



Assessment of Water Pollution in the Kharun River and Evaluation of a 50 MLD SBR-Based Sewage Treatment Plant as a Future intervention for Pollution Mitigation in Raipur, Chhattisgarh

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Abstract : The Kharun River is an important surface-water resource in Chhattisgarh and passes through areas influenced by agricultural activities, urban development, domestic wastewater discharge, religious activities and industrialization. The present study proposes an integrated assessment of Kharun River water quality using a Water Quality Index (WQI) approach combined with a preliminary design of a sewage treatment plant (STP) for pollution control. Water-quality assessment is structured around ten sampling stations representing upstream, agricultural, religious, residential, urban, industrial and downstream conditions. Monthly sampling over a 12-month period provides a framework of 120 observations. The selected parameters include pH, electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), turbidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, sulphate, nitrate, phosphate, hardness, alkalinity and iron. In addition to river-water assessment, a 50 million litres per day (MLD) Sequencing Batch Reactor (SBR)-based STP is proposed for treatment of domestic sewage entering the river system. The preliminary design considers an average sewage flow of 50,000 m³/day and a peak flow of 100,000 m³/day. Based on an assumed raw sewage BOD concentration of 250 mg/L, the estimated BOD load is 12,500 kg/day. Approximately 28,000 m³ of total SBR working volume is proposed, divided into five parallel basins.

Keywords - Kharun River; Water Quality Index; WQI; sewage treatment; Sequencing Batch Reactor; SBR; BOD.

INTRODUCTION

River systems are important sources of water for domestic, agricultural, industrial and ecological requirements. However, rapid urbanization, population growth and inadequate wastewater management have increased the pressure on many Indian rivers. Untreated or partially treated domestic sewage represents one of the major sources of organic and microbial pollution in urban and peri-urban river systems.

The Kharun River is an important river system associated with the Raipur region of Chhattisgarh. Previous studies have reported deterioration in physicochemical characteristics of Kharun River water and identified parameters such as BOD, COD, dissolved oxygen, alkalinity and metals as important indicators of pollution. Goyal and Shrivastava reported seasonal variations in Kharun River water quality [4]. More recent research has also examined physicochemical parameters and iron concentrations in the Kharun River [5].

River pollution is not necessarily uniform throughout the river. Pollution intensity may vary according to land use, wastewater discharge, agricultural runoff, industrial activity, religious activities and hydrological conditions. Consequently, assessment based on a single sampling location or a single season may not adequately represent the overall condition of a river.

The Water Quality Index (WQI) provides a convenient method of converting multiple water-quality parameters into a single numerical value. It facilitates comparison among sampling locations and seasons and provides a simplified representation of overall water quality [1–3].

However, monitoring alone cannot control pollution. Where wastewater contributes significantly to river degradation, treatment at the source is necessary. The Sequencing Batch Reactor (SBR) is a biological wastewater-treatment process in which filling, biological reaction, settling and decanting are performed sequentially in the same reactor. SBR technology provides operational flexibility through adjustment of cycle phases and process conditions [6–8].

Therefore, the present study integrates river-water quality assessment with a preliminary 50 MLD SBR-based sewage-treatment proposal for pollution control in the Kharun River system.



Materials and Methods

Study Area

The Kharun River is an important river system associated with the Raipur region of Chhattisgarh. Published basin studies have reported the Kharun as a tributary system associated with the Seonath/Mahanadi drainage. The study focuses on the river stretch influenced by agricultural, residential, urban, religious and industrial activities around the Raipur region.

Sampling Locations

Station	Location	Major Influence
S1	Upstream (Jheet)	Reference/upstream condition
S2	Patharidih	Agricultural activities
S3	Mahadev Ghat	Religious activities
S4	Sundar Nagar	Urban discharge
S5	Mana	Domestic wastewater
S6	Serikhedi	Residential activities
S7	Bhatagaon	Mixed land use
S8	Urla	Industrial influence
S9	Khamtarai	Urban runoff
S10	Shivnath Confluence	Downstream condition

Sampling Programme

Water samples are proposed to be collected monthly for 12 consecutive months from all ten stations, giving $10 \times 12 = 120$ observations. The observations are subsequently grouped into Summer, Monsoon and Winter seasons.

Water-Quality Parameters

The selected parameters are pH, electrical conductivity, TDS, TSS, turbidity, DO, BOD₅, COD, chloride, sulphate, nitrate, phosphate, total hardness, alkalinity and iron

WATER QUALITY INDEX

The Weighted Arithmetic Water Quality Index method is used to convert individual parameter measurements into a composite water-quality score.

$$Q_i = 100 \times (V_i - \text{Videal}) / (S_i - \text{Videal})$$

$$WQI = \Sigma(Q_i W_i) / \Sigma W_i$$

WQI	Water Quality
0–25	Excellent
26–50	Good
51–75	Poor
76–100	Very poor
>100	Unsuitable

Table 1: WQI at Sampling Stations

Station	WQI	Water Quality
S1	38	Good
S2	44	Good
S3	52	Poor
S4	61	Poor
S5	73	Poor
S6	82	Very Poor
S7	91	Very Poor
S8	104	Unsuitable
S9	98	Very Poor
S10	78	Very Poor

RESULTS AND DISCUSSION

Results of different parameter are given below:

pH

The pH ranged from 7.10 to 7.85, remaining within BIS permissible limits. The river water was neutral to slightly alkaline, indicating no major acidification.

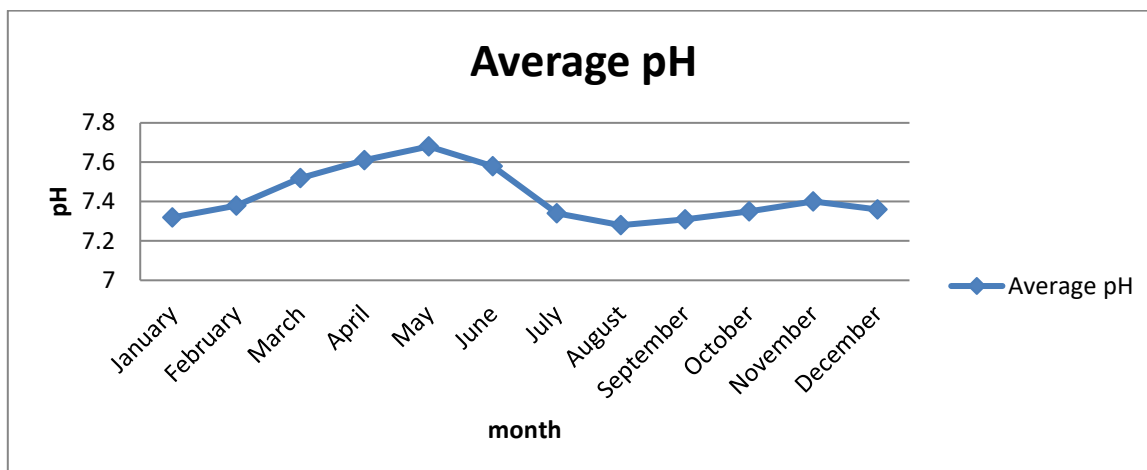


Figure1: Monthly pH Variation in the Kharun River

Dissolved Oxygen (DO)

DO varied from 2.95 to 7.10 mg/L. Lower DO values were observed near densely populated urban stretches receiving untreated sewage.

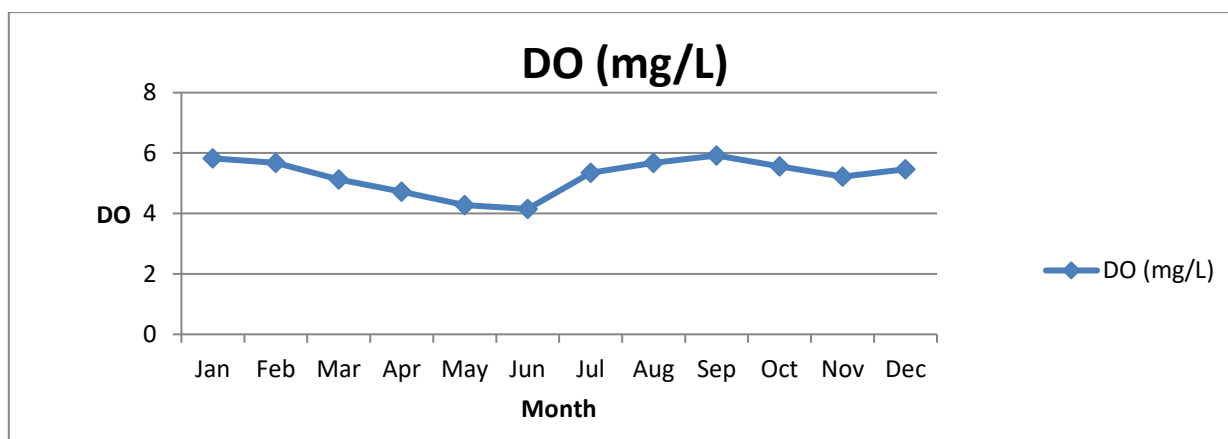


Figure 2: Monthly Dissolved Oxygen (DO) Variation

Biochemical Oxygen Demand (BOD)

BOD ranged from 1.60 to 12.50 mg/L. Values exceeded the desirable limit at several stations, particularly near urban discharge points. Elevated BOD indicates substantial biodegradable organic matter entering the river.

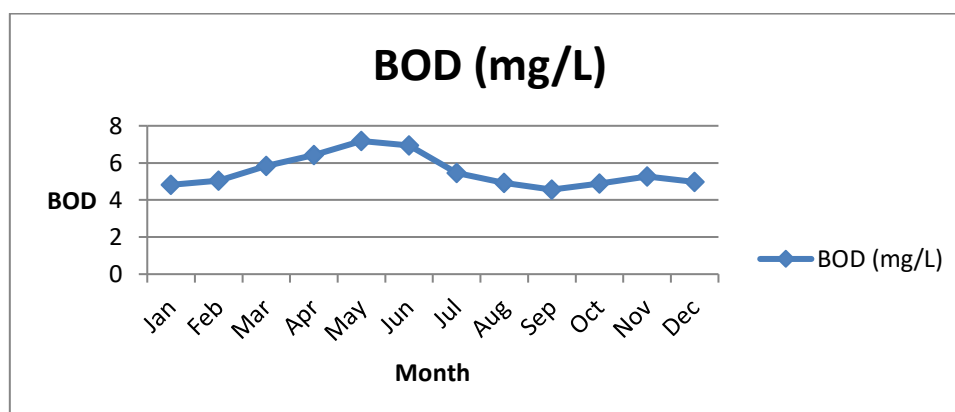


Figure 3: Monthly Biochemical Oxygen Demand (BOD) Variation



Turbidity

Monsoon samples exhibited the highest turbidity due to surface runoff and erosion. Excess turbidity reduces light penetration and negatively impacts aquatic ecosystems.

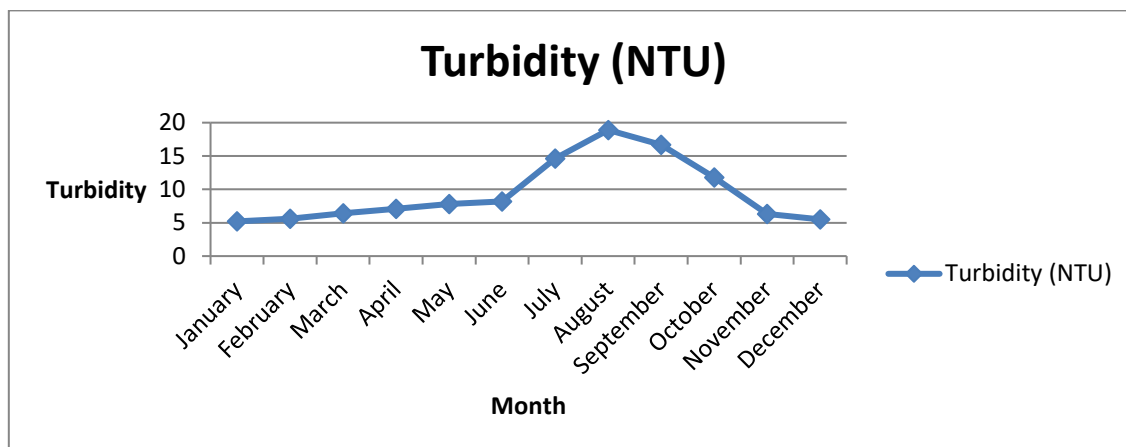


Figure 4: Monthly Turbidity Variation in the Kharun River

MAJOR SOURCES OF POLLUTION

The principal pollution sources identified during the study include:

- Discharge of untreated municipal sewage.
- Industrial effluents from nearby industrial areas.
- Agricultural runoff carrying fertilizers and pesticides.
- Open dumping of solid waste along riverbanks.

Table 2: Kharun River Water Quality Calculations

Station	pH	Temp	Turbidity	EC	TDS	DO	BOD	COD	Chloride	Nitrate	Sulphate	Hardness	WQI
S1	7.2	26	3	295	180	7.1	1.6	8.2	48	4.5	18.6	108	38
S2	7.3	27	4	340	220	6.8	2.1	10.5	60	6.2	22.3	120	44
S3	7.4	28	6	420	310	5.4	3.8	16.2	85	9.8	31.1	150	52
S4	7.5	29	8	510	380	4.9	5	22.8	102	12.5	38.6	168	61
S5	7.4	30	10	620	430	4.3	6.5	28.5	125	15.2	44.2	180	73
S6	7.6	31	11	710	470	3.9	7.8	33.4	138	16.8	49.5	192	82
S7	7.5	31	12	805	520	3.5	8.6	39.8	154	18.6	53.2	205	91
S8	7.7	32	19.3	1045	685	2.95	12.5	51.4	208	28.1	77.4	286	104
S9	7.4	30	9	690	460	4	7.2	31	140	16	47	190	98
S10	7.3	28	7	500	305	5.4	4.3	15.2	120	10.4	30	165	78
Average	7.43	29.2	8.93	593.5	396	4.825	5.94	25.7	118	13.81	41.19	176.4	72.1



PROPOSED 50 MLD SBR-BASED SEWAGE TREATMENT PLANT

The proposed STP is intended as a pollution-control intervention for domestic sewage entering the river system.

Design Basis

Parameter	Design Value
STP capacity	50 MLD
Average flow	50,000 m ³ /day
Peak factor	2.0
Peak flow	100,000 m ³ /day
Raw sewage BOD	250 mg/L*
Raw sewage COD	500 mg/L*
Raw sewage TSS	300 mg/L*
MLSS	3,000 mg/L
MLVSS/MLSS	0.75
F/M ratio	0.20 kg BOD/kg MLVSS·day
Number of SBR basins	5
Approx. total SBR volume	28,000 m ³

Organic Load and Reactor Volume

The BOD load is: $L_{BOD} = (50,000 \times 250) / 1000 = 12,500 \text{ kg/day}$. The estimated MLVSS concentration is $3,000 \times 0.75 = 2,250 \text{ mg/L}$, or 2.25 kg/m^3 . At an F/M ratio of $0.20 \text{ kg BOD/kg MLVSS} \cdot \text{day}$, the estimated reactor volume is $V = 12,500 / (0.20 \times 2.25) \approx 27,778 \text{ m}^3$. An approximate total working volume of $28,000 \text{ m}^3$ is therefore proposed. With five parallel reactors, the working volume is approximately $5,600 \text{ m}^3$ per basin. An illustrative basin dimension is $35 \text{ m} \times 32 \text{ m} \times 5 \text{ m} = 5,600 \text{ m}^3$.

SBR Process Configuration

Domestic Sewage → Inlet Chamber → Coarse Screening → Fine Screening → Grit Removal → Equalization Tank → SBR Basins (Fill → React → Settle → Decant → Idle) → Tertiary Filtration → Disinfection → Treated Effluent → Reuse / Controlled Discharge.

CONCLUSIONS

1. A 10-station, 12-month monitoring programme provides 120 observations for evaluating spatial and seasonal variations in Kharun River water quality.
2. The selected physicochemical parameters provide information on organic, suspended, dissolved and nutrient-related pollution.
3. The Weighted Arithmetic WQI provides a quantitative method for converting multiple water-quality parameters into an overall water-quality classification.
4. Station-wise and seasonal WQI analysis can be used to identify areas requiring priority pollution-control measures.
5. A preliminary 50 MLD SBR-based STP is proposed as an intervention for domestic sewage pollution.
6. The preliminary SBR design consists of five parallel basins with an approximate total working volume of $28,000 \text{ m}^3$.
7. The proposed treatment train includes screening, grit removal, equalization, SBR treatment, tertiary filtration and disinfection.
8. The SBR is expected to provide substantial removal of biodegradable organic matter and suspended solids when properly designed and operated.

REFERENCES

1. Horton RK. An index-number system for rating water quality. J Water Pollut Control Fed. 1965;37(3):300-306.
2. Brown RM, McClelland NI, Deininger RA, Tozer RG. A water quality index—do we dare? Water Sew Works. 1970;117(10):339-343.
3. Tyagi S, Sharma B, Singh P, Dobhal R. Water quality assessment in terms of water quality index. Am J Water Resour. 2013;1(3):34-38. doi:10.12691/ajwr-1-3-3.
4. Goyal S, Shrivastava S. Physico-chemical analysis of Kharun River water in Raipur, CG, India. Int Res J Environ Sci. 2020;9(3):72-74.
5. Shivhare A, Upadhyay A, Sinha P. Study of physio-chemical parameter of Kharun River and concentration of heavy metal (Iron). J Ravishankar Univ B Sci. 2025;38(2). doi:10.52228/JRUB.2025-38-2-6.
6. Singh M, Srivastava RK. Sequencing batch reactor technology for biological wastewater treatment: a review. Asia-Pac J Chem Eng. 2011;6(1):3-13. doi:10.1002/apj.490.