9th INDIA INTERNATIONAL WATER WEEK (IIWW 2026)

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THEME-
Climate Resilient Water Management

Technical Forum TF20: Water and Human Health

Trace and Toxic Metals in Indian Rivers:
Status, Hotspots, and Implications for Water Quality and Human Health

Dr. Jakir Hussain* and Geethu Krishna V

Middle Ganga Division, Central Water Commission, Ministry of Jal Shakti, Varanasi
River Data Compilation Directorate, Central Water Commission, Ministry of Jal Shakti, New Delhi

*Corresponding author: Dr. Jakir Hussain
drjhsnar-cwc@nic.in; drjakirhussain@gmail.com

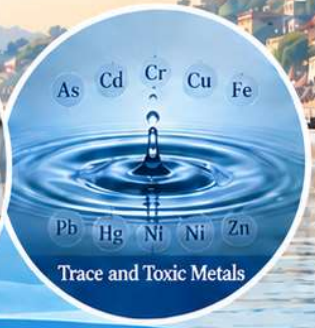


As Cd Cr
Cu Fe Pb
Hg Ni Zn









WATER QUALITY

"Water quality" is defined as "**those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water.**"



KEY ASPECTS OF WATER QUALITY

PHYSICAL	Temperature, color, turbidity, odor, taste, total dissolved solids
CHEMICAL	pH, hardness, alkalinity, dissolved oxygen, heavy metals, nutrients, pesticides, etc.
BIOLOGICAL	Bacteria, viruses, protozoa, algae and other microorganisms
ACCEPTABILITY	Determines suitability of water for drinking, domestic, agricultural, industrial and ecological uses



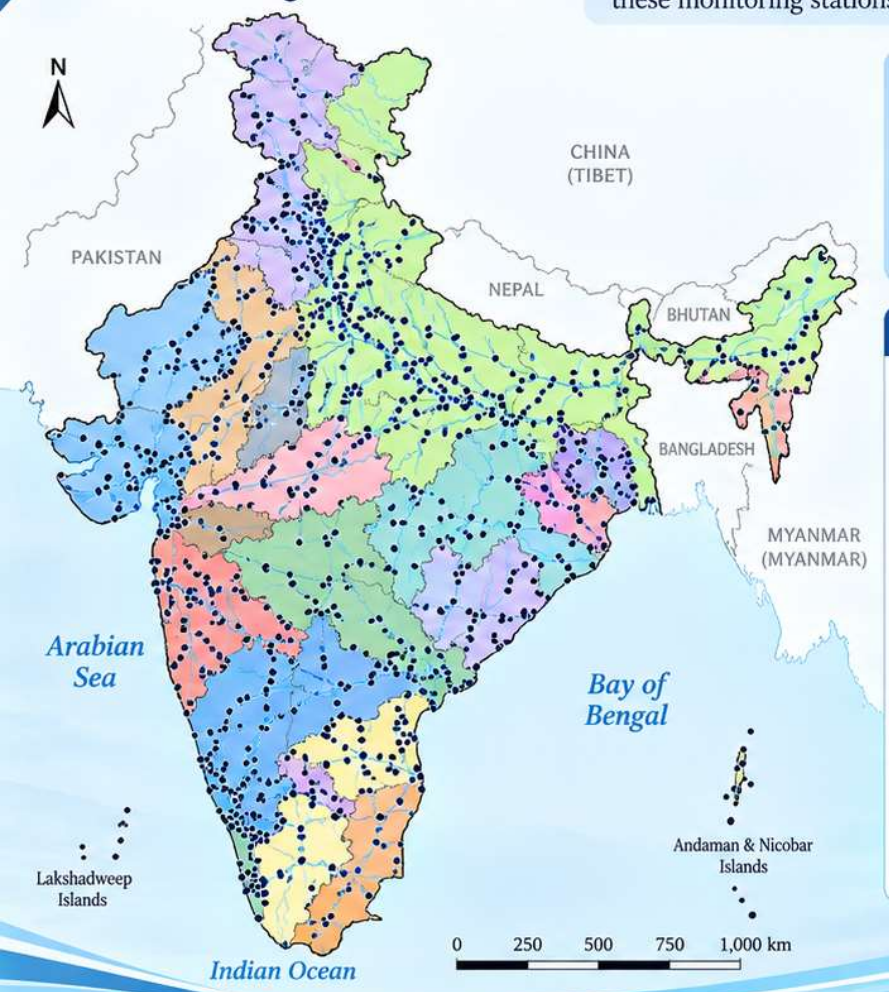


Good water quality is essential for **human health**, **ecosystem sustainability** and **socio-economic development**.

Drinking Water | Agriculture | Industry | Domestic Use | Ecosystem Protection

Study Area

The study covers river-water monitoring undertaken by the Central Water Commission across India. The 2025 assessment included 767 water-quality monitoring stations distributed across 20 river-basin groupings. The spatial distribution of these monitoring stations across the river basins is presented in **Figure 1.**



767
Monitoring Stations

20
River-Basin Groupings

Pan-India River-Water Monitoring

2025
Assessment

River-Basin Groupings (20)

1. Barak & Other
2. Brahmaputra
3. Cauvery
4. East Flowing Rivers (EFR) South of Cauvery
5. West Flowing Rivers (WFR) South of Tapi
6. Brahmani & Baitarani
7. EFR between Mahanadi and Godavari
8. EFR between Pennar and Cauvery
9. Ganga
10. Godavari
11. Indus
12. Krishna
13. Mahanadi
14. Mahi
15. Narmada
16. Pennar
17. Sabarmati
18. Subarnarekha
19. Tapi
20. WFR of Kutch & Saurashtra including Luni

Monitoring station (*n* = 767) — Major rivers — India boundary — State boundary

Key Highlights

- Coverage: River-water monitoring across India
- **767** water-quality monitoring stations (2025)
- **20** river-basin groupings
- Representation of major and minor river systems
- Wide spatial distribution across the country

Figure 1. Study area – Distribution of 767 river water quality monitoring stations across 20 river basins in India (2025).

Materials and Methods

Sampling & Analytical Technique

Sample Collection (at river site) → **Preservation & Labelling** → **Transportation to Laboratories** → **Sample Preparation (Level-II/III Labs)** → **Analysis (ICP-MS)** → **Data Generation**



River-water sampling in polyethylene containers (once per month)



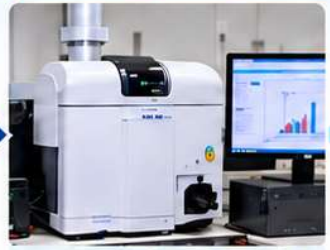
Sample preservation and labelling as per standard procedures



Transportation to CWC Level-I/II/III laboratories



Sample preparation and preservation (Level-II/III Labs)



Trace and toxic metals analysis using ICP-MS



Data generation for nine metals

Number of analysed samples (2025)

As Arsenic	Cd Cadmium	Cr Chromium	Cu Copper	Fe Iron	Pb Lead	Hg Mercury	Ni Nickel	Zn Zinc
6,660	6,667	6,660	6,667	6,459	6,549	5,120	6,648	6,691

Total samples collected (2025)

6,691

Chemicals, reagents and laboratory preparation



Analytical-reagent-grade chemicals and certified reference materials were used for the chemical analyses.



De-ionized water was used throughout.



Glassware and containers were cleaned by detergent washing.



Followed by immersion in 10% nitric acid for 48 hours.



Repeated rinsing with de-ionized water



Reference Benchmarks, Major Sources and Potential Effects of Trace and Toxic Metals in River Water

Metal (Symbol)	Adopted Reference Benchmark (BIS IS 10500:2012) (µg/L)	Major Sources in River Systems	Potential Effects	
			Effects on Human Health	Effects on Aquatic Ecosystems
As Arsenic	10	Mining, industrial discharge, agricultural runoff	Skin lesions, cardiovascular effects, neurotoxicity, increased risk of cancer	Toxic to aquatic life, bioaccumulation, reduced biodiversity
Cd Cadmium	3	Industrial waste, battery disposal, metal plating	Kidney damage, bone disorders, carcinogenic, reproductive toxicity	Highly toxic to aquatic organisms, accumulates in sediments
Cr Chromium	50	Tanneries, electroplating, industrial discharge	Respiratory irritation, liver and kidney damage, carcinogenic (Cr^{6+})	Toxic to fish and invertebrates, affects growth and reproduction
Cu Copper	50	Industrial discharge, plumbing corrosion, agricultural inputs	Nausea, vomiting, liver damage at high levels	Toxic to fish at high levels, affects gill function and enzyme activity
Fe Iron	1,000	Natural weathering, soil erosion, industrial discharge	Gastrointestinal irritation, affects nutrient absorption at high levels	Causes discoloration, affects habitat quality, increases sediment load
Pb Lead	10	Battery waste, paints, industrial emissions, plumbing	Neurotoxicity, developmental effects in children, anemia, kidney damage	Toxic to aquatic life, bioaccumulates in food web
Hg Mercury	1	Industrial discharge, gold mining, combustion, waste incineration	Neurotoxicity, affects brain development, kidney damage	Methylmercury bioaccumulates, highly toxic to fish and wildlife
Ni Nickel	20	Electroplating, stainless steel industries, battery waste	Respiratory problems, allergic reactions, carcinogenic (inhalation)	Toxic to fish at high levels, affects reproduction and survival
Zn Zinc	5,000	Galvanization, tyre wear, industrial discharge, agricultural runoff	Nausea, vomiting, interferes with copper metabolism at high levels	Toxic at high concentrations, affects growth and photosynthesis

Figure. IS 10500:2012, major sources, and potential effects of trace and toxic metals in river water.

Arsenic (As): Exceedance Status and Three-Year Comparison

2025 Snapshot (Arsenic)

Total samples analysed
6,660 (2025)

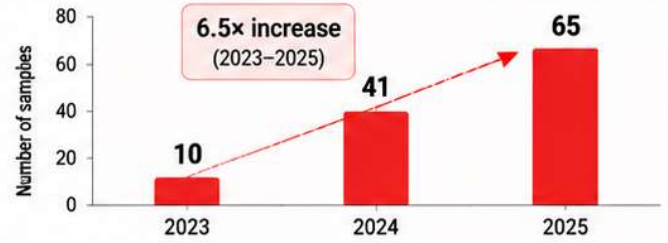
Samples exceeding BIS benchmark (10 µg/L)
65 (0.98%)

Monitoring stations affected
42 (2025)

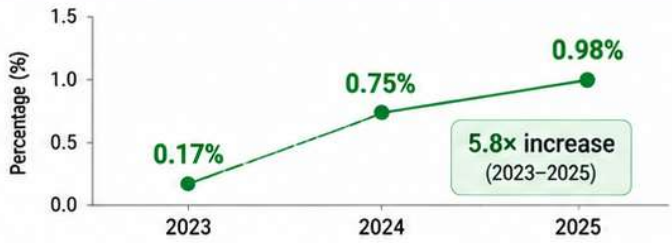
Maximum concentration
34.73 µg/L
Chapra, Jalangi River, West Bengal (02 July 2025)

Three-Year Comparison (2023–2025)

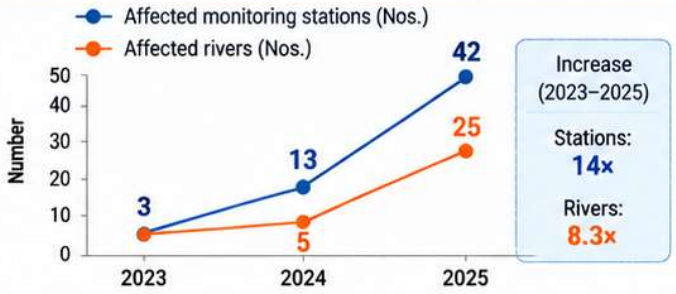
Samples exceeding BIS benchmark (>10 µg/L)



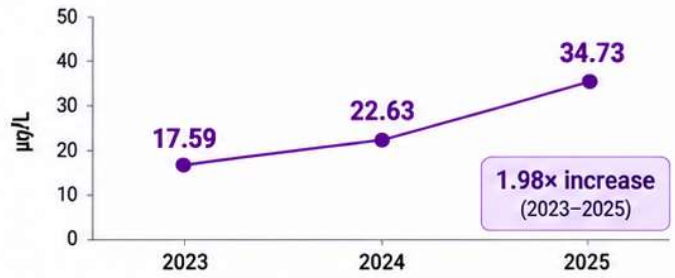
Percentage of samples exceeding benchmark



Geographical expansion



Maximum arsenic concentration observed

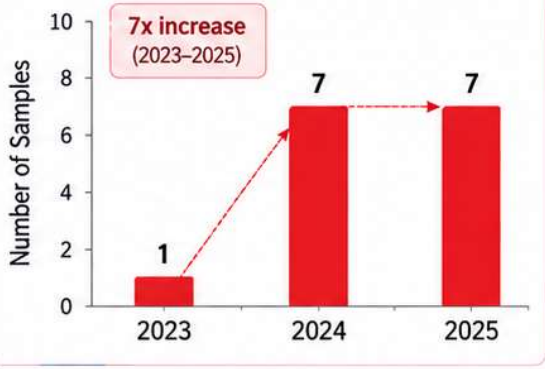


Key Observations

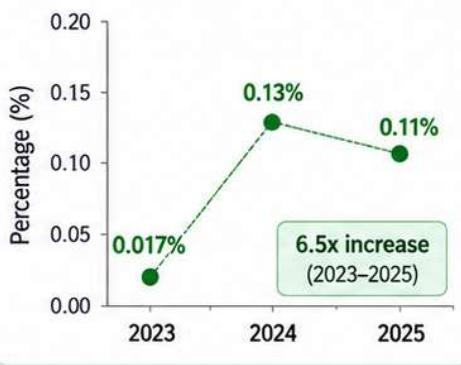
- The number and percentage of samples exceeding the BIS benchmark (10 µg/L) increased from **10 (0.17%)** in 2023 to **65 (0.98%)** in 2025.
- The number of monitoring stations affected increased from **3** in 2023 to **42** in 2025, and the number of affected rivers from **3** to **25.**
- The maximum arsenic concentration increased from 17.59 µg/L (2023) to **34.73 µg/L** (2025), with the highest value observed at **Chapra, Jalangi River, West Bengal (02 July 2025).**
- The apparent three-year increase should be interpreted in the context of **expansion of the national monitoring network in 2025**, which included a larger number of rivers and monitoring stations.

Cadmium (Cd): Exceedance Status and Three-Year Comparison

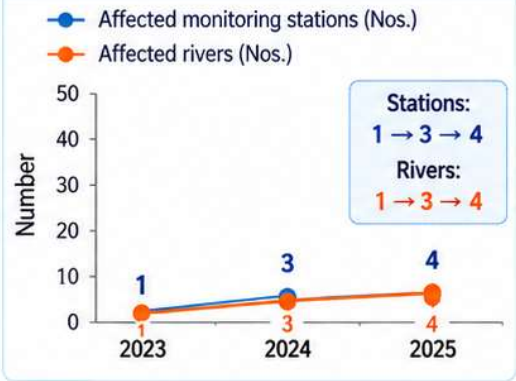
Samples above limit (>3 µg/L)



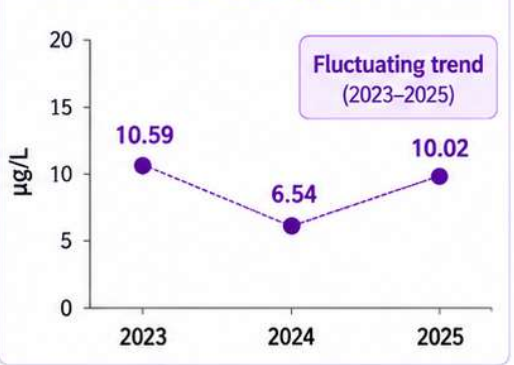
Percentage of samples above limit



Geographical expansion



Maximum cadmium concentration observed (µg/L)



2025 Snapshot (Cadmium)

Total samples analysed
6,667 (2025)

Samples exceeding benchmark (3 µg/L)
7 (0.11%)

Monitoring stations affected
4 (2025)

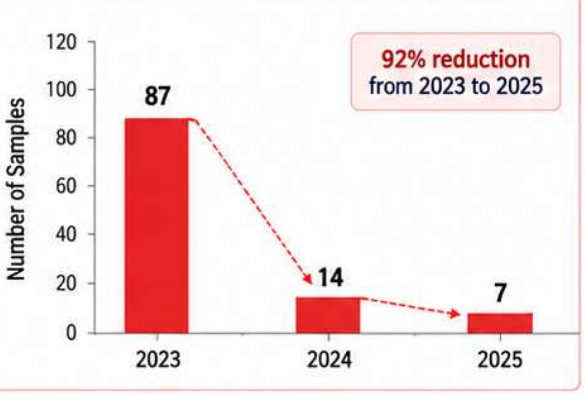
Maximum concentration
10.02 µg/L
Musiri, Cauvery River, Tamil Nadu
(11 June 2025)

Key Observations

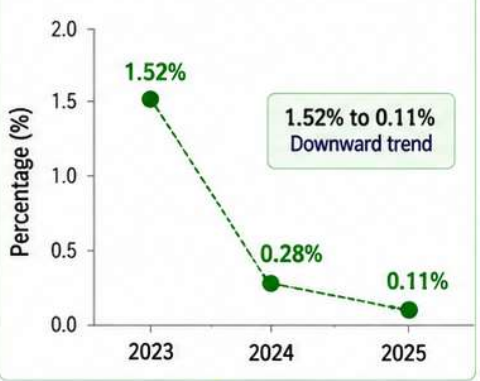
- Out of **6,667** samples analysed in **2025**, **7** samples (0.11%) exceeded the BIS benchmark (3 µg/L).
- The exceedances were reported in the Adhwara Group, Cauvery, Narmada and Ponnaiyar river systems.
- The maximum concentration of **10.02** µg/L was recorded at Musiri on the Cauvery River, Tamil Nadu, on 11 June 2025.
- Compared to 2023, the frequency of exceedance remained very low, but the spatial occurrence increased from one river in 2023 to three rivers in 2024 and four river systems in 2025.
- The maximum concentration fluctuated from 10.59 µg/L (2023) to 6.54 µg/L (2024) and 10.02 µg/L (2025), indicating a variable trend.

Chromium (Cr): Exceedance Status and Three-Year Comparison

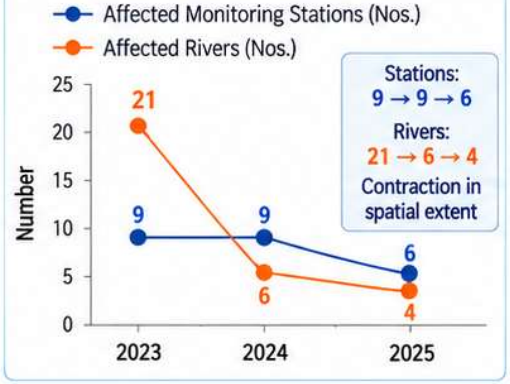
Samples above limit (>50 µg/L)



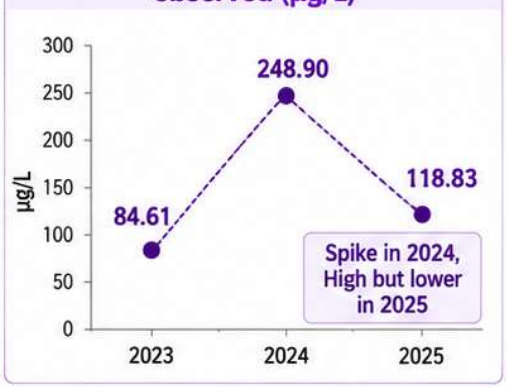
Percentage of samples above limit



Geographical expansion



Maximum chromium concentration observed (µg/L)



2025 Snapshot (Chromium)

Total samples analysed
6,660 (2025)

Samples exceeding benchmark (50 µg/L)
7 (0.11%)

Monitoring stations affected
6 (2025)

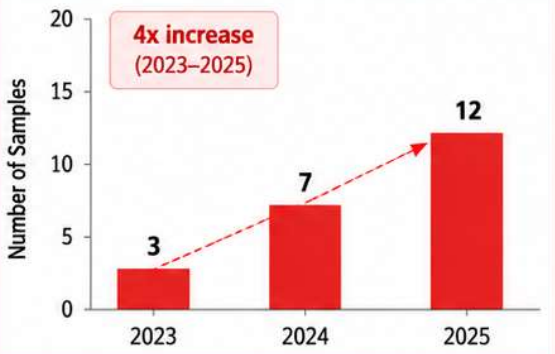
Maximum concentration
118.83 µg/L
Baleni, Hindon River, Uttar Pradesh
(02 April 2025)

Key Observations

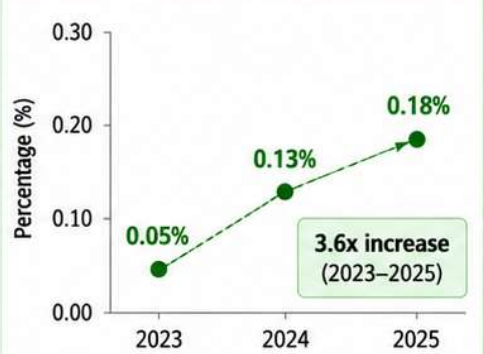
- Out of **6,660** samples analysed in 2025, **7 samples (0.11%)** exceeded the BIS benchmark (50 µg/L).
- The exceedances were reported from **6** monitoring stations across four river systems—Hindon, Malaprabha, Namchik and Siang.
- The maximum concentration of **118.83 µg/L** was recorded at Baleni on the Hindon River, Uttar Pradesh, on 02 April 2025.
- Compared to 2023, the number of exceedance samples decreased from **87 (1.52%)** in 2023 to **14 (0.28%)** in 2024 and **7 (0.11%)** in 2025, indicating a marked decline in frequency.
- The spatial extent also decreased from **21** rivers in 2023 to **6** rivers in 2024 and **4** rivers in 2025, with the number of monitoring stations reducing from **9** to **9** and then to **6**.
- The maximum concentration showed a fluctuating pattern: **84.61 µg/L** in 2023, increased to **248.90** µg/L in 2024, and decreased to **118.83** µg/L in 2025, but remained substantially above the reference benchmark.
- Overall, while widespread chromium exceedance has decreased, isolated high-concentration events continue to occur at specific river stretches.

Copper (Cu): Exceedance Status and Three-Year Comparison

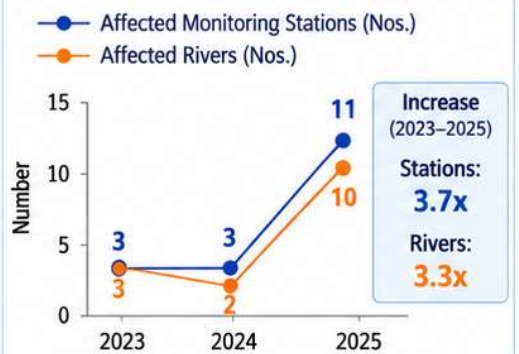
Samples above limit (>50 µg/L)



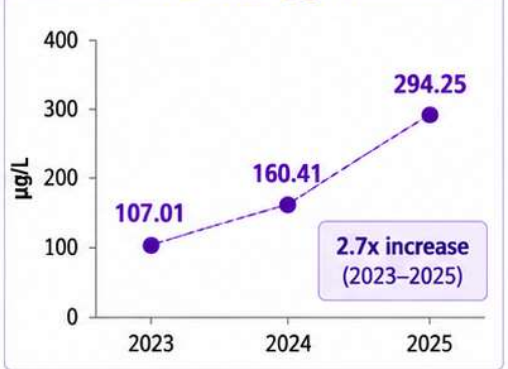
Percentage of samples above limit



Geographical expansion (Affected stations & rivers)



Maximum copper concentration observed (µg/L)



2025 Snapshot (Copper)

Total samples analysed
6,667 (2025)

Samples exceeding benchmark (50 µg/L)
12 (0.18%)

Monitoring stations affected
11 (2025)

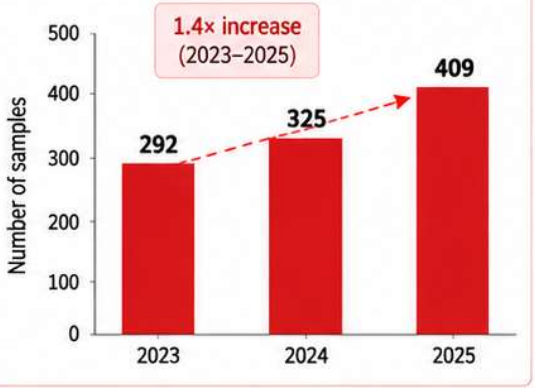
Maximum concentration
294.25 µg/L
Paramakudi, Vaigai River, Tamil Nadu
(15 January 2025)

Key Observations

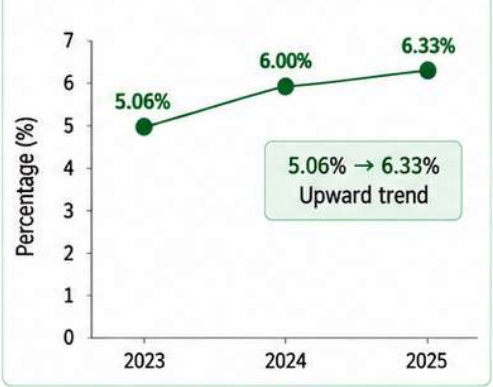
- Out of **6,667** samples analysed in 2025, **12 samples (0.18%)** exceeded the BIS benchmark (50 µg/L).
- The exceedances were reported from **11** monitoring stations across 10 river systems—Arkavathi, Bhavani, Brahmaputra, Cauvery, Krishna, Mahi, Ponnaiyar, Ranganadi, Sabarmati and Vaigai.
- The maximum concentration of **294.25 µg/L** was recorded at Paramakudi on the Vaigai River, Tamil Nadu, on 15 January 2025.
- Other notable concentrations were observed at Wadenaplly (Krishna River), Neamatighat (Brahmaputra), Vautha (Sabarmati), T.Bekuppe (Arkavathi), Singasadanapalli (Ponnaiyar) and Savandapur (Bhavani).
- Compared to 2023, the number of exceedance samples increased from **3** (0.05%) in 2023 to **7 (0.13%)** in 2024 and **12 (0.18%)** in 2025, indicating a progressive increase.
- The spatial occurrence also expanded from **3** rivers in 2023 to 2 rivers in 2024 and 10 rivers in 2025, with the number of monitoring stations increasing from **3** to 3 and then to 11.
- The maximum observed concentration increased from 107.01 µg/L in 2023 to 160.41 µg/L in 2024 and 294.25 µg/L in 2025.
- Overall, the results indicate an apparent increase in the frequency, magnitude and geographical occurrence of copper exceedances, albeit with a relatively low proportion of affected samples.

Iron (Fe): Exceedance Status and Three-Year Comparison

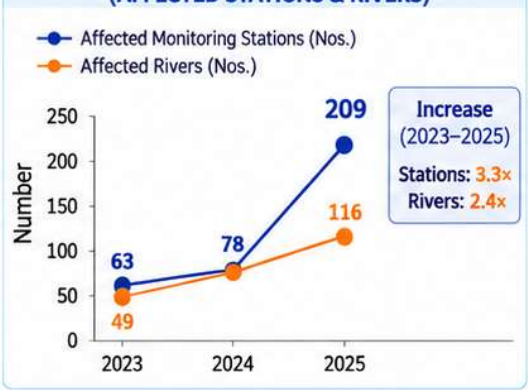
1. SAMPLES ABOVE LIMIT (>1,000 µg/L)



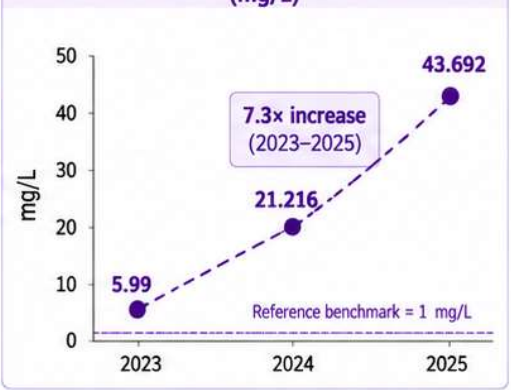
2. PERCENTAGE OF SAMPLES ABOVE LIMIT



3. GEOGRAPHICAL EXPANSION (AFFECTED STATIONS & RIVERS)



4. MAXIMUM IRON CONCENTRATION OBSERVED (mg/L)



2025 Snapshot (Iron)

Total samples analysed
6,459 (2025)

Samples exceeding benchmark (1,000 µg/L)
409 (6.33%)

Monitoring stations affected
209 (2025)

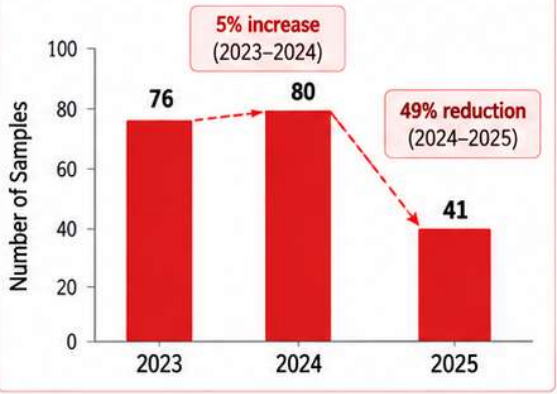
Maximum concentration
43.692 mg/L
Kuthnaur, Yamuna River
(02 September 2025)

Key Observations

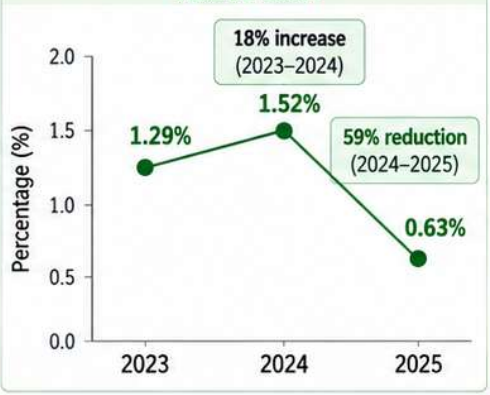
- Out of **6,459** samples analysed in 2025, **409 samples (6.33%)** exceeded the BIS benchmark (1,000 µg/L).
- The exceedances were reported from **209** monitoring stations across **116 rivers**.
- The maximum concentration of **43.692 mg/L** was recorded at Kuthnaur on the Yamuna River on 02 September 2025.
- Compared to 2023, the number of exceedance samples increased from **292** (**5.06%**) in 2023 to **325** (**6.00%**) in 2024 and **409** (**6.33%**) in 2025, indicating an increasing trend.
- The number of affected monitoring stations increased from **63** in 2023 to **78** in 2024 and **209** in 2025, while the number of affected **rivers** increased from **49** to **78** and **116**, respectively.
- The maximum observed concentration increased from **5.99 mg/L** in 2023 to **21.216 mg/L** in 2024 and **43.692 mg/L** in 2025, showing a marked increase.
- Overall, the results demonstrate an apparent increasing trend in iron exceedance during 2023–2025, particularly in the number of affected stations and the magnitude of the maximum observed concentration.

Lead (Pb): Exceedance Status and Three-Year Comparison

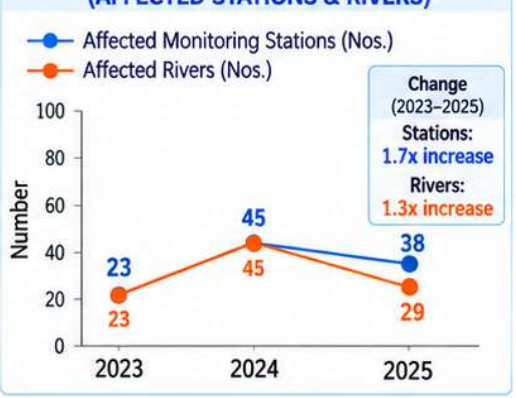
1. SAMPLES ABOVE LIMIT (>10 µg/L)



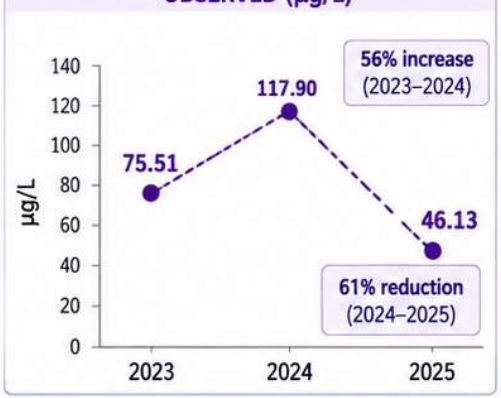
2. PERCENTAGE OF SAMPLES ABOVE LIMIT



3. GEOGRAPHICAL EXPANSION (AFFECTED STATIONS & RIVERS)



4. MAXIMUM LEAD CONCENTRATION OBSERVED (µg/L)



2025 Snapshot (Lead)

Total samples analysed
6,549 (2025)

Samples exceeding benchmark (10 µg/L)
41 (0.63%)

Monitoring stations affected
38 (2025)

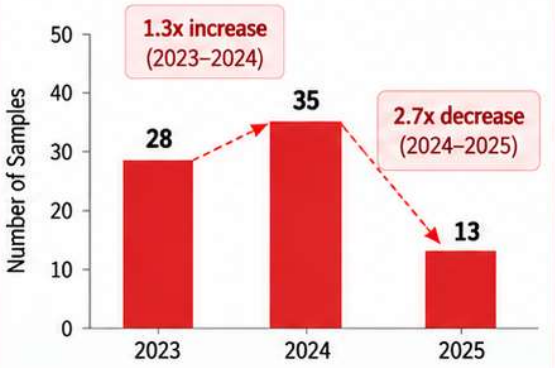
Maximum concentration
46.13 µg/L
T. Bekuppe, Arkavathi River
(21 November 2025)

Key Observations

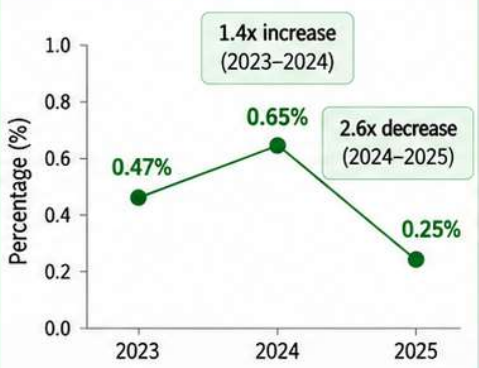
- Out of **6,549** samples analysed in 2025, **41 samples (0.63%)** exceeded the BIS benchmark (10 µg/L).
- The exceedances were reported from **38 monitoring stations** across **29 rivers**, including Arkavathi, Brahmaputra, Ganga, Narmada, Ponnaiyar, Subansiri, Tungabhadra and Yamuna.
- The maximum concentration of **46.13 µg/L** was recorded at T. Bekuppe on the Arkavathi River on 21 November 2025.
- Compared to 2023, the number of exceedance samples increased from **76 (1.29%)** in 2023 to **80 (1.52%)** in 2024 and then decreased to **41 (0.63%)** in 2025.
- The number of affected monitoring stations increased from **23** in 2023 to **45** in 2024 and **38** in 2025, while the number of affected rivers increased from **23** to **45** and **29**, respectively.
- The maximum observed concentration increased from **75.51 µg/L** in 2023 to **117.90 µg/L** in 2024 and decreased to **46.13 µg/L** in 2025.
- Although the exceedance frequency and maximum concentration declined in 2025 compared to 2024, the occurrence across **29 rivers** and **38 monitoring stations** indicates that lead contamination remained geographically widespread during the monitoring period.

Mercury (Hg): Exceedance Status and Three-Year Comparison

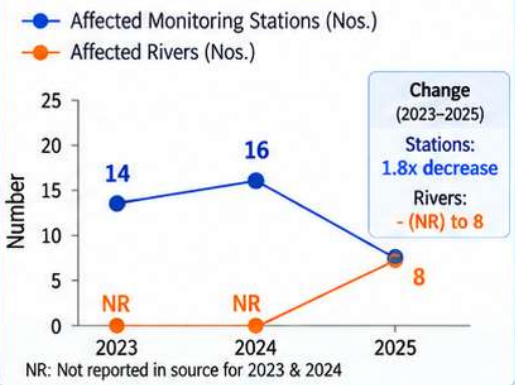
1. SAMPLES ABOVE LIMIT (>1 µg/L)



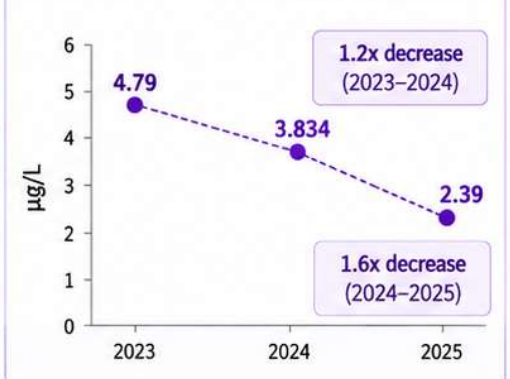
2. PERCENTAGE OF SAMPLES ABOVE LIMIT



3. GEOGRAPHICAL EXPANSION (AFFECTED STATIONS & RIVERS)



4. MAXIMUM MERCURY CONCENTRATION OBSERVED (µg/L)



2025 Snapshot (Mercury)

Total samples analysed
5,120 (2025)

Samples exceeding benchmark (1 µg/L)
13 (0.25%)

Monitoring stations affected
8 (2025)

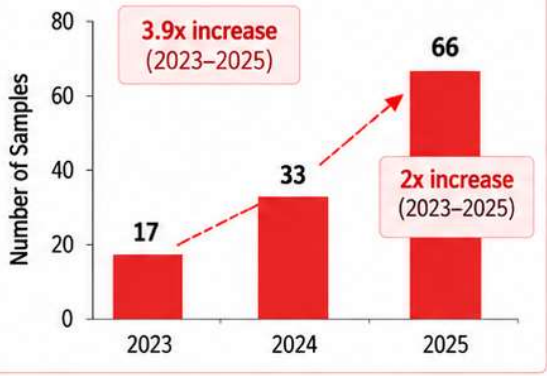
Maximum concentration
2.39 µg/L
Galeta, Hindon River, Uttar Pradesh
(03 November 2025)

Key Observations

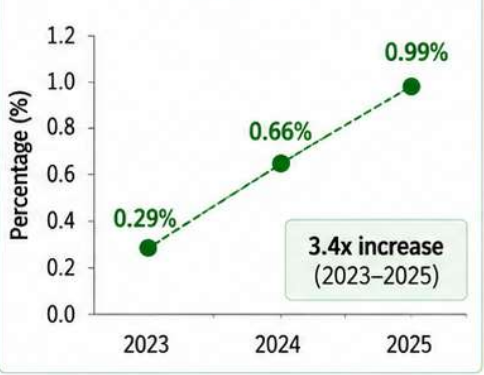
- Out of **5,120** samples analysed in 2025, **13 samples (0.25%)** exceeded the BIS benchmark (1 µg/L).
- The exceedances were reported from **8** monitoring stations across **8 river systems**—Baya, Dhadar, Hagari, Hindon, Kim, Krishna, Tungabhadra and Varna.
- The maximum concentration of **2.39 µg/L** was recorded at Galeta on the Hindon River, Uttar Pradesh, on 03 November 2025.
- Compared to 2023, the number of exceedance samples increased from **28 (0.47%)** in 2023 to **35 (0.65%)** in 2024 and then decreased to **13 (0.25%)** in 2025.
- The number of affected monitoring stations increased from **14** in 2023 to **16** in 2024 and decreased to **8** in 2025.
- The maximum observed concentration decreased from **4.79 µg/L** in 2023 to **3.834 µg/L** in 2024 and **2.39 µg/L** in 2025.
- Although the frequency and maximum concentration declined in 2025 compared to 2024, the occurrence across **8 river systems** and **8 monitoring stations** indicates that mercury exceedance remained geographically distributed during the monitoring period.

Nickel (Ni): Exceedance Status and Three-Year Comparison

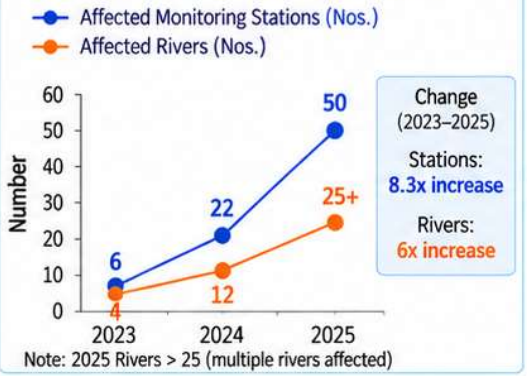
1. SAMPLES ABOVE LIMIT (>20 µg/L)



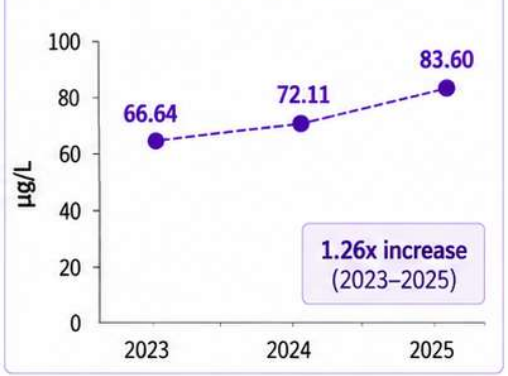
2. PERCENTAGE OF SAMPLES ABOVE LIMIT



3. GEOGRAPHICAL EXPANSION (AFFECTED STATIONS & RIVERS)



4. MAXIMUM NICKEL CONCENTRATION OBSERVED (µg/L)



2025 Snapshot (Nickel)

Total samples analysed
6,648 (2025)

Samples exceeding benchmark (20 µg/L)
66 (0.99%)

Monitoring stations affected
50 (2025)

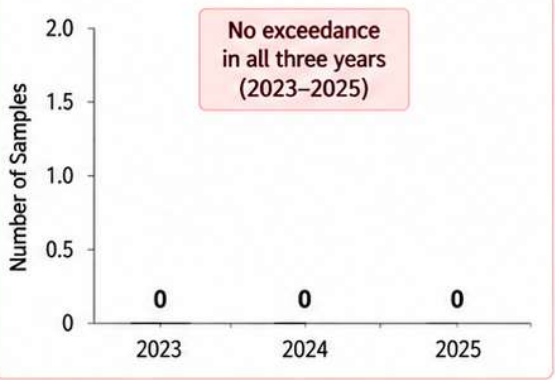
Maximum concentration
83.60 µg/L
Kuthnaur, Yamuna River
(02 September 2025)

Key Observations

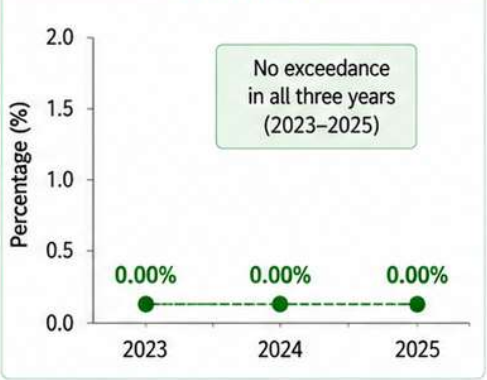
- Out of **6,648** samples analysed in 2025, **66 samples (0.99%)** exceeded the BIS benchmark (20 µg/L).
- The exceedances were reported from **50** monitoring stations across several river systems, including Banas, Bhadra, Bhavani, Brahmaputra, Cauvery, Chambal, Desang, Dikhow, Godavari, Hindon, Kodaganar, Kundi, Lohit, Malaprabha, Marudaiyar, Narmada, Raidak-I, Ranganadi, Rangpo Chu, Sahibi, Shipra, Siang, Subansiri, Tons (South), Tunga, Vaippar, Varadha and Yamuna.
- The maximum concentration of **83.60 µg/L** was recorded at Kuthnaur on the Yamuna River, on 02 September 2025.
- Compared to 2023, the number of exceedance samples increased from **17 (0.29%)** in 2023 to **33 (0.66%)** in 2024 and **66 (0.99%)** in 2025, indicating a progressive increase.
- The number of affected monitoring stations increased from **6** in 2023 to **22** in 2024 and **50** in 2025, while the number of affected rivers increased from **4** to **12** and **25+** respectively.
- The maximum observed concentration increased from **66.64 µg/L** in 2023 to **72.11 µg/L** in 2024 and **83.60 µg/L** in 2025.
- Overall, the results indicate an apparent increase in the frequency, intensity and spatial distribution of nickel exceedance during 2023–2025, with multiple river systems and monitoring stations affected.

Zinc (Zn): Status and Three-Year Comparison

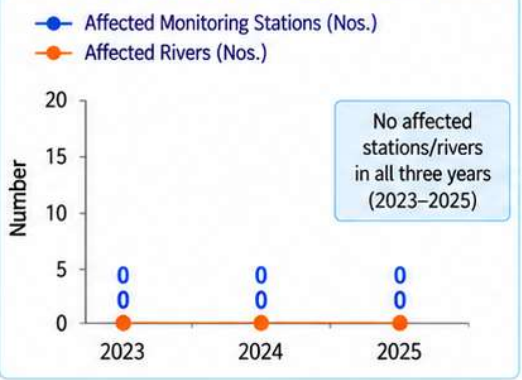
1. SAMPLES ABOVE LIMIT (>5,000 µg/L)



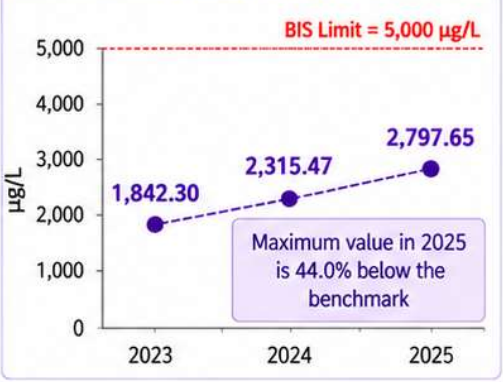
2. PERCENTAGE OF SAMPLES ABOVE LIMIT



3. GEOGRAPHICAL EXPANSION (AFFECTED STATIONS & RIVERS)



4. MAXIMUM ZINC CONCENTRATION OBSERVED (µg/L)



2025 Snapshot (Zinc)

Total samples analysed
6,691 (2025)

Samples exceeding benchmark (5,000 µg/L)
0 (0.00%)

Monitoring stations affected
0 (2025)

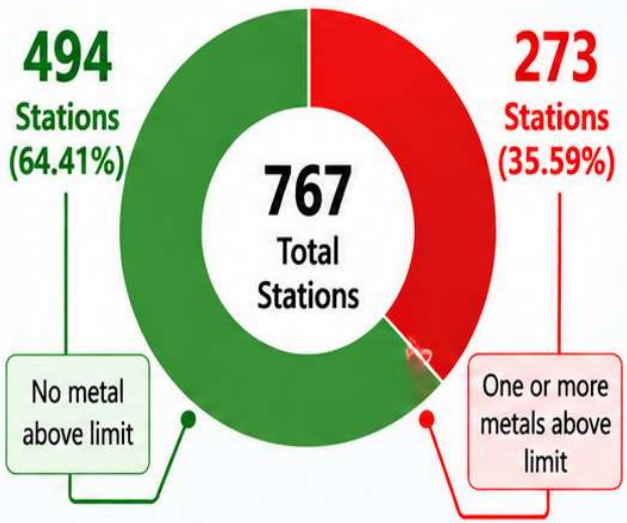
Maximum concentration
2,797.65 µg/L
Bardoh (Chhapriyal), Manawar Tawi River
(21 October 2025)

Key Observations

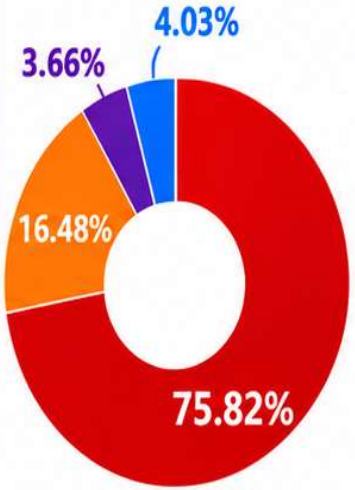
- During the 2025 monitoring cycle, **6,691** river-water samples were analysed for zinc and **none of the samples (0.00%)** exceeded the BIS benchmark (5,000 µg/L).
- Zinc concentrations in 2025 ranged from 0.000 to **2,797.65 µg/L**, with the maximum concentration recorded at Bardoh (Chhapriyal) on the Manawar Tawi River, on 21 October 2025.
- The maximum observed concentration in 2025 (2,797.65 µg/L) remained substantially below the benchmark of 5,000 µg/L (approximately **44.0% lower)**.
- No zinc exceedance was reported at any monitoring station in 2023, 2024 and 2025.
- Thus, zinc did not constitute a significant water-quality concern at the national level during the 2025 monitoring cycle, based on the adopted reference value (BIS IS 10500:2012).

Multi-Metal Hotspots and Station-Level Risk Patterns

1. OVERALL STATION STATUS
(Total: 767 Stations)



2. DISTRIBUTION OF AFFECTED STATIONS
(Among 273 Affected Stations)



Category	No. of Stations (%)
One metal above limit	207 (75.82%)
Two metals above limit	45 (16.48%)
Three metals above limit	10 (3.66%)
Four metals above limit	11 (4.03%)

Stations with ≥ 2 metals above limit:
66 (24.18% of affected stations)

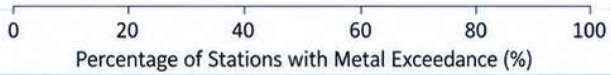
3. SINGLE-METAL EXCEEDANCE PATTERN
(Among 207 Stations)

Metal		No. of Stations	Share of Single-Metal Exceedances (%)
Fe	Iron	155	74.88%
As	Arsenic	18	8.70%
Pb	Lead	11	5.31%
Ni	Nickel	9	4.35%
Cu	Copper	6	2.90%
Hg	Mercury	4	1.93%
Cd	Cadmium	3	1.45%
Cr	Chromium	1	0.48%
Zn	Zinc	0	0%

Iron (Fe) alone was above the benchmark at 155 stations, the highest among all metals.

Basin-Wise Distribution of Metal Exceedance

Sl. No.	Basin	Percentage of Stations with Metal Exceedance (%)	Affected Stations / Total Stations (No.)
1	Brahmani & Baitarani Basin	88.00%	22 / 25
2	Subarnarekha Basin	86.67%	13 / 15
3	Mahi Basin	80.00%	4 / 5
4	Barak & Other Basin	75.76%	25 / 33
5	EFR South of Cauvery Basin	66.67%	6 / 9
6	Sabarmati Basin	66.67%	2 / 3
7	Cauvery Basin	56.41%	22 / 39
8	Krishna Basin	51.11%	23 / 45
9	Ganga Basin	36.32%	81 / 223
10	Narmada Basin	32.35%	11 / 34
11	Brahmaputra Basin	31.58%	48 / 152
12	EFR b/w Mahanadi & Godavari Basin	28.57%	2 / 7
13	Tapi Basin	25.00%	1 / 4
14	Godavari Basin	18.18%	10 / 55
15	WFR South of Tapi Basin	4.65%	2 / 43
16	Mahanadi Basin	2.38%	1 / 42
17	Indus Basin	0.00%	0 / 11
18	EFR b/w Pennar & Cauvery Basin	0.00%	0 / 10
19	Pennar Basin	0.00%	0 / 8
20	WFR of Kutch & Saurashtra (including Luni Basin)	0.00%	0 / 4



NATIONAL SUMMARY
(767 Water Quality Monitoring Stations)

767
Stations studied

273
Stations affected
(35.59%)

494
Stations with no metal above limit
(64.41%)

KEY HIGHLIGHTS

Highest prevalence: Brahmani & Baitarani (88.00%, 22/25), Subarnarekha (86.67%, 13/15), Mahi (80.00%, 4/5) and Barak & Other (75.76%, 25/33).

Other high-prevalence basins: EFR South of Cauvery (66.67%, 6/9), Sabarmati (66.67%, 2/3), Cauvery (56.41%, 22/39) and Krishna (51.11%, 23/45).

Highest number of affected stations: Ganga (81/223, 36.32%), Brahmaputra (48/152, 31.58%), Narmada (11/34, 32.35%) and Godavari (10/55, 18.18%).

Zero exceedance: Indus (0/11), EFR b/w Pennar & Cauvery (0/10), Pennar (0/8) and WFR of Kutch & Saurashtra including Luni (0/4).

Basin-wise distribution of trace and toxic metal exceedances in Indian river systems, 2025

Sl. No.	River Basin / Basin Grouping	Metals found above the reference limit									No. of metals found above limit
		As	Cd	Cr	Cu	Fe	Hg	Pb	Ni	Zn	
1	Barak & Other Basin	–	–	–	–	✓	–	–	–	–	1
2	Brahmaputra Basin	✓	–	✓	✓	✓	–	✓	✓	–	6
3	Cauvery Basin	–	✓	–	✓	✓	–	✓	✓	–	5
4	EFR South of Cauvery Basin	–	✓	–	✓	✓	–	✓	✓	–	5
5	WFR South of Tapi Basin	–	–	–	–	✓	–	–	–	–	1
6	Brahmani & Baitarani Basin	–	–	–	–	✓	–	–	–	–	1
7	EFR b/w Mahanadi & Godavari	–	–	–	–	✓	–	–	–	–	1
8	EFR b/w Pennar & Cauvery	–	–	–	–	–	–	–	–	–	0
9	Ganga Basin	✓	✓	✓	✓	✓	✓	✓	✓	–	8
10	Godavari Basin	✓	–	–	–	✓	–	–	✓	–	3
11	Indus Basin	–	–	–	–	–	–	–	–	–	0
12	Krishna Basin	✓	–	✓	✓	✓	✓	✓	✓	–	7
13	Mahanadi Basin	–	–	–	–	✓	–	–	–	–	1
14	Mahi Basin	✓	–	–	✓	–	✓	✓	–	–	4
15	Narmada Basin	–	✓	–	–	✓	–	✓	✓	–	4
16	Pennar Basin	–	–	–	–	–	–	–	–	–	0
17	Sabarmati Basin	–	–	–	✓	–	–	–	–	–	1
18	Subarnarekha Basin	–	–	–	–	✓	–	–	–	–	1
19	Tapi Basin	–	–	–	–	–	✓	–	–	–	1
20	WFR of Kutch & Saurashtra (including Luni Basin)	–	–	–	–	–	–	–	–	–	0

Summary | **All 9 metals considered** | **16 basin groupings with exceedance (≥1 metal)**

✓ Exceedance present | – Not above limit / Not found | **0** No metals above limit

As Arsenic | **Cd** Cadmium | **Cr** Chromium | **Cu** Copper | **Fe** Iron | **Hg** Mercury | **Pb** Lead | **Ni** Nickel | **Zn** Zinc

EFR: East Flowing Rivers; WFR: West Flowing Rivers; b/w: between

Comparative Analysis of Trace and Toxic Metal Exceedances in River Water: 2024 vs 2025

Metal-wise analysis results

Sl. No.	Heavy metal	Acceptable limit as per BIS 10500:2012 (µg/L)	2024			2025		
			No. of samples analysed	No. of samples > limit	% of samples > limit	No. of samples analysed	No. of samples > limit	% of samples > limit
1	Arsenic (As)	10	5456	41	0.75%	6660	65	0.98%
2	Cadmium (Cd)	3	5459	7	0.13%	6667	7	0.10%
3	Chromium (Cr)	50	5039	14	0.28%	6660	7	0.11%
4	Copper (Cu)	50	5457	7	0.13%	6667	12	0.18%
5	Iron (Fe)	1000	5417	325	6.00%	6459	409	6.33%
6	Lead (Pb)	10	5265	80	1.52%	6549	41	0.63%
7	Mercury (Hg)	1	5361	35	0.65%	5120	13	0.25%
8	Nickel (Ni)	20	5014	33	0.66%	6648	66	0.99%
9	Zinc (Zn)	5000	5456	0	0.00%	6691	0	0.00%
	TOTAL	-	5460	455	8.33%	6691	552	8.25%

All values are in µg/L (microgram per litre)

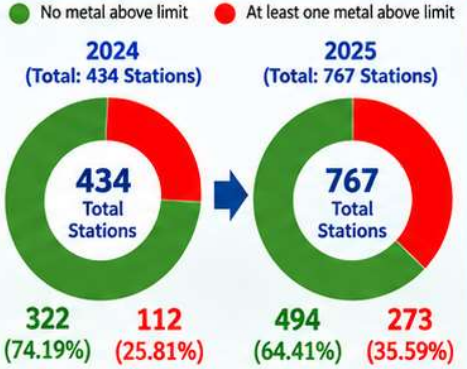
Values in red indicate samples above acceptable limit

Acceptable limits as per BIS: 10500, 2012

Overall comparison of 2 reports

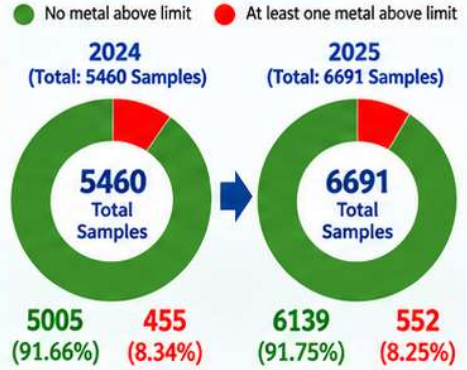
Parameter	Water Quality Stations			Water Quality Samples		
	2024	2025	Change (2025 vs 2024)	2024	2025	Change (2025 vs 2024)
Stations with no metal above acceptable limit	322	494	▲ 172 (+53.42%)	5005	6139	▲ 1134 (+22.66%)
Stations with at least one metal above acceptable limit	112	273	▲ 161 (+143.75%)	455	552	▲ 97 (+21.32%)
Total stations/ samples under study	767	767	–	5460	6691	▲ 1231 (+22.54%)

Station-wise comparison



Increase in stations studied: 333 (76.73%)

Sample-wise comparison

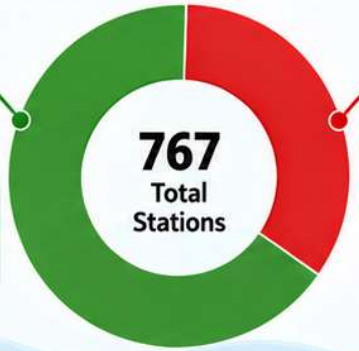


Increase in samples analysed: 1231 (22.54%)

Conclusions

1. National Status (2025)

767 Monitoring Stations assessed



494 (64.41%) Stations with all metals within BIS benchmark

273 (35.59%) Stations with one or more metal exceedances

2. Major Metals of Concern (2025)

Fe — Iron (Fe)
Benchmark: 1,000 µg/L



409 exceedance samples

209 stations

Principal parameter of concern

Ni — Nickel (Ni)



66 exceedance samples

Second most frequent exceedance (at sample level)

As — Arsenic (As)



65 exceedance samples

Third most frequent exceedance (at sample level)

Zn — Zinc (Zn)
Benchmark: 5,000 µg/L

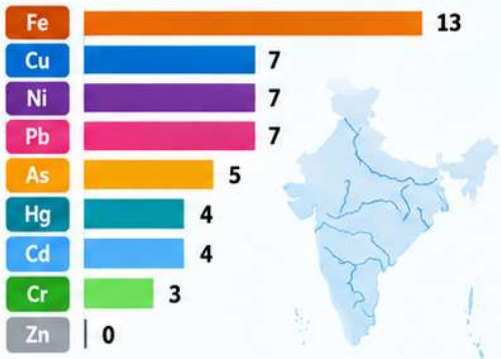


0 exceedance samples

No exceedance in analysed samples

3. Basin-level Pattern (Occurrence of Metals Above Benchmark)

Number of basin groupings with exceedance (for each metal)



Basin groupings with multiple metals above benchmark

Ganga Basin	8 metals
Krishna Basin	7 metals
Brahmaputra Basin	6 metals
Cauvery Basin	5 metals
EFR South of Cauvery Basin	5 metals

No station-level exceedance observed in:

- Indus Basin
- EFR between Pennar and Cauvery Basin
- Pennar Basin
- WFR of Kutch & Saurashtra including Luni Basin

4. Management Interpretation and Implications

66 stations with two or more metals above their benchmarks

Priority investigation sites

- Repeat sampling
- Upstream–downstream investigation
- Source identification

Interpretation of Iron Exceedance

- Iron is naturally abundant and may reflect geogenic processes (geology, mineral weathering, sediment interaction and redox conditions).
- High iron concentrations do not necessarily indicate an anthroppgenic source.
- However, repeated or multi-metal exceedances warrant further site-specific investigation.

Basin-level findings should be interpreted together with station-level patterns, as national averages can conceal significant regional differences in metal occurrence.

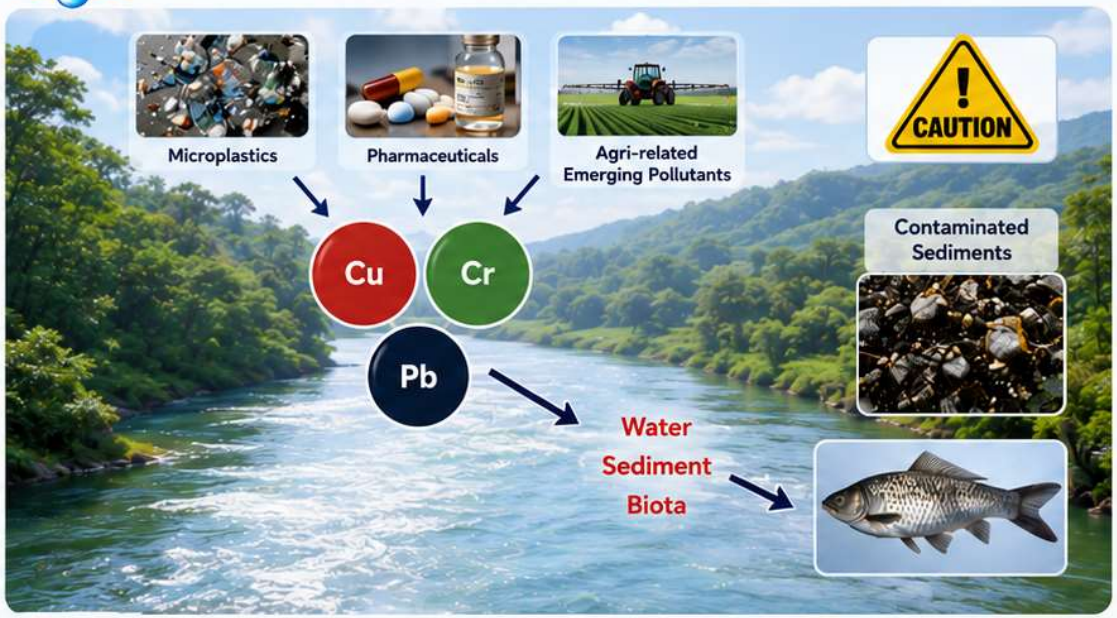
FUTURE RESEARCH AND EXPANSION RELATED TO CWC WATER QUALITY

RESEARCH PRIORITIES

- Monitoring of Microplastics, Pharmaceuticals, and Emerging Organic Pollutants
- Metal Speciation and Toxicity Assessment
- Trace Metals and Contaminants in River Sediments
- Development of a National River Water Quality Index (RWQI)
- Real-Time Water Quality Monitoring and Public Information Display Systems
- Application of Non-Target Screening (NTS) and Contaminant Fingerprinting
- Assessment of Climate Change Impacts on River Water Quality

PROGRAMME EXPANSION

- Expansion of Monitoring Network (Stations, Parameters, and Frequency)
- Inclusion of Emerging Pollutants, Trace Metals, and Organic Contaminants
- Modernization of Water Quality Laboratories with Advanced Instrumentation
- Provision of Analytical Services to Government and External Agencies
- Capacity Building and Training for State Water Resources Departments
- Strengthening Data Analytics, AI, and Decision Support Systems
- Development of Integrated Water Quality and Sediment Monitoring Programmes




Real-Time Monitoring


Data Analytics & AI


Advanced Laboratories


Capacity Building & Training



Public Information Display Systems


SAVE