International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **14(3),** 1-6, July **(2025)** *Int. Res. J. Environmental Sci.*

Water Quality Analysis of Kahn, Narmada, and Kshipra Rivers, MP, India

Ashutosh Tripathi[1], Ranu Patidar[2*], Ruby Kharwar[3] and Bhavesh Mali[4]
[1]Health and Allied Sciences, ITM Vocational University, Vadodara, Gujarat, India
[2]Department of Chemistry, Institute of Sciences, SAGE University, Indore, Madhya Pradesh, India
[3]Department of Industrial Chemistry, ITM Vocational University, Vadodara, Gujarat, India
[4]Institute of Forensic Science Mumbai, Mumbai University, Mumbai, Maharashtra, India,
ranushivpatidar@gmail.com

Available online at: www.isca.in, www.isca.me
Received 29th November 2024, revised 24th April 2025, accepted 28th June 2025

Abstract

Urbanization and industrialization have contributed significantly to water pollution, particularly in rivers. This study examines the water quality of the Kahn, Narmada, and Kshipra rivers, focusing on parameters such as Water Quality Index (WQI), physical and chemical properties, and their seasonal variations. The findings highlight significant pollution levels primarily due to industrial effluents, agricultural runoff, and sewage discharge. The analysis underscores the urgent need for stricter enforcement of water management regulations and the implementation of sustainable practices. A study on the water quality of the Kahn, Narmada, and Kshipra rivers found high pollution levels due to industrial effluents, sewage, and agricultural runoff. The study analyzed parameters like pH, TDS, BOD, COD, turbidity, and dissolved oxygen. Stations near pollution sources had the highest pollutant levels, often exceeding permissible limits. Winter pollution increased due to reduced water flow and higher turbidity and COD levels during the monsoon. The Water Quality Index (WQI) showed that while some stations improved from 2014-2015 to 2023-2024; many still did not meet drinking water standards. Urgent actions are needed to mitigate pollution and restore river health.

Keywords: Urbanization, Industrialization, Kahn, Narmada, Kshipra, Pollution, WQI.

Introduction

The rapid urbanization and industrialization in India, while necessary for economic growth, have resulted in substantial pollution of river water. The Kahn River in Indore, for instance, faces severe contamination from industrial discharges, domestic sewage, and municipal waste[1]. The polluted waters eventually merge with the Kshipra River, compounding the environmental impact. Similar issues are observed in the Narmada River, which is a lifeline for Madhya Pradesh and other regions[2].

To mitigate the effects of pollution, the government introduced the Water (Prevention and Control of Pollution) Act, 1974. However, compliance remains a challenge[3]. This study aims to assess the water quality of these rivers through an analysis of their physical and chemical parameters, thereby providing insights into the status and trends of river water pollution. India faces increasing pollution in its river water due to urbanization and rapid industrialization[4]. The government has framed a law in 1974 to restore water and discharge aquatic animals, but the quality of water has reduced due to human activities[5]. The Kahn river in Indira is a prime example of this pollution, with industrial waste causing harmful effects on the water[6]. The water moves into the Kshipra river, where heavy metals and chemicals are found. Domestic use has also contributed to the pollution of rivers in Ujjain City[7].

Researchers have checked and analyzed water quality in tributaries and rivers, finding a grade E standard during the analysis of water between November 2023 and March 2024[8]. Physical and chemical parameters such as BOD, COD, TDS, and turbidity were found to be high due to industrial waste removal from industries[9].

The water quality was reduced due to the disposal of sewage and municipal waste in the river Kahn[9]. The water quality of the Kumbhmela and Kshipra rivers was also analyzed, with Mangalnath Ghat water being more polluted than Lalpul Ghat and Narshingh Ghat. Triveni Ghat's water had a D grade[10]. IS standards were used for calculating parameters such as NO^{3-}, SO_2^{4-}, Cl^-, PO4, Ca, Na^+, K^+, F^-, Mg H, pH, TH, H,DO, EC,TA, COD, TDS, turbidity, BOD, and boron content[11].

The objective of this study is to: i. Analyze the water quality of the Kahn, Narmada, and Kshipra rivers. ii. Evaluate the Water Quality Index (WQI) using parameters like Total Dissolved Solids (TDS), turbidity, pH, and biochemical oxygen demand (BOD). iii. Investigate seasonal variations in water quality and identify pollution sources. iv. Provide recommendations for improving water quality[12].

The study examined water quality in three tributaries, including the Narmada river, using IS 10500-2004 parameters. The water was found to be polluted due to household sewage, agricultural runoff, and industrial effluent from various sources. The water quality index (WQI) was also checked using various instruments[13]. The winter and monsoon seasons were chosen for the study. The WQI values were more than 100 for every analysis, indicating poor water quality. Industrial effluent and municipal waste were found to be significant contributors to the water's quality. The study concluded that the water quality was very poor, and the WQI was affected by these factors[14].

Materials and Methods

Study Area: The study focuses on rivers flowing through Madhya Pradesh, including the Kahn River (Indore), Narmada River (Omkareshwar), and Kshipra River (Ujjain). Sampling stations were chosen based on sewage discharge and industrial effluents. The major rivers in Ujjain, including Narmada, Kshipra, and Kahn, are of significant religious importance and serve as a lifeline for the Madhya Pradesh district. However, human activities have polluted the river water. The study analyzed the WQI and phyico chemical parameters of these rivers and their water, comparing them with previous analyses. The selected rivers and their water were Indira, Ujjain, and Omkareshwar, as shown in Table-1.

Sampling and Analysis: Water samples were collected during the winter and monsoon seasons from 10 stations across the three rivers. Parameters such as pH, TDS, BOD, Chemical Oxygen Demand (COD), turbidity, and dissolved oxygen (DO) were analyzed using methods outlined in APHA (20th edition, 1998). The WQI was calculated based on weighted factors and ratings for individual parameters. The analysis involved sampling points based on sewage and industrial effluent, taking samples from three major rivers, as depicted in Figure-1 and Table-2.

Table-1: Sampling and station code details[4].

Area	Station Code for Sampling (ST)	Description
Area-1	I	Kahn (Kabitkhedi), before STP
	II	Kahn (Kabitkhedi) ,after STP
	III	Shakarkhedi
	IV	Narmada ,Omkareshwar
	V	River Kshipra ,Ujjain
	VI	Kshipra - Narmada river
	VII	Jamal pura
Area-2	VIII	Dhediya ,Triveni Ghat
	IX	Dham of Prashant
	X	Ghat of Ram

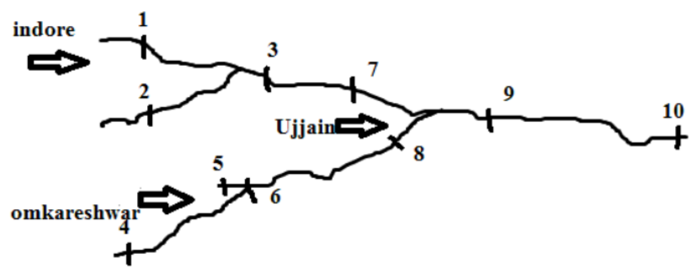

Figure-1: Diagram Sketch of Sampling station (I-X)[4].

Table-2: River and its Important Parameters[4].

S. No.	Names of River	Major Tributaries	River length	Longitudes And Latitudes	Description
1.	River Kahn	Saraswati River	73	215°38_ N and 72°55_ E	Lifeline of Indore city. Limbodi is the Starting point. 21 KM goes from the city Indore.
2.	River Narmada		>1,011	74°32′ E to 83°45′ E &23°23′ N to 23°42′ N	Lifeline of Madhya Pradesh. Beginning of narmada in Madhya Pradesh is Amarkantak. Madhya Pradesh area of 85 %, Gujarat 16% also MH 2.1% indicates the figure of people living there near river narmada.
3.	River Kshipra	River Kahn	189	24°13′ N to 73°73′ E	15 km from, Indore near the Kakari-Badi hill. Lifeline of Ujjain cities. Passing in the city of Ujjain 96 KM.

The APHA (1998) was used to assess various parameters such as carbonates, hardness, TDS, pH, chloride, bicarbonates, DO, BOD, COD, TSS, turbidity, and total alkalinity. General indices were detected using the Horton method in 1965. The national sanitation foundation used the Delphi technique for organic pollutant and bacterial detection. Results were categorized as poor, fair, good, and excellent. Hardness, turbidity, TSS, TDS, fecal coliform, BOD, DO, COD, pH, and Q values were found and multiplied with weighting factors. Water Quality Index (WQI) and water quality were assessed using various parameters, with WQI being the most suitable method. The World Health Organization and ICMR 1975 standards were used for analysis. The sub index (qn) equation was calculated using the formula Qn=100(Vn-Vio)/(Sn-Vio).

Results and Discussion

Water Quality Index (WQI): The WQI results indicate poor water quality across the rivers during both study periods (2014–2015 and 2023–2024). The overall WQI decreased from 86.58 in 2014–2015 (very poor quality) to 54.58 in 2023–2024 (poor quality), suggesting some improvement. The water quality in Kabitkhedi, India, has been found to be very poor from 2014-2015, with a water index of 86.58. In 2023-2024, the water quality was also poor at 54.58, indicating a decrease in water levels. The study used the ICMR WQI to analyze waste water samples from various rivers, including Kahn, Narmada, Kshipra, Shakarkhedi, Ghat Ram, Pura Jamal, Prashant Dham, Dhediya, and Triveni Ghat. The results were based on ICMR standard value, unit weight, and quality rating, with data from figs four to eleven.

Table-3: WQI and the standard of drinking water as per (ICMR)[3].

Physical Chemical Parameter	Standards(Sn)	Unit Weight
pH	6.6-8.7	0.2805
DO mg/lit	5.6	0.3624
Total Hardness mg/lit	318	0.0556
TDS mg/lit	513	0.0639
BOD mg/lit	5.4	0.3728
Chloride mg/lit	242	0.0676
TSS mg/lit	516	0.0834
Alkalinity mg/lit	135	0.0568
COD mg/lit	23	0.0851
Turbidity	4.5	0.3925

Table-4: WQI and Status of Water Quality[4].

Index Level of Water Quality	Status of Water Quality
0 –23	Water quality is Excellent
24–56	Water quality is Good
57–77	water quality is Poor
78–102	water quality is Very Poor
>102	Not useful as potable water

Table-5: ICMR standard value, unit weight and the quality rating.

Sn	Vn	Qn	VnQn									
			ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
6.95	0.4555	22.13	13.35	23.65	5.62	24.35	12.53	14.65	2.685	7.568	2.123	0.854
120	0.0135	67.1656	1.0510	234	1.5320	1.504	1.56	1.360	5.555	1.3966	1.470	1.485
5	0.532	0.4 5	0.55	7.36	0.47	12.16	35.6330	23.42682	41.04338	32.31364	438.7565	42.3661
500	0.0037	4110	1.528	1.5535	0.8561	0.2583	0.24131	0.2155	0.952	0.5699	0.8385	0.8255
500	0.0047	133	0.38	0.03335	0.2506	0.0662	0.0598	0.0156	0.0362	0.0674	0.1896	0.0661
300	0.0052	93	0.633	0.1542	0.4586	0.3673	0.2789	0.2734	0.5852	0.1542	0.1542	0.2508
250	0.0084	4.0	0.0657	0.0585	0.0537	0.0612	0.0437	0.0568	0.0447	0.0358	0.5643	0.05538
25	0.0744	867	106	48.716	38.0928	26.5696	17.0464	2.5676	9.3532	9.4252	37.0958	24.6696

Table-6: WQI for the year 2014-15 and 2023-24.

Year	WQI Overall	Water category(ICMR)
2014 -2015	95.51	Very Poor water quality
2023-2024	56.43	Poor Water quality

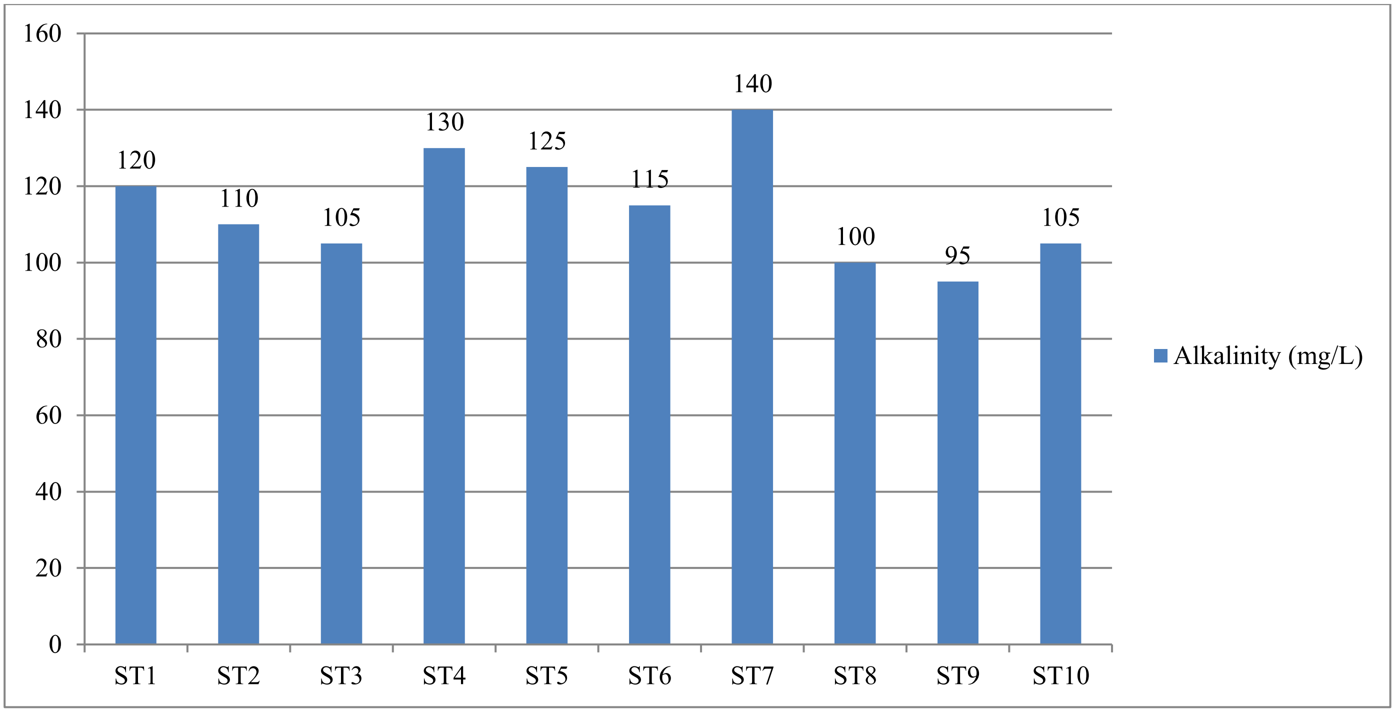

Figure-2: ST1 to ST10 stations for 2023-24 changes in Alkalinity.

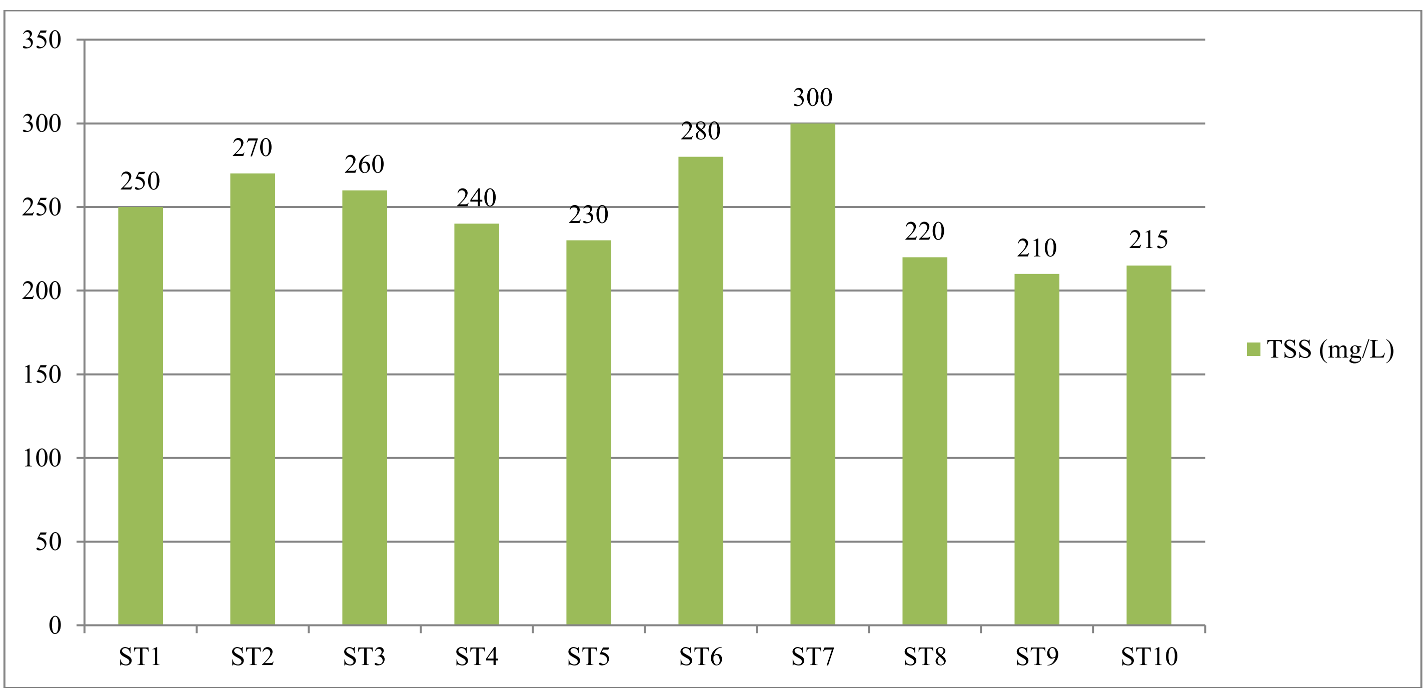

Figure-3: ST1 to ST10 stations 2023-24 changes in TSS.

Seasonal Variations: In winter Season, higher pollution levels were recorded due to reduced water flow, which concentrated pollutants. In monsoon season, increased turbidity and COD levels were observed due to runoff carrying organic and inorganic pollutants.

Key Findings: Stations near industrial and domestic discharge points (e.g., ST1, ST2) exhibited the highest levels of pollutants. DO levels ranged from 1.5 mg/L (ST1) to 6.4 mg/L (ST10), with low levels near major pollution sources.COD values exceeded permissible limits at most stations, indicating organic matter degradation.

Interpretation: The study analyzed soil erosion, greenery, and anthropogenic activity in a river system using DO, Cl^-, COD, and TDS values. The highest values were observed in ST4, ST5, and ST1, ST2, ST3 and ST9. DO was used to assess pollution, with S1 having a high organic content and domestic discharge. DO values ranged from 5 to 6.4 mg/lit for animals living in water, while COD values ranged from 64 to 224 mg/lit for stations S1 to S10. The study found that biodegradation, effluent, agricultural waste runoff, and pollution is major problems. The physical and chemical parameters have exceeded limits, with COD levels nearly 3-6 times higher in 2014-2015 and TDS and TSS higher in 2023-24 for S1. DO values were higher for all stations but less for S1, posing potential harm to animals and plants. The results were limited in total hardness, total alkalinity, and pH. Monsoon season saw increased organic content in COD, disrupting water balance and affecting water quality. The study highlights the need for improved water quality management to mitigate these issues.

The water quality in the region has been poor since 2014-2015, with values around 85.56 (75-99) and 60.21 (75-99). However, improvements have been observed in certain stations since 2014-2018, attributed to government plans and the STP. The sewage discharge is the main reason for the poor water quality, with values less than 4 times for stations S1.S2.S3 in 2023-2024. The government's Swacch Bharat mission program, which began in 2014, has also contributed to the improvement. As people become more aware of the issue, the water quality has seen significant improvements. The improvement in water quality is attributed to the government's efforts and the increased awareness among the public.

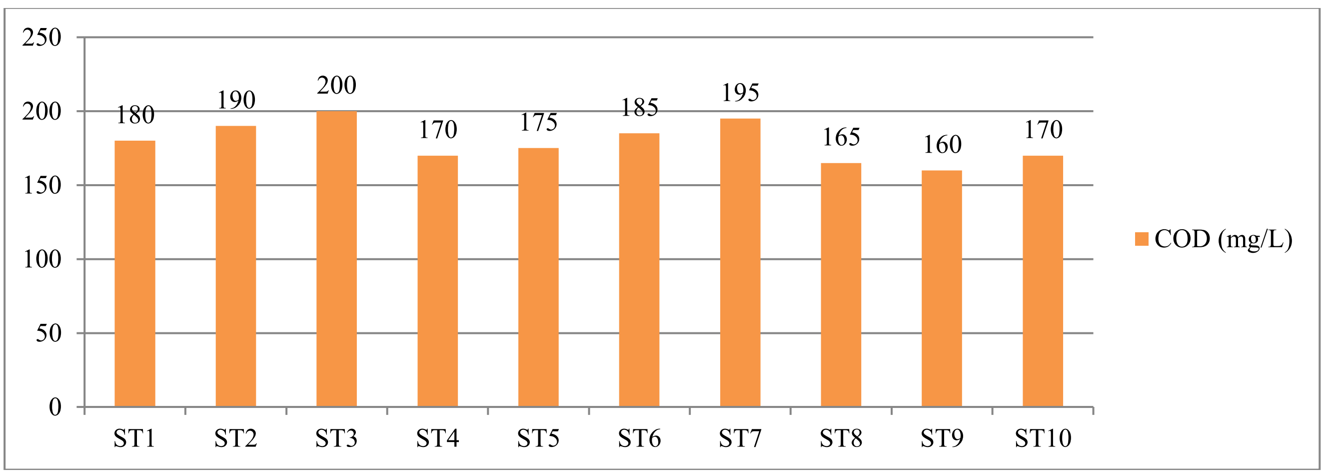

Figure-4: ST1 to ST10 station 2023-24 changes in COD.

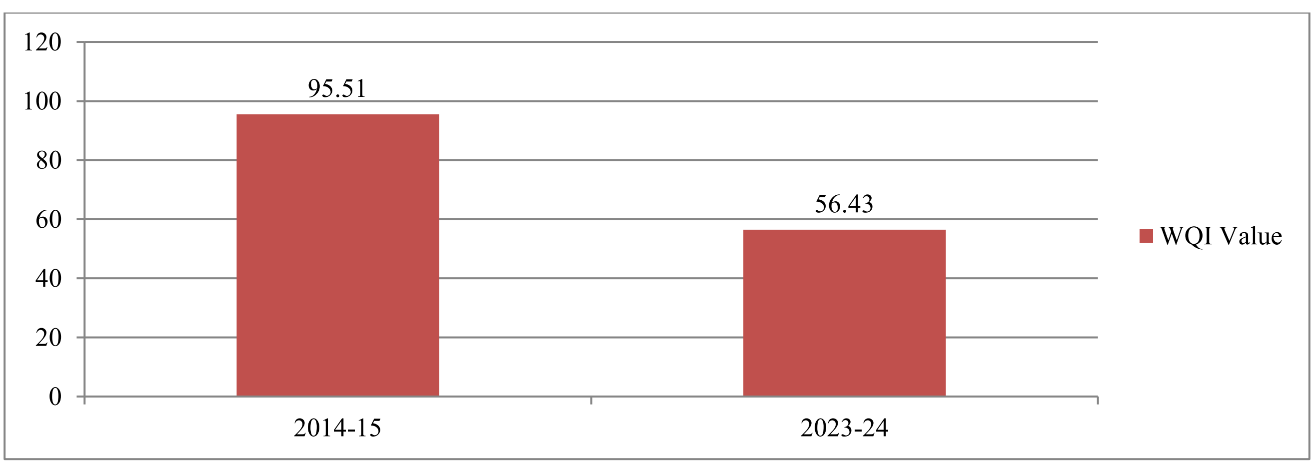

Figure-5: Comparison of WQI for 2018 and 2014-15[3].

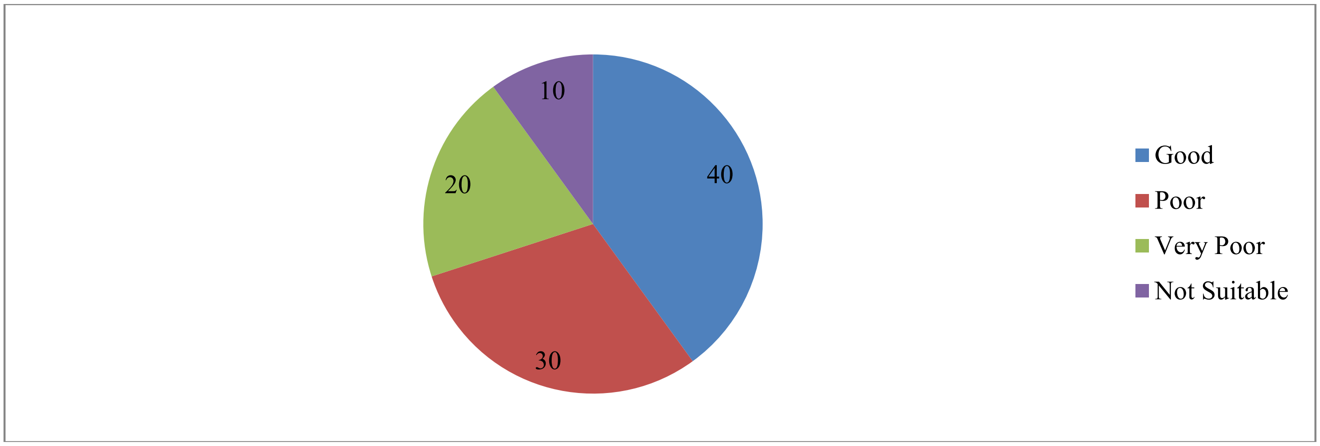

Figure-6: Categories of WQI and its samples in percentage (2023-24).

Conclusion

The results of three rivers show significant differences, with 2014-2015 having higher values than 2023-2024, with a WQI of 72.65. In 2023-2024, the WQI is not very satisfactory, but the quality has improved. Good water was found in 40% of stations in 2014-2015, while 50% of stations have an ICMR value of 50%, indicating they are not suitable for drinking. Waste discharge has reduced, improving water quality. Door-to-door surveys were conducted for commercial sectors and IMC Indore, and STPs were created for waste separation. However, more waste discharge remains a major problem. Factors for pollution are identified.

The study reveals significant pollution in the Kahn, Narmada, and Kshipra rivers, primarily from industrial effluents, sewage, and agricultural runoff. Despite some improvements due to governmental initiatives like the Swachh Bharat Mission and STP installations, the water quality remains unsatisfactory. Urgent actions, including stricter regulations, enhanced public awareness, and sustainable wastewater management practices, are required to restore these vital water bodies: i. Strengthen enforcement of pollution control laws. ii. Expand and upgrade sewage treatment facilities. iii. Promote community engagement and awareness programs. iv. Implement eco-friendly agricultural practices to reduce runoff. v. Conduct regular monitoring and publicize water quality data.

References

1. American Public Health Association (APHA) (1998). Standard Methods for the Examination of Water and Wastewater (20th ed.). Washington, DC: APHA.

2. Horton, R. K. (1965). An index number system for rating water quality. *Journal of Water Pollution Control Federation*, 37(3), 300–305.

3. Indian Council of Medical Research (ICMR) (1975). Drinking Water Standards. New Delhi: ICMR.

4. Rules, D. R. A. F. T. (2000). Ministry of Environment and Forests. *Government of India. Regulation and Control*.

5. WHO. World Health Organization (2004). Guidelines for drinking-water quality (Vol. 1). World health organization.

6. World Health Organization (2004). Guidelines for drinking-water quality (Vol. 1). World health organization.

7. Kumawat, D. M., & Sharma, M. K. (2015). Quality status study of river Kshipra at Ujjain before its linkage with Narmada water. *J. Global Sci*, 4, 1508-1516.

8. Mishra, S. (2016). Comprehensive Water Quality Indexing Using Functional Data and Principal Component Analysis for River Narmada (Doctoral dissertation).

9. Abhineet, N., & Dohare, E. R. D. (2014). Physico-chemical parameters for testing of present water quality of Khan River at Indore, India. *International Research Journal of Environment Sciences*, 3(4), 74-81.

10. Hanna, N., Purohit, M., Diwan, V., Chandran, S. P., Riggi, E., Parashar, V., ... & Lundborg, C. S. (2020). Monitoring of water quality, antibiotic residues, and antibiotic-resistant Escherichia coli in the Kshipra River in India over a 3-year period. *International Journal of Environmental Research and Public Health*, 17(21), 7706.

11. Gangwar, S., Shivdayal, M., Dave, K., & Wanganeo, A. (2017). Change in Physico-chimical characteristic of River Kshipra during the Simhasth festival. *Int. J. Curr. Microbiol. App. Sci*, 6(5), 1331-1336.

12. Sastry, C. (1972). Water pollution problems in Madhya Pradesh. *Indian J. envir. Hlth*, 14, 297-309.

13. Rao, N. L., & Rao, M. N. (2017). Pollution in Selected Rivers of India—Three Case Studies. In *Water and the Environment* (pp. 17-26). CRC Press.

14. Ahmad, S., Khan, I. H., & Parida, B. P. (2001). Performance of stochastic approaches for forecasting river water quality. *Water research*, 35(18), 4261-4266.