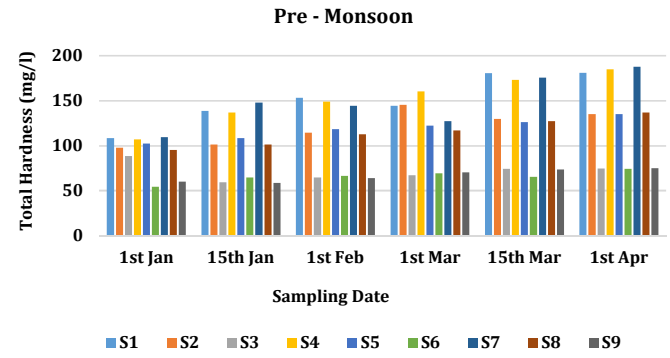
Sulphate



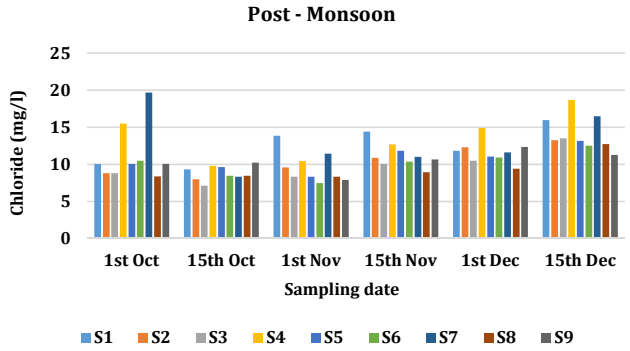


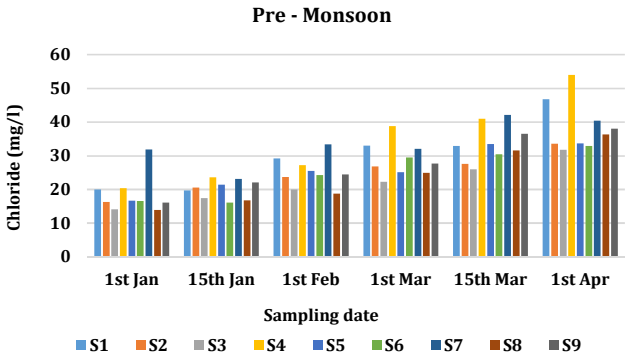
Total Hardness



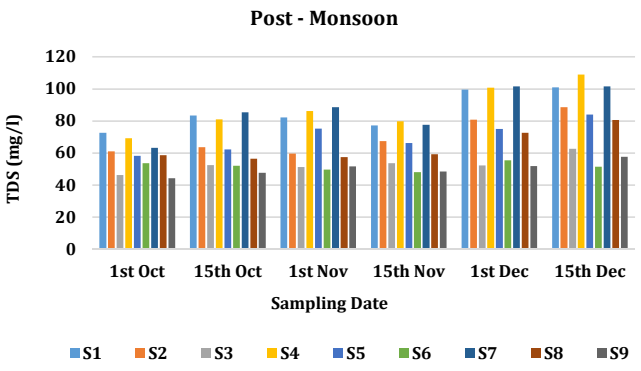


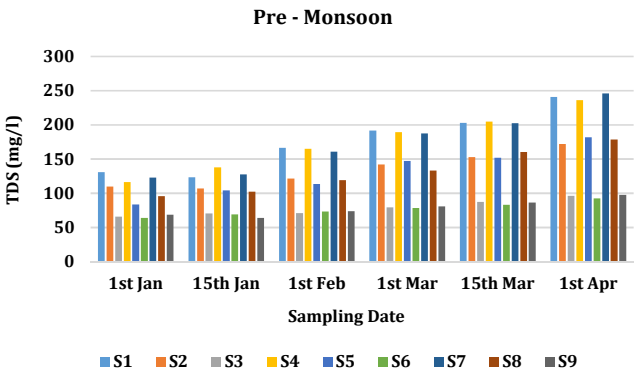
Chloride



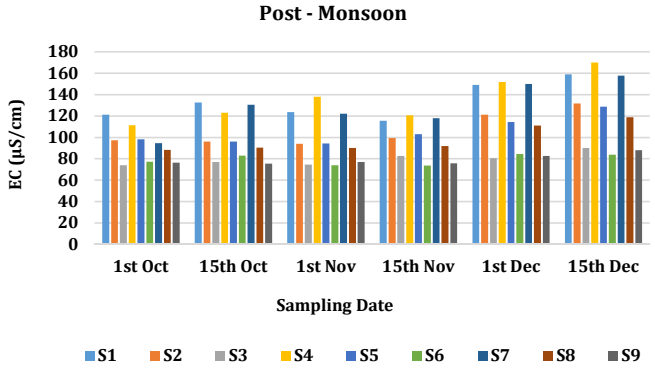


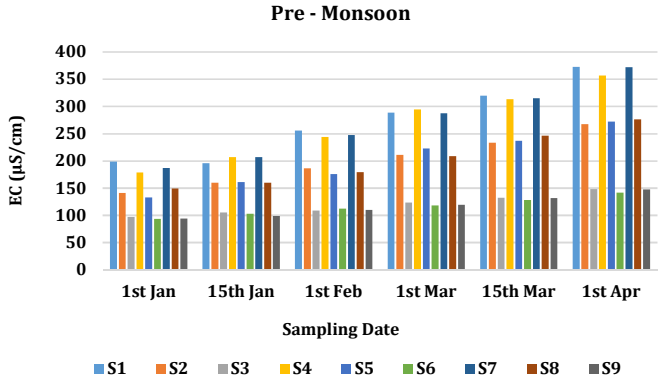
Total Dissolved Solids



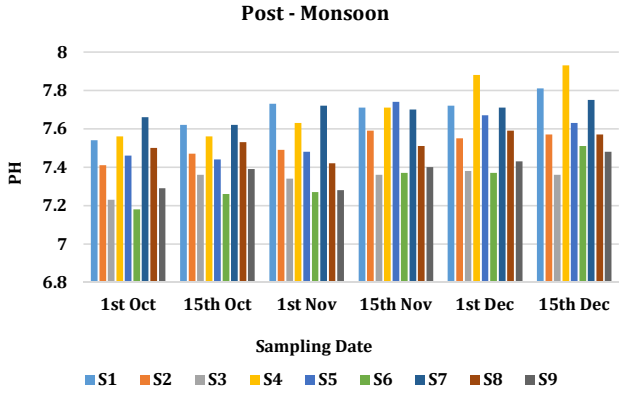


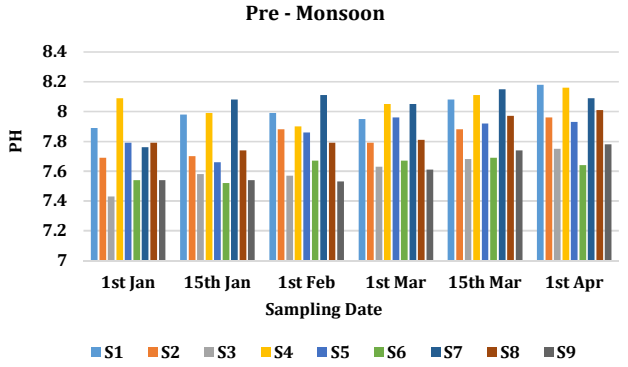
Electrical Conductivity





pH





Microbiological Assessment: Coliform Detection

- While physicochemical parameters such as COD and BOD provided mathematical evidence of organic pollution, it was necessary to visually confirm the active biological threat present in the water.
- **Coliform detection** was carried out to complement the physicochemical assessment of organic pollution.
- Water samples were tested using **standard HiMedia dip slides** for rapid coliform detection.
- The test was conducted on **three separate occasions** during the study period.
- **All three testing events showed strongly positive results for coliform bacteria.**

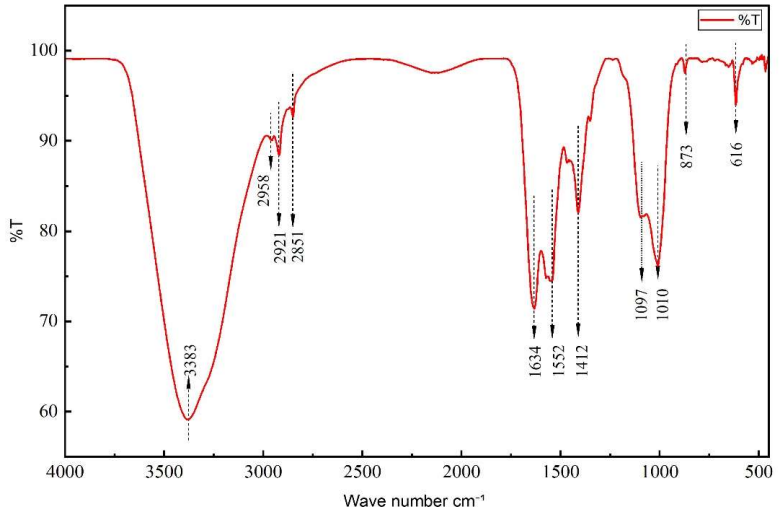
The findings indicate **significant microbial contamination** and potential sanitary concerns in the study area.





Molecular Characterization (FTIR Analysis)

Raw Drain Sewage Sample



- Raw sewage exhibited **strong signatures of organic matter**, particularly proteinaceous and lipid-rich compounds.
- The spectrum indicates the presence of **proteins, lipids, surfactants, and biodegradable organic compounds** associated with domestic and municipal wastewater.
- Additional spectral features suggest the presence of **carbohydrates, phosphates, carboxylates, and siliceous minerals**.
- Signals corresponding to **carbonate and sulphate compounds** were also observed.
- Overall, the FTIR profile confirms that the urban drain contains a **complex mixture of organic and inorganic constituents characteristic of untreated sewage**.
- **Raw sewage showed a strong presence of diverse organic pollutants along with inorganic mineral constituents.**

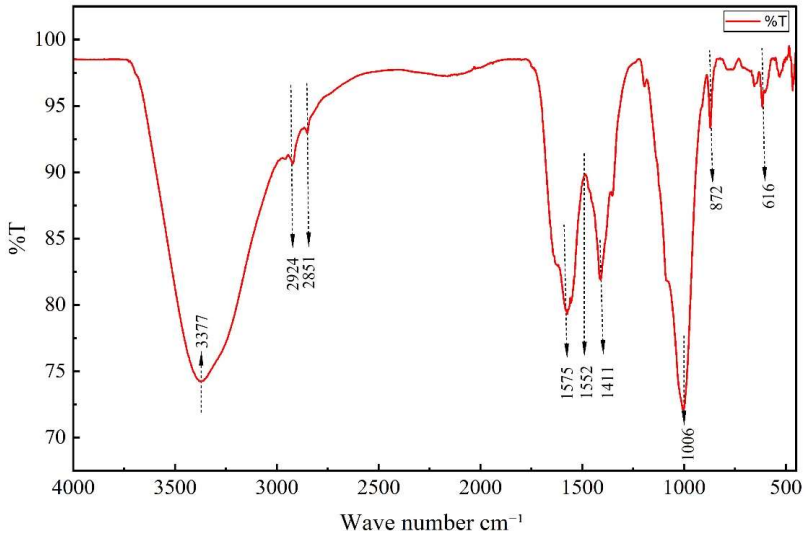
Peak (cm^{-1})	Functional Group	Interpretation
3383	O–H / N–H stretching	Water, amines, proteins
2921 & 2851	C–H stretching	Lipids, fatty acids, surfactants
1634	Amide I (C=O)	Proteinaceous organic matter
1552	Amide II (N–H bending)	Peptides and sewage proteins
1412	COO^- stretching	Humic substances & organic acids
1097 & 1010	C–O–C / P–O / Si–O	Carbohydrates, phosphates, minerals
873 & 616	Carbonate/Sulfate vibrations	Inorganic salts

Molecular Characterization (FTIR Analysis)

Drain Sewage Sample at Mixing Zone

- The mixed sample exhibited **reduced signatures of organic matter** compared with raw sewage, indicating dilution after mixing with river water.
- The spectrum indicates **reduced sewage-derived proteins, amines, lipids, and surfactants**.
- The **shift in Amide I and absence of Amide II** suggest dilution and reduction of proteinaceous sewage matter.
- The **COO^- band remained relatively persistent**, indicating the presence of **humic substances and organic acids**.
- The sulphate signature remained relatively similar, indicating the presence of **inorganic salts from both sewage and river sources**.

Overall, the FTIR profile indicates that **river mixing altered the composition of sewage-derived constituents through dilution and increased contribution from natural river materials**.



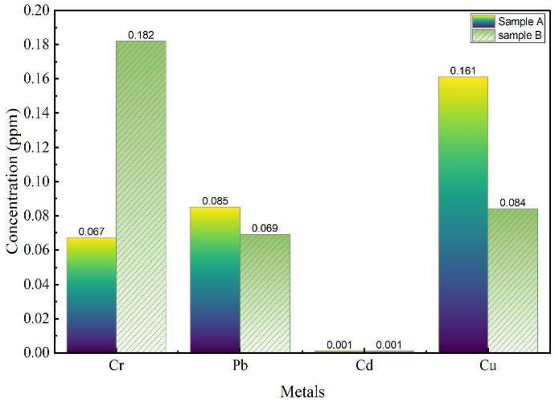
Peak (cm^{-1})	Functional Group	Interpretation
3377	Reduced O–H/N–H intensity	Dilution of sewage proteins & amines
2924 & 2851	Lower C–H absorption	Reduced lipids & surfactants
1575	Shifted Amide I band	Transition toward humic-rich DOM
1552	Amide II absent	Proteinaceous sewage matter diluted/removed
1411	Similar COO^- intensity	Humic/carboxylic substances persist
1006	Stronger C–O–C / Si–O	Increased minerals & polysaccharides
872	Increased carbonate peak	Higher river-derived inorganic content

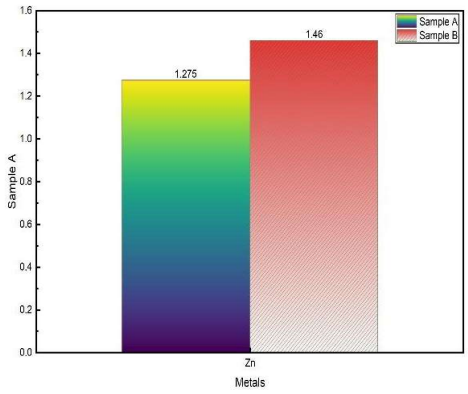
Heavy Metal and Trace Element Detection (ICP-MS Analysis)

- ICP-MS analysis detected **Pb, Cr, Cu, Zn and Cd** in both sewage and mixed samples.
- **Zinc was the most prominent metal** detected in the samples.
- **Lead and copper decreased** after mixing with river water.
- **Chromium showed an increase** after mixing.
- **Cadmium remained very low** in both samples.

The results indicate the presence of **anthropogenic metal contamination** in the sewage and mixing zone.

Comparison with applicable standards highlighted **chromium as a parameter requiring attention**.





Analyte Mass	Raw Drain (384_A)	Mixed Zone (384_B)	Observed Shift
Lead (^{208}Pb)	0.085 ppm (85 ppb)	0.069 ppm (69 ppb)	**18.8% Reduction**
Chromium (^{52}Cr)	0.067 ppm (67 ppb)	0.182 ppm (182 ppb)	**River Contribution**
Copper (^{63}Cu)	0.161 ppm (161 ppb)	0.084 ppm (84 ppb)	**47.8% Reduction**
Zinc (^{66}Zn)	1.275 ppm (1275 ppb)	1.460 ppm (1460 ppb)	**Marginally Stable**
Cadmium (^{111}Cd)	0.001 ppm (1 ppb)	0.001 ppm (1 ppb)	**Trace Baseline**

Conclusion

Seasonal Toxicity Window

The **Pre-Monsoon (Summer)** is identified as the critical period. Low discharge and high evaporation create a "Concentration Trap," doubling EC and tripling Chloride levels.

Point-Source Assimilation

Shivamogga urban drain is a major stressor; however, the Tunga River shows high resilience with **50% COD and 68% Sulphate reduction** in mixing zones.

Heavy Metal Warning

ICP-MS confirms that **Lead (Pb) and Chromium (Cr)** exceed BIS IS:10500 limits. These non-biodegradable toxins pose a long-term risk via benthic sediment accumulation.

Path to Restoration

Immediate installation of **STPs in Shivamogga** and regulated agricultural runoff management are essential to restore the stretch.

Human Health Implication: The presence of **coliform bacteria, untreated sewage-derived organic pollutants, and heavy metals** indicates potential risks to human health, particularly where river water is used for domestic or other direct-contact purposes, highlighting the need for **effective wastewater treatment and regular water-quality monitoring**.

References

1. APHA (2017). *Standard Methods for the Examination of Water and Wastewater*, 23rd Edition. American Public Health Association, Washington D.C.
2. BIS *Indian Standard Drinking Water – Specification (Second Revision)*, IS 10500:2012. Bureau of Indian Standards, New Delhi.
3. CPCB *River Water Quality Monitoring Report*. Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India.
4. CPCB . *Water Quality Criteria and Designated Best Use Classification of Rivers*. Central Pollution Control Board, India.
5. Trivedy, R.K., & Goel, P.K. (1984). *Chemical and Biological Methods for Water Pollution Studies*. Environmental Publications, Karad.
6. Sawyer, C.N., McCarty, P.L., & Parkin, G.F. (2003). *Chemistry for Environmental Engineering and Science*, 5th Edition. McGraw-Hill.
7. Singh, U.K., Mehta, A., & Pandey, A.C. (2017). “Water Quality Assessment of the Ganga River System: A Review.” *Journal of Environmental Management*, 196, 168–182.
8. Karnataka State Pollution Control Board (KSPCB). (2020). *Tungabhadra River Basin Water Quality Report*. Government of Karnataka.

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THANK YOU