CWC/2024/148

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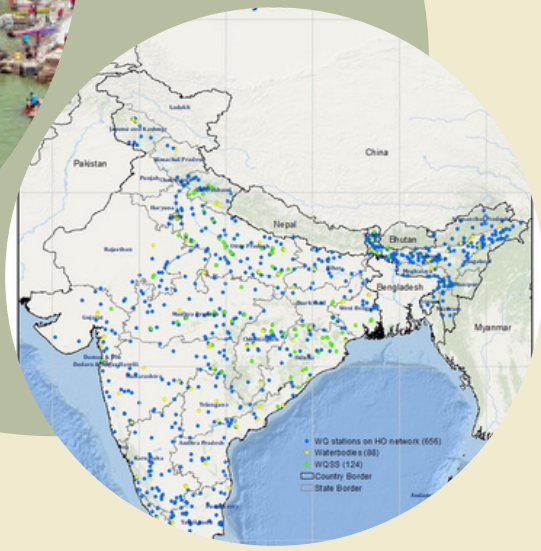
GOVERNMENT OF INDIA
Ministry of Jal Shakti
Department of Water Resources
River Development and Ganga Rejuvenation



Report on Water Quality Hot-spots in Rivers of India

(5TH Edition)

(January-December 2022)

CENTRAL WATER COMMISSION

August, 2024

Shri Kushvinder Vohra

Chairman
Central Water Commission
Department of WR, RD, & GR
Ministry of Jal Shakti

Water, the world's most valuable natural resource, is essential for the survival of all living organisms on the earth. With population growth, industrial development, urbanisation & agricultural activities, the demand & consumption for freshwater is rising. This has caused increased utilisation of water from rivers, lakes and other water sources affecting the diversity of flora and fauna. Further, after utilisation by industries, agriculture, human settlements etc., the effluent/discharge is generally poorer in quality/quantity than the original intake. This necessitates creation of treatment facilities, defining standards of effluent discharge, and foremost continuous monitoring of water quality of rivers and other water sources.

Since 1963, Central Water Commission has been involved in water quality monitoring. Central Water Commission has been monitoring the water quality at 782 (as on January, 2023) stations across various rivers and 88 water bodies (April, 2023) in India.

This report, now in its fifth edition, aims to provide insights into the water quality scenario based on standards set by the Ministry of Environment, Forest and Climate Change (MoEFCC), the Central Pollution Control Board (CPCB) and Bureau of Indian Standards (BIS). Previous editions were published in August 2011, November 2017, and November 2021. This fifth edition is based on the seasonal average values (Pre-monsoon, Monsoon and Post-monsoon) observed during January-December, 2022 at monitoring stations across India. It is our hope that future editions will be expanded to include additional data from more monitoring stations, accompanied by comprehensive maps and graphs.

Shri P. Manroi Scott

Member (RM)
Central Water Commission
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Ministry of Jal Shakti

Water in its purest form on Earth, comes from rain and snow. This water is available first in the form of surface water through rivers and Lakes. Thus we can say the journey of water on Earth starts in the shape of surface runoff. This surface water forms the lifeline of almost all the human activities as also most of nature's activities. It is the surface water which percolates down and recharges the aquifers and becomes part of Ground Water. Due to the fast pace of industrialization and urbanization, a lot of effluent and sewage is being generated, for a major portion of which there are no effluent treatments. This has resulted in discharge of this sewage into the rivers untreated or only partially treated. Rivers are our lifeline and we all have the responsibility of preserving it, to make our development and consequently quality of life sustainable. Pollution of rivers does not mean that they are polluted from its source to mouth, but there are stretches in some rivers which are polluted and actions are being taken by the Government to bring these stretches to acceptable conditions.

Central Water Commission has been monitoring the quality of river water at 782 stations on different rivers & 88 water bodies, all over India. It all started with the aim of monitoring the water quality parameters for agricultural purposes, but later on many more parameters were added and at present it covers more or less the entire spectrum of water quality. This is the fifth edition of Hot spots report and it is based on the seasonal average values observed during January-December, 2022 at 776 WQ monitoring stations of CWC.

I would like to place on record my appreciation of Sh Satish Jain, Deputy Director, RDC-II; Dr. Jakir Hussain, Research Officer, RDC-II; Rajesh Kumar, Research Officer, RDC-II; Nitish Kumar Singh, Assistant Research Officer, RDC-II for excellently bringing out fifth edition of this publication. I also appreciate the sampling, testing and compilation work done by scientific officers of CWC.

Shri Davendra Pratap Mathuria

Chief Engineer (P&DO)
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Water is one of the most important and a basic natural resource on the Earth and it sustain lives of all organism of the Earth. Only 2.5% of surface water is fresh water. The rest is sea water and is undrinkable. Out of the 2.5%, over1.75 % is locked as frozen form and thus remaining 0.75 % of all the water is available for human consumption. Central Water Commission, an apex engineering Organization under the Ministry of Water Resources, River Development and Ganga Rejuvenation is playing an active role in the field not only for water resource development but also in field of water quality.

CWC is monitoring the water quality of rivers since 1960's. Its water quality network consists of 782 water quality stations (as on January, 2023) along with 88 water bodies and a 3-tier laboratory system of 427 Level-I, 18 Level-II and 5 Level-III laboratories across the country. Water quality monitoring in Indian rivers is gaining importance in present day context with increasing urbanization, rapid industrialization and rising standards of living. The present 5th edition of the Report "Water Quality Hot spots in Rivers of India" is based on the seasonal average values observed for 13 parameters (pH, Electrical Conductivity (EC), Fluoride (F^-), Ammonia as N (NH_3-N), Nitrate as N (NO_3-N), Chloride (Cl^-), Total Hardness (TH), Boron (B), Sodium Adsorption Ratio (SAR), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform (TC) and Faecal Coliform (FC))during January-December 2022 at monitoring stations across India. The report brings out the identified locations having concentration of these parameters above the acceptable limits.

I appreciate the hard work done by Sh. Rajat Sharma, Senior Research Assistant (Lead Author) of River Data Compilation-2 Directorate & my appreciation to all field Chief Engineers of CWC for collection and submission of water quality data to River Data Compilation-2 Directorate and thus paving way to publish such a useful report.

CONTRIBUTIONS

A. GUIDANCE:

1. Shri Kushvinder Vohra, Chairman, Central Water Commission, New Delhi
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5. Shri Satish Jain, Deputy Director (River Data Compilation -2 Dte), CWC, New Delhi.
6. Shri Rajesh Kumar, Research Officer, (River Data Compilation -2 Dte), CWC,New Delhi.
7. Shri Nitish Kumar Singh, Assistant Research Officer, (River Data Compilation -2 Dte), CWC, New Delhi.

B. DATA CHECKING AND ITS VALIDATION:

All Scientific Staffs & Officers of concerned divisional laboratories of Central Water Commission. Data and results were shared vide email and presented during Technical discussion on 08 February, 2024 with all the staff/ officers of regional CWC offices /labs.

C. DATA COMPILATION AND REPORT PREPARATION TEAM:

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EXECUTIVE SUMMARY

The assessment of water quality is an essential measure within environmental monitoring. When water quality is poor, it affects not only the aquatic life but also the surrounding ecosystems. Rivers are unquestionably important parts of the hydrological cycle, mainly because they are fluxes of water and not reservoirs of water. Rivers, along with water, drag off sediments and other suspended materials (biotic and abiotic) that ultimately will reach all the other aquatic environments. The present study (5th Edition) based on the data of 13 water quality parameters observed at 776 monitoring stations during 2022. The eight parameters — pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total coliform bacteria (TC), free ammonia (NH_3-N), electrical conductivity (EC), boron (B), sodium adsorption ratio (SAR) are important for classification based on the uses defined by the Central Pollution Control Board (CPCB). Fluoride (F^-), Chloride (Cl-), Total Hardness (TH) and Nitrate (NO_3^--N) are among the parameters defined by the Bureau of Indian Standards (BIS: 10500:2012) for drinking water. Faecal Coliform (FC) is based on the primary water quality criteria for bathing water listed in the Gazette Notification issued by the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2000. These samples were analyzed at 23 water quality laboratories of CWC. The analysis results are compared with the prescribed limits of CPCB deginated best uses, BIS 10500:2012 and MoEFCC standards to find out the hot spot in Indian river. The parameter-wise summary of the analysis results is given below:

pH

The recommended acceptable limit of pH used for Drinking Water Source without conventional treatment but after disinfection (Class A); Outdoor bathing Organised (Class B) and propagation of wild life and fisheries (Class D). Total of 23557 river water samples were analyzed, and 1619 samples exceeded the acceptable limit. 19 water quality monitoring stations on 17 rivers were found to exceed the acceptable limit. The pH range was from 3.88 to 9.9 in 2022. The highest pH value (9.9) was observed at the Balijagaon water quality monitoring station on the Buri Dihing River during 2022.

Acceptable Limit of Designated Best Uses of Water by CPCB (Class A, B, D)	**pH 6.5 – 8.5**
No. of Samples Tested	23557
No. of samples where pH value found beyond acceptable limit	1619
No. of Monitoring stations where average (pre-monsoon/, monsoon / post monsoon) pH value found beyond acceptable limit	19
No. of basins/rivers where pH value found beyond acceptable limit	8/17

Electrical Conductivity (EC)

The recommended acceptable limit of electrical conductivity is 2250 µS/cm for Class E, Irrigation, Industrial Cooling, and Controlled Waste Disposal. Total of 23564 river water samples were analyzed, and 131 samples exceeded the acceptable limit. 7 water quality

Acceptable Limit of Designated Best Uses of Water by CPCB (Class E)	**EC < 2250 µS/cm**
No of Samples Tested	23564
No. of samples where electrical conductivity found above acceptable limit	131
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) electrical conductivity found above acceptable limit	7
No. of basins/rivers **where electrical conductivity found above acceptable limit**	5/7

monitoring stations on 7 rivers were found to exceed the acceptable limit. The electrical conductivity range was from 13.3 to 7983 µS/cm in 2022. The highest electrical conductivity (7983 µS/cm) was observed at the Kopergaon water quality monitoring station on the Godavari River.

Ammonia as N (NH_3-N)

The recommended acceptable limit of ammonia as N (NH_3-N) is 1.2 mg/L for Class D, Propagation of wild life and fisheries. Total of 14713 river water samples were analyzed, and 942 samples exceeded the acceptable limit. 28 water quality monitoring stations on 11 rivers were found to exceed the acceptable limit. The highest ammonia concentration 82.5 mg/L was observed at Noida water quality monitoring station on the Yamuna River.

Acceptable Limit of Designated Best Uses of Water by CPCB (Class D)	NH_3 < 1.2 mg/L
No of Samples Tested	14713
No. of samples where ammonia found above acceptable limit	942
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) ammonia found above acceptable limit	28
No. of basins/rivers where ammonia found above acceptable limit	7/11

Boron (B)

The recommended acceptable limit of boron is 2.0 mg/L for Class E, Irrigation, Industrial Cooling, and Controlled Waste Disposal. Total of 12,951 river water samples were analyzed. The average values of water quality monitoring stations during the pre-monsoon/monsoon/post-monsoon seasons of 2022 have been found to be within the acceptable limit for boron.

Acceptable Limit of Designated Best Uses of Water by CPCB (Class E)	B < 2.0 mg/L
No of Samples Tested	12951
No. of samples where boron found above acceptable limit	1
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) boron found above acceptable limit	0

Fluoride (F^-)

Bureau of Indian Standard (10500:2012) has recommended the acceptable limit of 1.5 mg/ for fluoride. Total of 18050 river water samples were analyzed, and 117 samples exceeded the acceptable limit. 7 water quality monitoring stations on 6 rivers were found to exceed the acceptable limit. The fluoride concentration range was from BDL to 7.91 mg/L in 2022. The highest fluoride concentration (7.91 mg/L) was observed at the Lingdem (HS) water quality monitoring station on the Talangchu River.

Acceptable Limit as BIS 10500: 2012	F^- < 1.5 mg/L
No of Samples Tested	18050
No. of samples where fluoride found above acceptable limit	117
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) fluoride found above acceptable limit	7
No. of basins/rivers where fluoride found above acceptable limit	4/6

Nitrate as N (NO_3^--N)

Acceptable Limit as BIS 10500: 2012	NO_3^- – N < 10.16 mg/L
No of Samples Tested	16326
No. of samples where nitrate found above acceptable limit	1583
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) nitrate found above acceptable limit	93
No. of basins/rivers where nitrate found above acceptable limit	10/39

Bureau of Indian Standard (10500:2012) has recommended that the acceptable limit for nitrate is 45 mg/L or 10.16 mg/L as NO_3^- – N in drinking water. Total of 16326 river water samples were analyzed, and 1583 samples exceeded the acceptable limit. 93 water quality monitoring stations on 39 rivers were found to exceed the acceptable limit. The nitrate concentration range was from BDL to 69.5 mg/L in 2022. The highest nitrate concentration (69.5 mg/L) was observed at the Sorada water quality monitoring station on the Rushikulya River during 2022.

Chloride (Cl^-)

Acceptable Limit as BIS 10500: 2012	Cl^- < 1000 mg/L
No of Samples Tested	22303
No. of samples where chloride found above acceptable limit	24
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) chloride found above acceptable limit	1
No. of basins/rivers where chloride found above acceptable limit	1/1

BIS (Bureau of Indian Standard) 10500:2012) has recommended an acceptable limit of 1000 mg/L of chloride in drinking water. Total of 22303 river water samples were analyzed, and 24 samples exceeded the acceptable limit. 1 water quality monitoring station was found to exceed the acceptable limit. The highest chloride concentration (1946 mg/L) was observed at the Luwara water quality monitoring station on the Shetrunji River.

Total Hardness (TH)

Acceptable Limit as BIS 10500: 2012	TH < 600 mg/L
No of Samples Tested	22412
No. of samples where total hardness found above acceptable limit	64
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) total hardness found above acceptable limit	3
No. of basins/rivers where total hardness found above acceptable limit	2/3

BIS (Bureau of Indian Standard) 10500:2012) has recommended an acceptable limit of 600 mg/L of total hardness in drinking water. Total of 22412 river water samples were analyzed, and 64 samples exceeded the acceptable limit. 3 water quality monitoring stations on 3 rivers were found to exceed the acceptable limit. The highest total hardness concentration was observed at 1454.05 mg/L at Kopergaon water quality monitoring station on the Godavari River during 2022.

Dissolved Oxygen (DO)

Acceptable Limit of Designated Best Uses of Water by CPCB (Class B)	DO > 5.0 mg/L
No. of Samples Tested	21288
No. of samples where dissolved oxygen found above acceptable limit	3738
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) dissolved oxygen found above acceptable limit	110
No. of basins/rivers where dissolved oxygen found above acceptable limit	11/56

The recommended acceptable limit of dissolved oxygen is < 5.0 mg/L for Class B, outdoor bathing (organised). Total of 21288 river water samples were analysed and 3738 samples exceeded the acceptable limit. 110 water quality monitoring stations on 56 rivers were found to exceed the acceptable limit. The lowest DO concentration (0 mg/L) observed at 5 water quality monitoring stations during the pre-monsoon period, 3 during the monsoon season and 5 during the post-monsoon period.

Bio-chemical Oxygen Demand (BOD)

Acceptable Limit of Designated Best Uses of Water by CPCB (Class B)	BOD < 3.0 mg/L
No of Samples Tested	18184
No. of samples where BOD found above acceptable limit	3412
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) BOD found above acceptable limit	144
No. of basins/rivers where BOD found above acceptable limit	8/60

The recommended acceptable limit of biochemical oxygen demand is > 3.0 mg/L for Class B, outdoor bathing (organised). Total of 18184 river water samples were analyzed, and 3412 samples exceeded the acceptable limit. 144 water quality monitoring stations on 61 rivers were found to exceed the acceptable limit. The highest biochemical oxygen demand concentration 95.33 mg/L at Singasadanapalli water quality monitoring station on the Ponnaiyar river during 2022.

Total Coliform (TC)

Acceptable Limit of Designated Best Uses of Water by CPCB (Class B)	TC < 500 MPN/ 100ml
No of Samples Tested	6520
No. of samples where total coliform found above acceptable limit	6156
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) total coliform found above acceptable limit	291
No. of basins/rivers where total coliform found above acceptable limit	11/126

The recommended acceptable limit of total coliforms are > 500 MPN/100 ml for Class B, outdoor bathing (organised). Total of 6520 river water samples were analyzed, and 6156 samples exceeded the acceptable limit. 291 water quality monitoring stations on 126 rivers were found to exceed the acceptable limit. The highest total coliform level (16,0000000 MPN/100 ml) was observed at Noida water quality monitoring station on the Yamuna River during 2022.

Faecal Coliform (FC)

Primary Water Quality Criteria for Bathing water (MoEF & CC) Gazette Notification, 2000 recommended acceptable limit of faecal coliform is > 500 MPN/100 ml. Total of 6520 river water samples were analyzed and 5448 samples exceeded the acceptable limit. 280 water quality monitoring stations on 121 rivers were found to exceed the acceptable limit. The highest faecal coliform value 24000000 MPN/100 ml at Noida water quality monitoring station on the Yamuna River during 2022.

Primary Water Quality Criteria for Bathing water (MoEF & CC) Gazette Notification, 2000	**FC < 500 MPN/ 100ml**
No of Samples Tested	6520
No. of samples where faecal coliform found above acceptable limit	5448
No. of Monitoring stations where faecal coliform found above acceptable limit	280
No. of basins/rivers where faecal coliform found above acceptable limit	10/121

Sodium Adsorption Ration (SAR)

The recommended acceptable limit of SAR is 26 for Class E, Irrigation, Industrial Cooling, and Controlled Waste Disposal. Total of 18843 river water samples were analyzed. The average values of water quality monitoring stations during the pre-monsoon/monsoon/post-monsoon seasons of 2022 have been found to be within the acceptable limit for SAR.

Acceptable Limit of Designated Best Uses of Water by CPCB (Class B)	**SAR < 26**
No of Samples Tested	18843
No. of samples where SAR found above acceptable limit	0
No. of Monitoring stations where average (pre-monsoon/monsoon/post-monsoon) SAR found above acceptable limit	0

In the 3rd edition, the average values for the last 10 years of both the Monsoon and Non-Monsoon seasons were considered to identify values exceeding the acceptable limits (CPCB designated best uses of water and Indian Standard 10500; 2012). Additionally, the chosen data year was the water year (June to May).

In the 5th edition, the selected data year has transitioned from the water year (June to May) to the Calendar year (January to December). The analysis is now based on average values observed during the Pre-monsoon (January to May), Monsoon (June to October) and Post-monsoon (November to December) seasons.

In the 5th edition, two types of comparisons are included:

a) Yearwise comparisons between 2021 and 2022 are discussed in the results section for each parameter.
b) Comparisons with the long-term average involve assessing average values for the period 2011-2020 (Chapter 8). To maintain similarity in data comparison, the data for 2021 and 2022 taken together were rearranged into monsoon and non-monsoon categories before the comparison.

CHAPTER – 1

1. Introduction

1.1 Water Quality & its Importance

“Water quality," in general, can be defined as the suitability of water to sustain various uses or processes. Any particular use will have specific requirements for the physical, chemical, or biological characteristics of water. The term is most frequently employed by reference to a set of standards against which compliance, generally achieved through water treatment, can be assessed. The most common standards used to monitor and assess water quality convey the health of ecosystems, the safety of human contact, the extent of water pollution, and the condition of drinking water. Water quality significantly impacts water supply and often determines supply options. The parameters for water quality are determined by the intended use. Work in the area of water quality tends to be focused on water that is treated for potability, industrial/domestic use, or restoration (of an environment/ecosystem, generally for the health of human/aquatic life).

The composition of surface and underground waters depends on natural factors (geological, topographical, meteorological, hydrological, and biological) in the drainage basin and varies with seasonal differences in runoff volumes, weather conditions and water levels. Large natural variations in water quality may, therefore, be observed even when only a single watercourse is involved. Human intervention also has significant effects on water quality. Some of these effects result from hydrological changes, such as the construction of dams, draining of wetlands, and diversion of flow. More obvious are the polluting activities, such as the discharge of domestic, industrial, urban, and other wastewaters into the watercourse (whether intentional or accidental) and the spreading of chemicals on agricultural land in the drainage basin. Water quality is influenced by a wide range of natural factors. The most important of these natural influences are geological, hydrological and climatic, as they affect the quantity and quality of water available.

The water quality of Indian rivers is of considerable importance, as these waters serve various purposes, including drinking for domestic and residential water supplies, agriculture (irrigation), hydroelectric power plants, tourism, recreation, and other human or economic uses of water.

The monitoring of river water quality is a crucial aspect of restoring water quality. One of the primary objectives of river water quality monitoring is to evaluate the suitability of river water for drinking purposes, irrigation, outdoor bathing and the propagation of wildlife and fisheries. The physical and chemical quality of river water plays a key role in determining its fitness for drinking. Therefore, the suitability of river water for potable uses, particularly in terms of its chemical quality, must be assessed based on vital characteristics. The Bureau of Indian Standards (BIS), formerly known as the Indian Standard Institute (ISI), has outlined quality standards for drinking water in its document IS 10500:2012 serving as a reference for determining the suitability of river water.

Monitoring and assessing water quality are essential for comprehending the extent and magnitude of the water quality challenge. Unlike water quantity, monitoring water quality is a complex process. Managing the water quality of rivers is a challenging task, with various manmade and natural factors likely to increase complexity in the future. One significant reason is the introduction and use of numerous new chemicals each year in agriculture, chemical industries, pharmaceutical industries etc. The large quantity of these new chemicals, along with the difficulty in quantifying many of them due to certain limitations, makes it challenging to reliably assess the health and environmental consequences. This complexity is further compounded by the continuous introduction of new chemicals, making it difficult to predict the long-term impact on water quality and associated ecosystems.

1.2 Water Quality Hot Spots

As per the Guidelines for Water Quality Monitoring, 2017, a 'Hotspot' is defined as a location or Monitoring station where the concentration of a particular parameter exceeds the permissible limits prescribed by the water quality standards in the BIS code IS 10500:2012. In this report, a 'Hotspot' is determined based on the location or Monitoring station where the concentration of a specific parameter surpasses the permissible limits set by the drinking water quality standards in the BIS code IS 10500:2012, 'Designated Best Use Water Quality Criteria' established by the Central Pollution Control Board (CPCB) and Primary Water Quality Criteria for Bathing Water mentioned in the Ministry of Environment, Forest and Climate Change (MoEFCC) Gazette Notification, 2000. The report incorporates data from 776 water quality monitoring stations in year 2022 of the Central Water Commission (CWC), covering significant rivers in India.

It is based on the average values observed during Pre-monsoon (January to May), Monsoon (June to October) and Post-monsoon (November to December) seasons for the year 2022. River water quality has been evaluated based on 13 parameters: pH, Electrical Conductivity (EC), Fluoride (F^-), Ammonia as N (NH_3-N), Nitrate as N (NO_3^-N), Chloride (Cl^-), Total Hardness (TH), Boron (B), Sodium Adsorption Ratio (SAR), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform (TC) and Faecal Coliform (FC). These parameters are crucial in defining the quality of surface water in rivers. Therefore, the presence of these parameters in river water beyond the permissible limits is considered as river water quality hotspots.

CHAPTER -2

2. Indian Water Resources Scenario

2.1 River Basins of India

CWC under its publication No. 30/88 “Water Resources of India”, April 1988 has standardized the river basins of India. The country is classified into 20 river basins comprising of 12 major basins and 8 composite river basins.

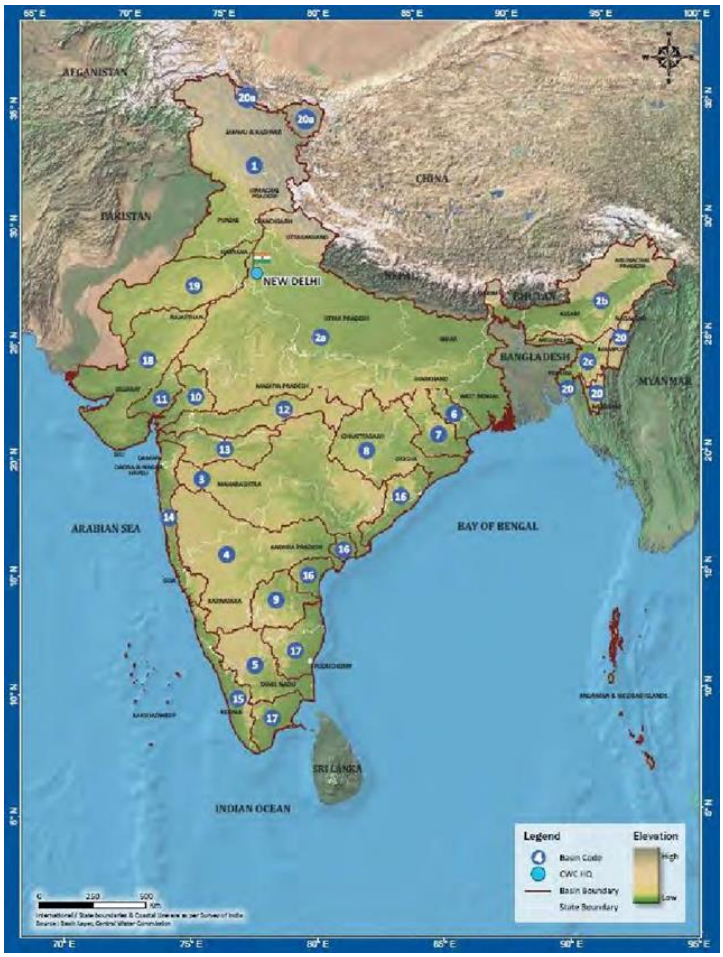
The 12 major basins are: (1) Indus; (2) Ganga-Brahmaputra-Meghna; (3) Godavari; (4) Krishna; (5) Cauvery; (6) Mahanadi; (7) Pennar; (8) Brahmani-Baitarani; (9) Sabarmati; (10) Mahi; (11) Narmada and (12) Tapi. Each of these basins is having a drainage area exceeding 20000 sq.km.

The 8 composite river basins are:

1) Subarnarekha – combining Subarnarekha and other small rivers between Subarnarekha and Baitarni.
2) East flowing rivers between Mahanadi and Pennar.
3) East flowing rivers between Pennar and Kanyakumari.
4) Area of Inland Drainage in Rajasthan Desert.
5) West flowing rivers of Kutch and Saurashtra including Luni;
6) West flowing rivers from Tapi to Tadri.
7) West flowing rivers from Tadri to Kanyakumari.
8) Minor rivers draining into Myanmar (Burma) and Bangladesh.

2.2 Indian River System

The Indian River Systems can be divided into four categories:- the Himalayan, the Rivers traversing the Deccan Plateau, the Coastal and those in the inland drainage basin (Figure 1).



The Himalayan Rivers are perennial as they are fed by melting glaciers every summer. During the monsoon, these Rivers assume alarming proportions. Swollen with rainwater, they often inundate villages and towns in their path. The Gangetic basin is the largest River system in India, draining almost a quarter of the country.

The Rivers of the Indian peninsular plateau are mainly fed by rain. During summer, their flow is greatly reduced, and some of the tributaries even dry up, only to be revived in the monsoon. The Godavari basin in the peninsula is the largest in the country, spanning an area of almost one-tenth of the country. The Rivers Narmada and Tapi flow almost parallel to each other but empty themselves in opposite directions. The two Rivers make the valley rich in alluvial soil and teak forests cover much of the land. While coastal River's gush down the peaks of the Western Ghats into the Arabian Sea in torrents during the rains, their flow slow down after the monsoon. Streams like the Sambhar in western Rajasthan are mainly seasonal in character, draining into the inland basins and salt lakes. In the Rann of Kutch, the only River that flows through the salt desert is the Luni.

2.2.1 Indus system

This comprises the river Indus and its tributaries like the Jhelum, Chenab, Ravi, Beas and Sutlej. These originate in the North and generally flow in a West or South-West direction to eventually flow into Arabian Sea through Pakistan.

2.2.2 Ganga-Brahmaputra-Meghna system

The main river Ganga and its tributaries like the Yamuna, Sone, Gandak, Kosi and many others; similarly, main rivers Brahmaputra, Meghna and their tributaries. All these

eventually flow into Bay of Bengal, through Bangladesh. Some of the tributaries of these rivers are larger than other independent rivers. e.g. Yamuna, a tributary of Ganga, has a larger catchment area than the Tapi, a small peninsula river.

2.2.3 Rivers of Rajasthan and Gujarat

Mahi, Sabarmati, Luni etc. These are rivers of arid regions, they carry relatively little flow, some of them flow to Arabian Sea through Gujarat while some are land-locked and their flow is lost through percolation and evaporation in the vast arid regions.

2.2.4 East Flowing Peninsular Rivers

The important members of this group are: Damodar, Mahanadi, Brahmani, Baitarani, Subarnarekha, Krishna, Godavari and Cauvery. They all flow into Bay of Bengal at various places along the Eastern Coast of India.

2.2.5 West Flowing Peninsular Rivers

Narmada and Tapi rivers originate in Central India and flow in a western direction to meet Arabian Sea south of Gujarat.

2.2.6 Western Coast Rivers

There are large number of rivers in the Western Coast - i.e. coastal Maharashtra and Karnataka, and entire Kerala. These rivers are small in length but carry a significant amount of water due to very high rainfall in Western Ghats. They drain only 3% of the India’s land area but carry 11% of India’s water resources.

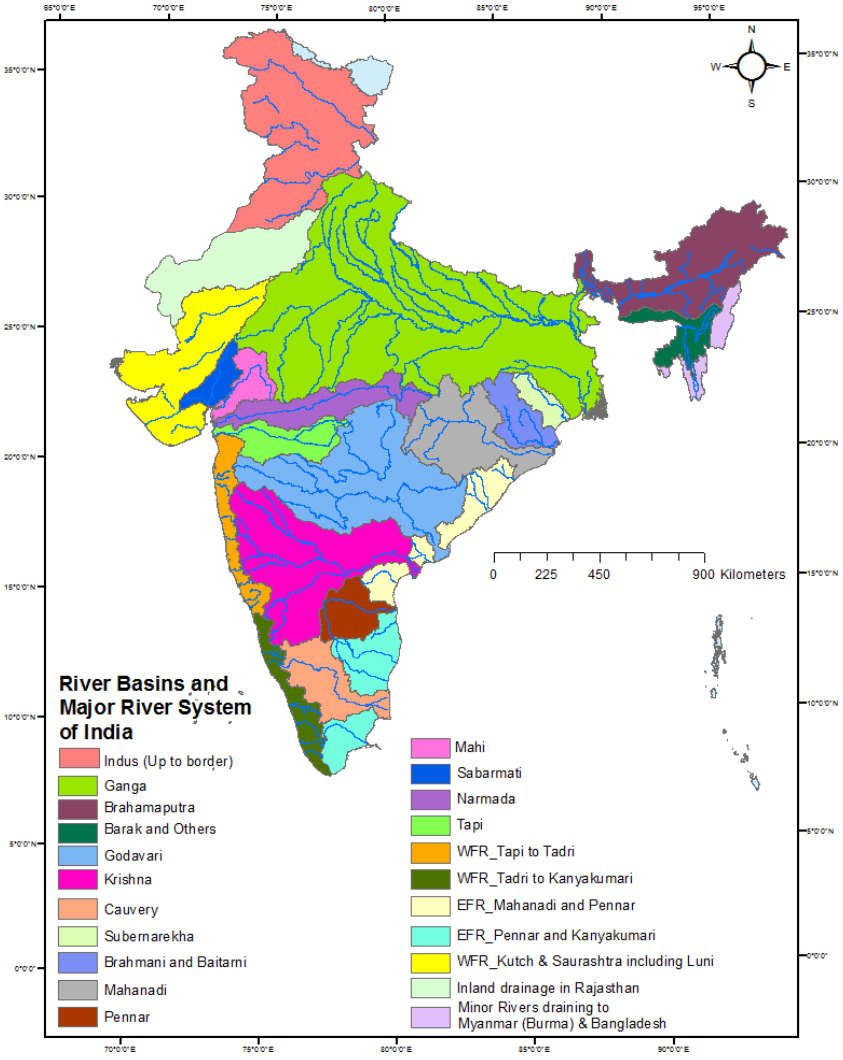


Figure.2 River Basins and Major River Systems of India

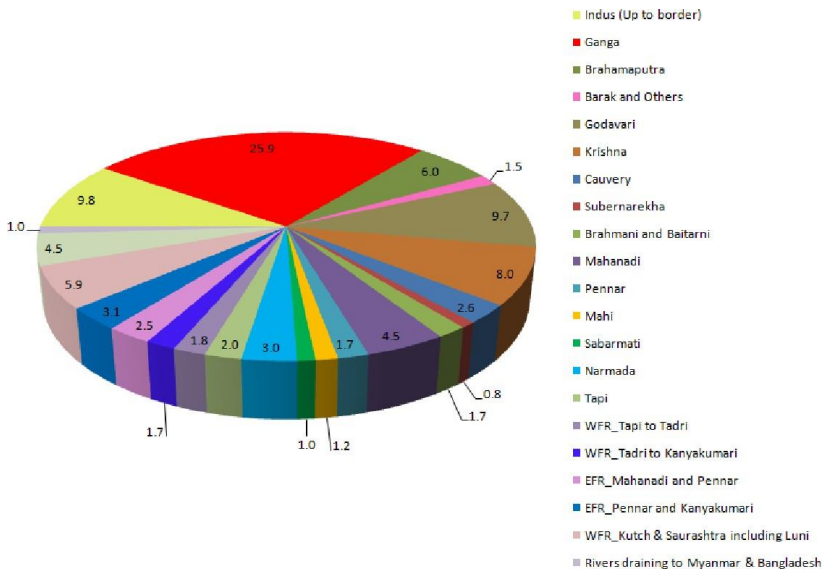


Figure.3 Percentage of geographical area in each basin

Sources:

1. CWC publication “Reassessment of Water Availability in India using Space inputs” June 2019 from Basin Planning & Management Organization, CWC, New Delhi. India WRIS:
2. India Water Resources Information System

The more details may be assessed by clicking the links given below: (http://old.cwc.gov.in/main/downloads/ReassessmentMainReport.pdf)&(https://indiawris.gov.in/wris)

CHAPTER – 3

3. Hydrochemistry

Hydrochemistry is an interdisciplinary science that deals with the chemistry of water in the natural environment. Professional fields such as chemical hydrology, aqueous chemistry, hydrochemistry, water chemistry and hydro-geochemistry are all more or less synonyms. The classical use of chemical characteristics in chemical hydrology is to provide information about the regional distribution of water qualities.

Main areas of work are the chemical characterization of the water (which is highly dependent on the regional and geochemical event units), the determination of water-chemical parameters and the assessment of anthropogenic and other influences on the water quality.

At the same time, hydrochemistry can also be of immense help in yielding information about the environment through which water has circulated. It is essential to study the entire system like atmospheric water (rainwater), surface water and ground water simultaneously in evaluating their hydrochemistry and pollution effect.

3.1 Chemistry of Rainwater

The atmosphere is composed of water vapors, dust particles and various gaseous components such as N_2, O_2, CO_2, CH_4, CO, SO_2, NO_2 etc. Pollutants in the atmosphere can be transported through long distances by the wind. These pollutants are mostly washed down by precipitation and partly as dry fall out. Composition of rainwater is determined by the source of water vapors and by the ion, which are taken up during transport through the atmosphere. In general, chemical composition of rainwater shows that rainwater is slightly mineralized with specific electrical conductance (EC) generally below 50 µS/cm, chloride (Cl^-) below 5 mg/l and HCO_3 below 10 mg/l. Among the cations, concentration of Ca, Mg, Na & K vary considerably but the total cations content is generally below 15 mg/l except in samples contaminated with dust. The concentration of sulphates and nitrates in rainwater may be high in areas near industrial hubs.

3.2 Chemistry of Surface Water

Surface water chemistry is a direct indicator of the effects of acid rain on water bodies. Networks that monitor surface water chemistry over long time periods provide valuable information on aquatic ecosystem health and how water bodies respond to changes in acid-causing emissions.

Surface water is found extremely variable in its chemical composition due to variations in relative contributions of ground water and surface water sources. The possible causes and consequences of changes in climate, land use and industrial, urban and agricultural pollution can be expected to be indicated by changes in the physical and

chemical composition of water in rivers and streams. The mineral content in river water usually bears an inverse relationship to discharge. The mineral content of river water tends to increase from source to mouth, although the increase may not be continuous or uniform. Other factors like discharge of city wastewater, industrial waste and mixing of waters can also affect the nature and concentration of minerals in surface water. Among anions, bicarbonates are the most important and constitute over 50% of the total anions in terms of milli equivalent per litre (meq/l). In case of cations, alkaline earths or normally calcium predominates but with increasing salinity the hydro chemical facies tend to change to mixed cations or even to Na- HCO_3 type.

3.3 Chemistry of Ground Water

The downward percolating water is not inactive, and it is enriched in CO_2. It can also act as a strong weathering agent apart from general solution effect. Consequently, the chemical composition of ground water will vary depending upon several factors like frequency of rain, which will leach out the salts, time of stay of rain water in the root-zone and intermediate zone, presence of organic matter etc. It may also be pointed out that the water front does not move in a uniform manner as the soil strata are generally quite heterogeneous. The movement of percolating water through larger pores is much more rapid than through the finer pores. The overall effect of all these factors is that the composition of ground water varies from time to time and from place to place.

Before reaching the saturated zone, percolating water is charged with oxygen and carbon dioxide and is most aggressive in the initial stages. This water gradually loses its aggressiveness, as free CO_2 associated with the percolating water gets gradually exhausted through interaction of water with minerals.

The oxygen present in this water is used for the oxidation of organic matter that subsequently generates CO_2 to form H_2CO_3. This process goes on until oxygen is fully consumed.

Apart from these reactions, there are several other reactions including microbiological mediated reactions, which tend to alter the chemical composition of the percolating water. For example, the bicarbonate present in most waters is derived mostly from CO_2 that has been extracted from the air and liberated in the soil through biochemical activity.

Some rocks serve as sources of chloride and sulphate through direct solution. The circulation of sulphur, however, may be greatly influenced by biologically mediated oxidation and reduction reactions. Chloride circulation may be a significant factor influencing the anion content in natural water.

CHAPTER - 4

4. River Water Pollution

The World Health Organisation (WHO) says that polluted water is water whose composition has been changed to the extent that it is unusable. In other words, it is toxic water that cannot be drunk or used for essential purposes like agriculture and which also causes diseases like diarrhoea, cholera, dysentery, typhoid and many more.

River Water pollution occurs when pollutants are discharged directly or indirectly into rivers without adequate treatment of harmful compounds. River Water pollution affects humans, plants and organisms living in these rivers. Water pollutants are damaging not only the individual species and populations, but also the natural biological communities. Moving water dilutes and decomposes pollutants more rapidly than standing water.

The primary reasons for river water pollution are because of three major sources of pollution i.e. industry, agriculture and domestic situated along the rivers. Industries and cities have been located along rivers historically, because rivers provide transportation and have traditionally been a convenient place to discharge waste. Agricultural activities have tended to be concentrated near rivers, because river floodplains are exceptionally fertile due to the many nutrients that are deposited in the soil when the river overflows.

4.1 Sources of Pollution

4.1.1. Point source pollution

Point source pollution refers to the pollution entering the water way through a discrete conveyance like pipes, channels etc., from source such as industry.

4.1.2 Non- point source pollution

Non-point source pollution refers to the pollution that does not enter the water way through a discrete source but accumulative in nature. The pollutants are collected in small amounts from over a large area. These pollutants are:

- Natural contaminants such as dry leaves, dead insects and animals, bird droppings etc.
- Agricultural contaminants such as agricultural runoff containing fertilizers, pesticides etc. The fertilizers and pesticides can be washed through the soil by rain, to end up in rivers.
- Industrial contaminants such as industrial runoff containing industrial wastes.
- Microbial contaminants such as faecal & Total Coliform.
- Human added contaminants such as organic matter through domestic discharges.

If large amounts of fertilizers or farm waste drain into a river the concentration of nitrate and phosphate in the water increases considerably. Algae use these substances to grow and multiply rapidly turning the water green. This massive growth of algae, called eutrophication, leads to pollution. When the algae die they are broken down by the action of the bacteria which quickly multiply, using up all the oxygen in the water which leads to the death of many animals.

Chemical waste products from industries are discharged in to rivers. Such pollutants include cyanide, zinc, lead, copper, cadmium and mercury. These substances may enter the water in such high concentrations that fish and other animals are killed immediately. Sometimes the pollutants enter a food chain and accumulate until they reach toxic levels, eventually killing birds, fish and mammals.

Factories use water from rivers to power machinery or to cool down machinery. Dirty water containing chemicals is put back in to the rivers. Water used for cooling is warmer than the river itself. Raising the temperature of the water, lowers the level of dissolved oxygen and upsets the balance of life in the water. People sometimes carelessly throw rubbish directly into rivers.

4.2 Effects of Environmental factors on River water quality

River water quality is highly variable by nature due to environmental conditions such as basin lithology, vegetation and climate. In small watersheds spatial variations extend over orders of magnitude for most major elements and nutrients, while this variability is an order of magnitude lower for major basins. Standard river water for use as reference is therefore not applicable. As a consequence, natural waters can possibly be unfit for various human uses, even including drinking.

There are three major natural sources of dissolved and soluble matter carried by rivers: the atmospheric inputs of material, the degradation of terrestrial organic matter and the weathering of surface rocks. These substances generally transit through soil and porous rocks and finally reach the rivers. On their way, they are affected by numerous processes such as recycling in terrestrial biota, recycling and storage in soils, exchange between dissolved and particulate matter, loss of volatile substances to the atmosphere, production and degradation of aquatic plants within rivers and lakes etc. As a result of these multiple sources and pathways, the concentrations of elements and compounds found in rivers depend on physical factors (climate, relief), chemical factors (solubility of minerals) and biological factors (uptake by vegetation, degradation by bacteria). The most important environmental factors controlling river chemistry are:

- Occurrence of highly soluble (halite, gypsum) or easily weathered (calcite, dolomite, pyrite, olivine) minerals.
- Distance to the marine environment which controls the exponential decrease of ocean aerosols input to land (Na^+, Cl^-, SO_4^{2-}, and Mg^{2+}).

- Aridity (precipitation/runoff ratio) which determines the concentration of dissolved substances resulting from the two previous processes.
- Terrestrial primary productivity which governs the release of nutrients (C, N, Si, K).
- Ambient temperature which controls, together with biological soil activity, the weathering reaction kinetics.

5. Water Quality Monitoring by CWC

Central Water Commission (CWC) is playing an important role in the field of water quality monitoring of river water and is observing water quality at various rivers since 1960's. As on January, 2023, CWC is observing water quality at 782 key locations in different rivers across the country: 657 on Hydrological Observation network and 125 Water Quality Sampling stations (WQSS). In addition, CWC has started monitoring of water quality of water bodies across India since 01.03.2023. Till date, 88 water bodies have been identified for water quality monitoring purpose across various states of the country (Figure 4).

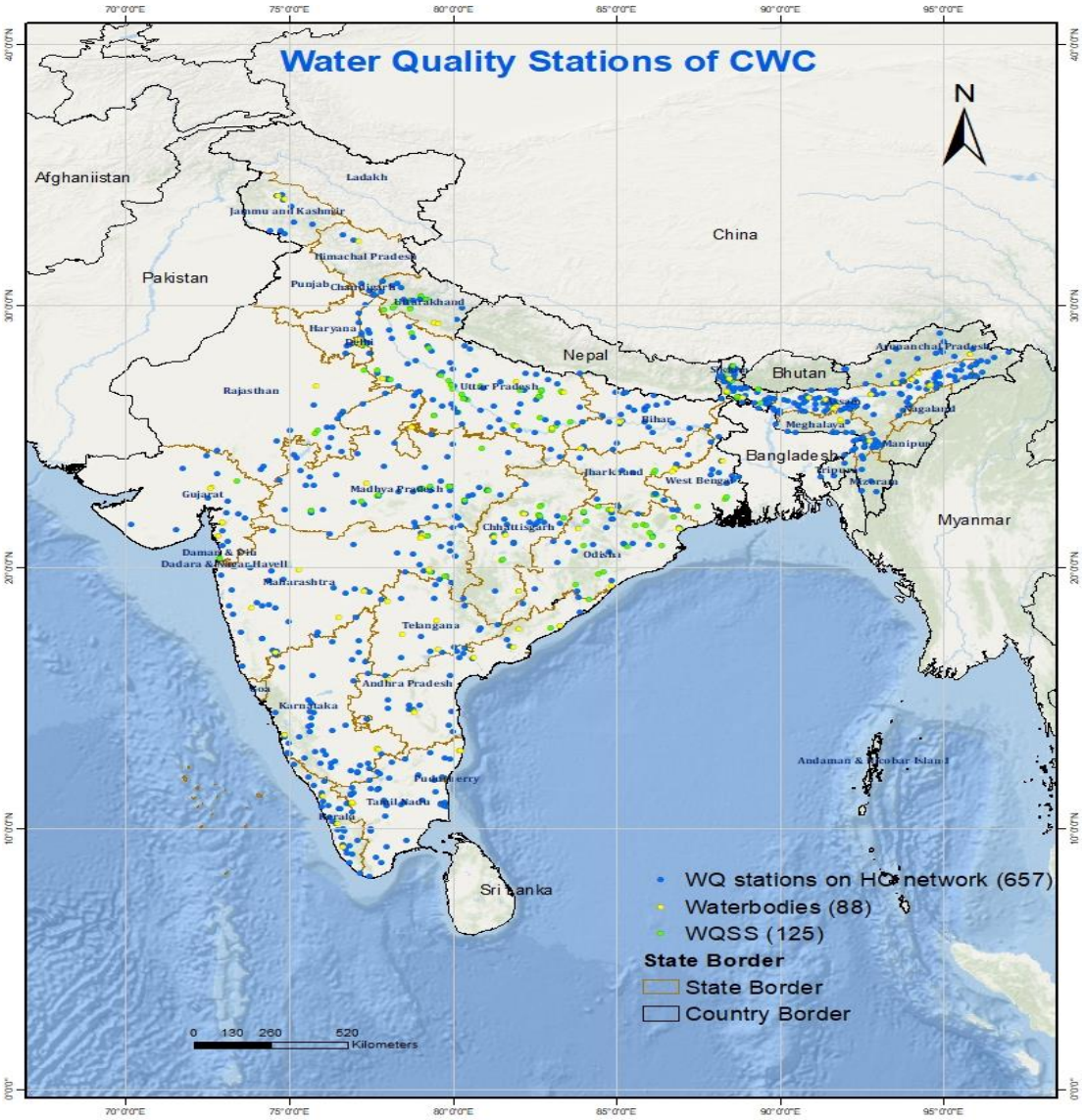


Figure 4: Water quality network of CWC

The details of distribution of WQ monitoring stations among different states and organisations/basins of CWC are given in the tables and figures given below.

Table 1: State–wise distribution of Water Quality Monitoring stations of CWC

S.No.	State	GDQ	GDSQ	GQ	WQSS	Water Bodies	Total
1	Andhra Pradesh	4	14	1	2	7	28
2	Arunachal Pradesh	9	9	10	-	2	30
3	Assam	21	26	53	-	11	111
4	Bihar	6	22	1	-	2	31
5	Chhattisgarh	2	18	-	12	4	36
6	Delhi	1	2	-	3	3	9
7	Gujarat	4	9	-	2	6	21
8	Haryana	3	1	-	-	-	4
9	Himachal Pradesh	-	6	-	-	1	7
10	Jammu & Kashmir	3	6	-	-	2	11
11	Jharkhand	4	6	1	6	2	19
12	Karnataka	17	23	2	-	4	46
13	Kerala	2	24		-	3	29
14	Madhya Pradesh	20	24	4	12	2	62
15	Maharashtra	17	25	4	6	10	62
16	Manipur	-	-	1	-	-	1
17	Meghalaya	5	3	1	-	2	11
18	Mizoram	-	5	-	-	-	5
19	Odisha	2	22	1	25	4	54
20	Puducherry	3	-	-	-	-	3
21	Rajasthan	8	8		2	1	19
22	Sikkim	-	11	6	5	1	23
23	Tamil Nadu	21	21	-	-	5	47
24	Telangana	4	8	1	-	4	17
25	Tripura	-	3	2	-	-	5
26	Uttar Pradesh	14	47	4	28	6	99
27	Uttarakhand	5	9		15	3	32
28	West Bengal	7	21	10	7	3	48
	Grand Total	**182**	**373**	**102**	**125**	**88**	**870**

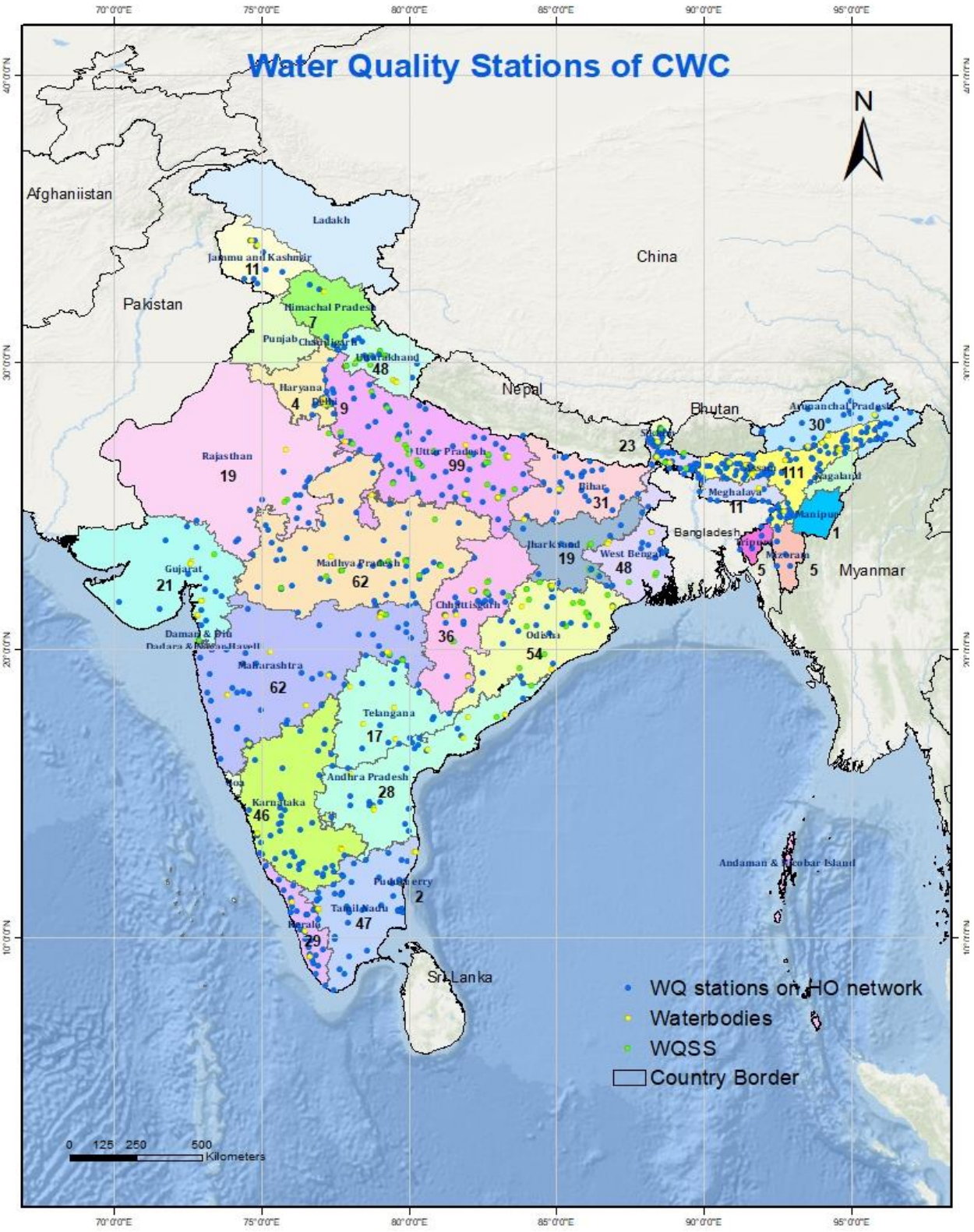


Figure 5: State-wise distribution of Water Quality Monitoring stations monitored by CWC

Table 2: Organisation–wise distribution of Water Quality Monitoring stations of CWC

S.No.	Organization	GDQ	GDSQ	GQ	WQSS	Water Bodies	Total
1	Barak and Other Basins Organisation, Shillong	7	22	8	-	3	40
2	Brahmaputra Basin Organisation, Guwahati	27	24	58	-	12	121
3	Cauvery and southern rivers Organisation, Coimbatore	35	53	-	-	11	99
4	Indus Basin Organisation, Chandigarh	3	8	-	-	3	14
5	Krishna & Godavari Basin Organisation, Hyderabad	19	34	7	-	15	75
6	Lower Ganga Basin Organisation, Patna	9	33	1	6	5	54
7	Mahanadi and Eastern Rivers Organisation, Bhubaneswar	2	43	1	43	7	96
8	Mahi & Tapi Basin Organisation, Gandhinagar	6	15		2	6	29
9	Monitoring Central Organisation, Nagpur	10	14	1	6	5	36
10	Monitoring South Organisation, Bengaluru	11	17	-	-	3	31
11	Narmada Basin Organisation, Bhopal	8	9	4	11	1	33
12	Teesta & Bhagirathi Damodar Basin Organisation, Kolkata	11	32	18	14	6	81
13	Upper Ganga Basin Organisation, Lucknow	6	32	1	33	5	77
14	Yamuna Basin Organisation, New Delhi	28	37	3	10	6	84
	Grand Total	**182**	**373**	**102**	**125**	**88**	**870**

Figure 6: Organisation-wise distribution of water quality Monitoring stations monitored by CWC.

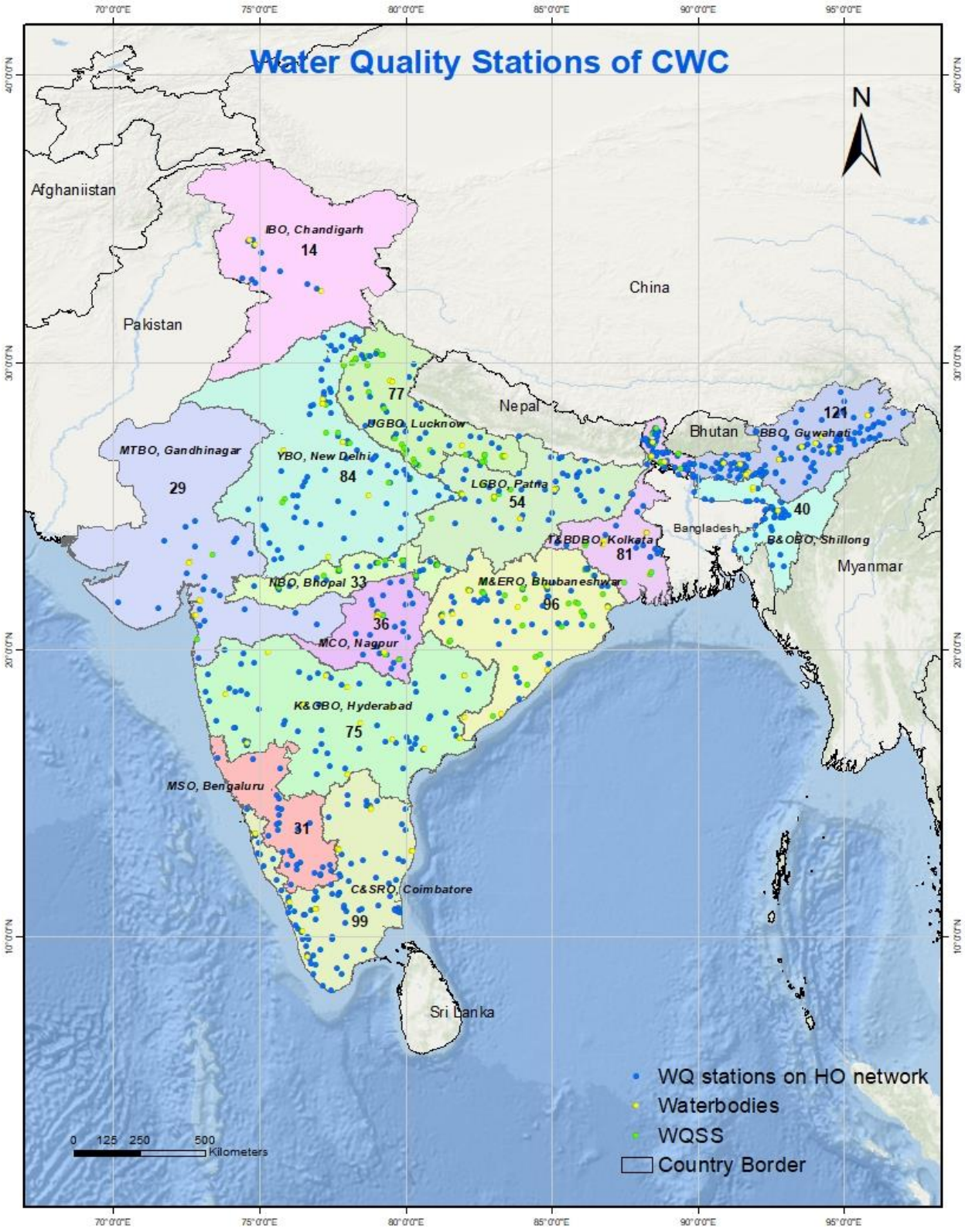
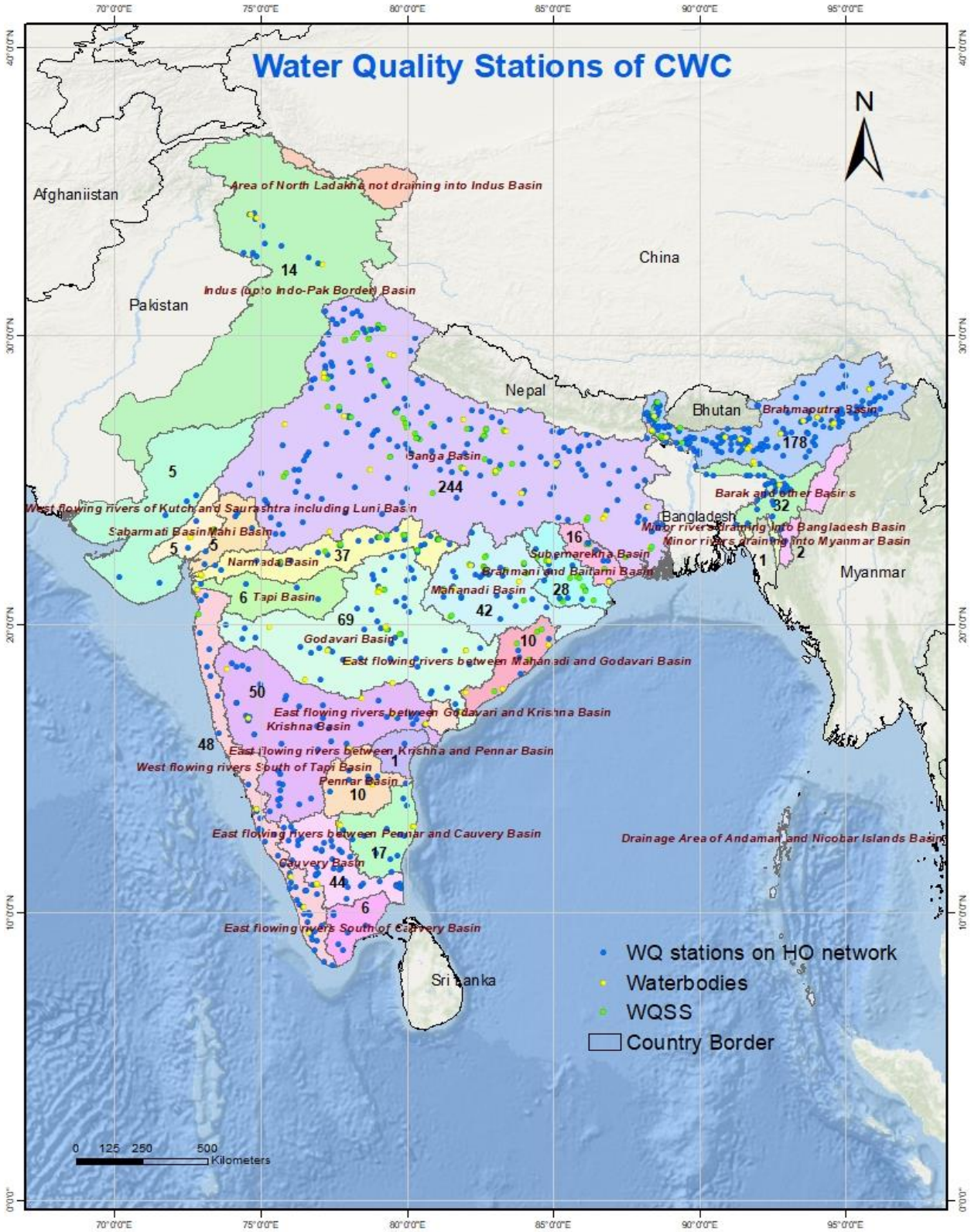


Table 3: Basin-wise water-quality Monitoring stations monitored by CWC

S.No.	Basin	GDQ	GDSQ	GQ	WQSS	Water Bodies	Total
1	Barak and Others Basin	6	18	7	-	1	32
2	Brahmani and Baitarni Basin	-	11	1	15	1	28
3	Brahmaputra Basin	34	44	76	7	17	178
4	Cauvery Basin	17	24	-	-	3	44
5	EFR bertween Pennar and Cauvery	8	4	-	-	5	17
6	EFR between Krishna and Pennar	-	1	-	-	-	1
7	EFR between Mahanadi and Godavari	-	4	-	5	1	10
8	EFR South of Cauvery	2	4	-	-	-	6
9	Ganga Basin	48	115	6	56	19	244
10	Godavari Basin	19	26	4	6	14	69
11	Indus (Up to border) Basin	3	8	-	-	3	14
12	Krishna Basin	14	27	3	-	6	50
13	Mahanadi Basin	1	22	-	15	4	42
14	Mahi Basin	2	3	-	-	-	5
15	Narmada Basin	8	11	4	11	3	37
16	Pennar Basin	4	4		-	2	10
17	River draining into Bangladesh Basin	-	1	-	-	-	1
18	River draining into Myanmar Basin	-	2	-	-	-	2
19	Sabarmati Basin	1	1	-	1	2	5
20	Subarnarekha Basin	1	6	-	8	1	16
21	Tapi Basin	1	3	-	-	2	6
22	WFR of Kutch and Saurashtra including Luni Basin	2	3	-	-	-	5
23	WFR South of Tapi	11	31	1	1	4	48
	Grand Total	**182**	**373**	**102**	**125**	**88**	**870**

Figure 7: Map showing the basin-wise distribution of water quality Monitoring stations monitored by CWC.



The water quality samples collected at these monitoring stations are analysed at laboratories of CWC. At present, CWC follows a three-tier laboratory system which consists of Level I, II and III types of laboratories for providing analytical facilities for the analysis of river water samples collected from water quality monitoring Monitoring stations covering all the important river basins of India.

The three-tier laboratory system consists of:

1. **Level-I Laboratories:** 427 level-I laboratories located at field water quality monitoring monitoring stations on various rivers of India for monitoring of 6 in-situ parameters: Colour, Odour, Temperature pH, Electrical Conductivity and Dissolved Oxygen (a map showing 427 Level-I labs can be seen at figure-5).
2. **Level-II Laboratories:** 18 level-II laboratories located at division offices to analyse 25 physico-chemical and bacteriological parameters of river water.
3. **Level-III Laboratories:** 5 regional labs located at New Delhi, Varanasi, Hyderabad, Coimbatore and Guwahati for analysis of 41 parameters including trace & toxic metals and pesticides.

Out of 23 level-II/III laboratories of CWC, 22 laboratories of CWC have got accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL) in the field of testing in accordance with Standard ISO/IEC 17025:2017. A map showing level-II/III labs can be seen at figure-6. The details of monitoring parameters in each level labs are depicted in table-10.

Table 4: List of Water Quality Parameters monitored by CWC

Sl. No.	Level-I	Level-II	Level-III
1	Temperature	Temperature	Temperature
2	Colour	pH	pH
3	Odour	Electrical Conductivity	Electrical Conductivity
4	pH	Dissolved Oxygen (DO)	Dissolved Oxygen (DO)
5	Electrical Conductivity	Turbidity	Turbidity
6	Dissolved Oxygen (DO)	Biochemical Oxygen Demand (BOD)	Biochemical Oxygen Demand (BOD)
7		Chemical Oxygen Demand (COD)	Chemical Oxygen Demand (COD)
8		Total Dissolved Solids (TDS)	Total Dissolved Solids (TDS)
9		Sodium	Sodium
10		Calcium	Calcium
11		Magnesium	Magnesium
12		Potassium	Potassium
13		Carbonate	Carbonate
14		Bicarbonate	Bicarbonate
15		Chloride	Chloride
16		Sulphate	Sulphate
17		Fluoride	Fluoride
18		Boron	Boron
19		Ammoniacal Nitrogen	Ammoniacal Nitrogen
20		Nitrate	Nitrate
21		Nitrite	Nitrite
22		Phosphate	Phosphate
23		Silicate	Silicate
24		Total Coliform	Total Coliform
25		Faecal Coliform	Faecal Coliform
26			Arsenic
27			Cadmium
28			Chromium
29			Copper
30			Iron
31			Lead
32			Nickel
33			Mercury
34			Zinc
35			Alpha Benzenehexachloride (BHC), Beta BHC, Gama BHC (Lindane)
36			OP-Dichlorodiphenyltrichloroethane (OP DDT), PP-DDT
37			Alpha Endosulphan, Beta Endosulphan
38			Aldrin, Dieldrin
39			Carbaryl (Carbamate)
40			Malathion, Methyl Parathion
41			Anilophos, Chloropyriphos

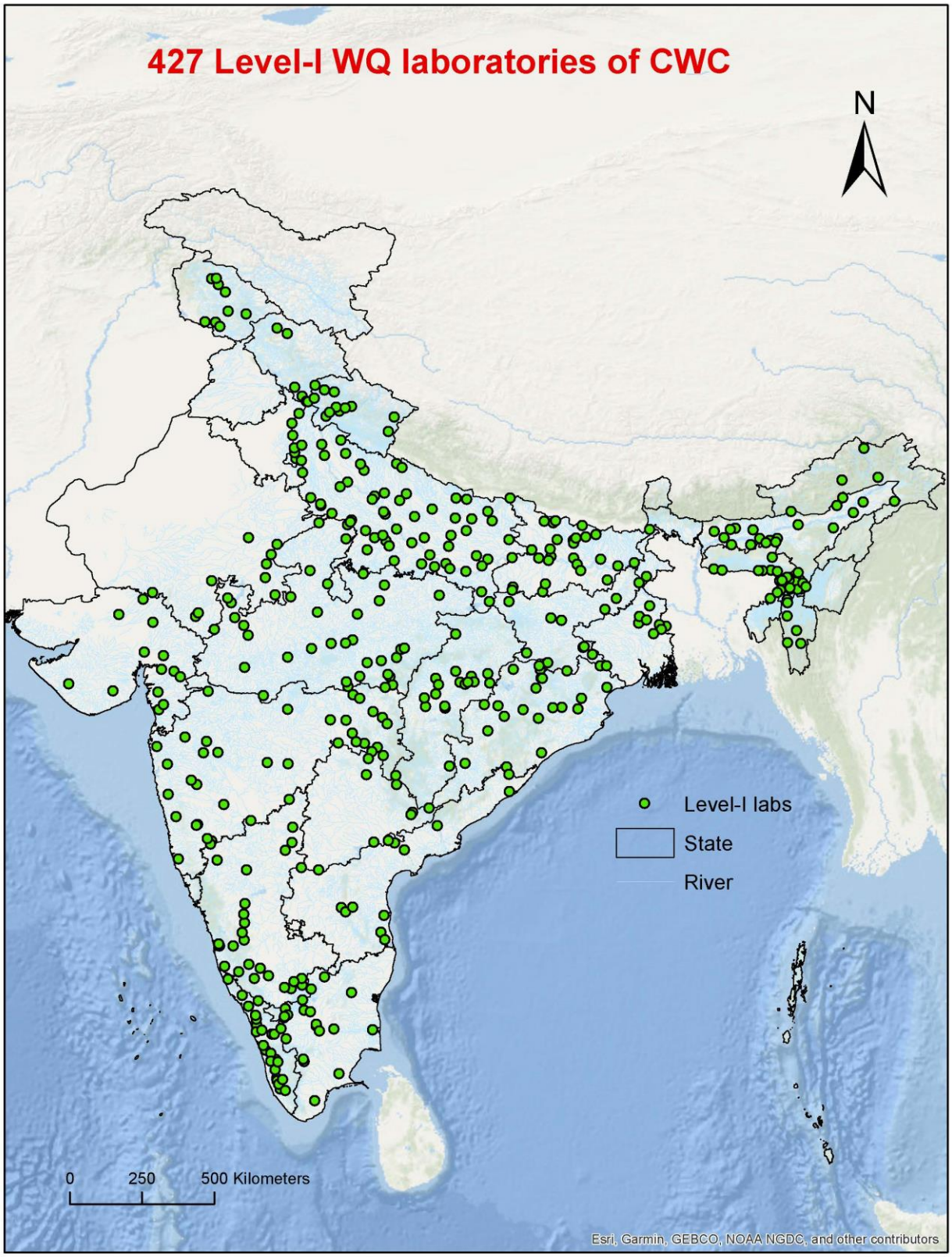


Figure 8: Level-I Water quality laboratories of CWC

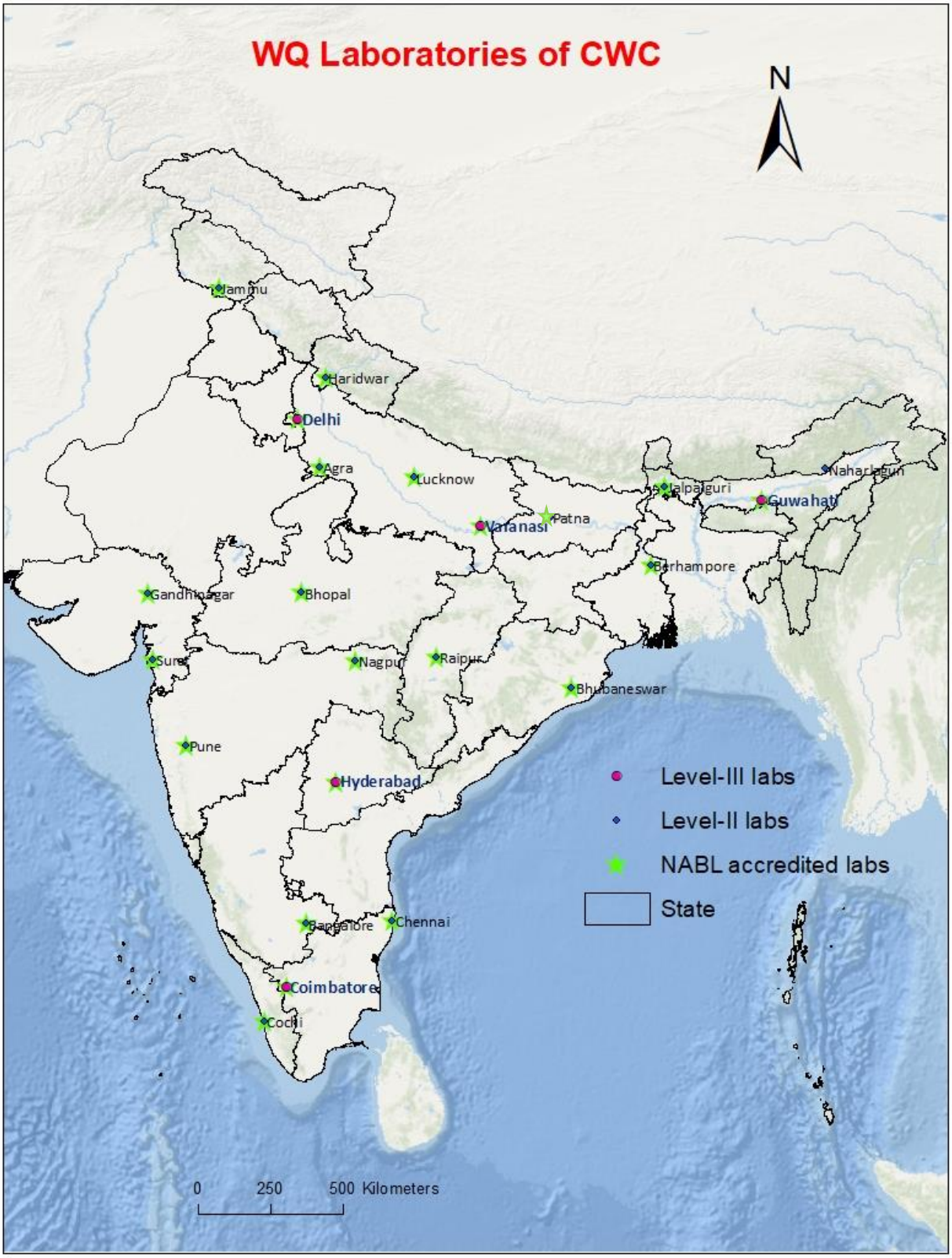


Figure 9: Level-II/III Water quality laboratories of CWC

CHAPTER – 6

6.1 River Water Quality Hot Spots in India

Monitoring of river water quality is the most essential aspect of restoring the water quality. One of the main objectives of monitoring of river water quality is to assess the suitability of river water for drinking purposes, irrigation, outdoor bathing and propagation of wildlife, fisheries. The physical and chemical qualities of river water are important in deciding its suitability as a source of drinking water after treatment/bathing etc. As such, the suitability of river water for potable uses with regard to its chemical quality has to be determined and defined on the basis of some vital characteristics of the water. River water quality is very important for aspect in India. The physico-chemical parameters such as pH, Electrical Conductivity (EC), Fluoride (F^-), Ammonia as N (NH_3-N), Nitrate as N (NO_3^--N), Chloride (Cl^-), Total Hardness (TH), Boron (B), Sodium Adsorption Ratio (SAR), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform (TC) and Faecal Coliform (FC) are important constituents defining the quality of river water in surface water. Therefore, presence of these parameters in river water beyond the value for permissible limit has been considered as river water quality hot spots. The best use classification is essential, for maintaining the quality of river water of the particular stretch. The study is based on average values of 13 parameters observed during Pre-monsoon (January to May), Monsoon (June to October) and Post-monsoon (November to December) seasons for the year 2021 and 2022 individually.

In this study identification of hot spots in Indian rivers wrt pH, Electrical Conductivity (EC), Ammonia as N (NH3-N), Boron (B), Sodium Adsorption Ratio (SAR), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Total Coliform (TC) parameters are done based on Class B, D & E of Designated best uses of water by Central Pollution Control Board (CPCB) (Table.4). In addition to the above parameters, hotspots identification in Indian Rivers w.r.t. Fluoride (F^-), Nitrate as N (NO_3^--N) , Chloride (Cl^-), Total Hardness (TH) parameters are done based on BIS (Bureau of Indian Standards) IS 10500: 2012(Table.5) for drinking water as a benchmark in absence of any standard for these parameters for drinking water.Faecal Coliform (FC) is based on the Primary Water Quality Criteria for Bathing Water mentioned in the Ministry of Environment, Forest and Climate Change (MoEFCC) Gazette Notification, 2000.

Study Area

A total of 776 water quality monitoring stations in year 2022 covering all the important rivers of country were studied for water quality hotspots in rivers of India. The details of these monitoring stations are shown in map in Figure 10.

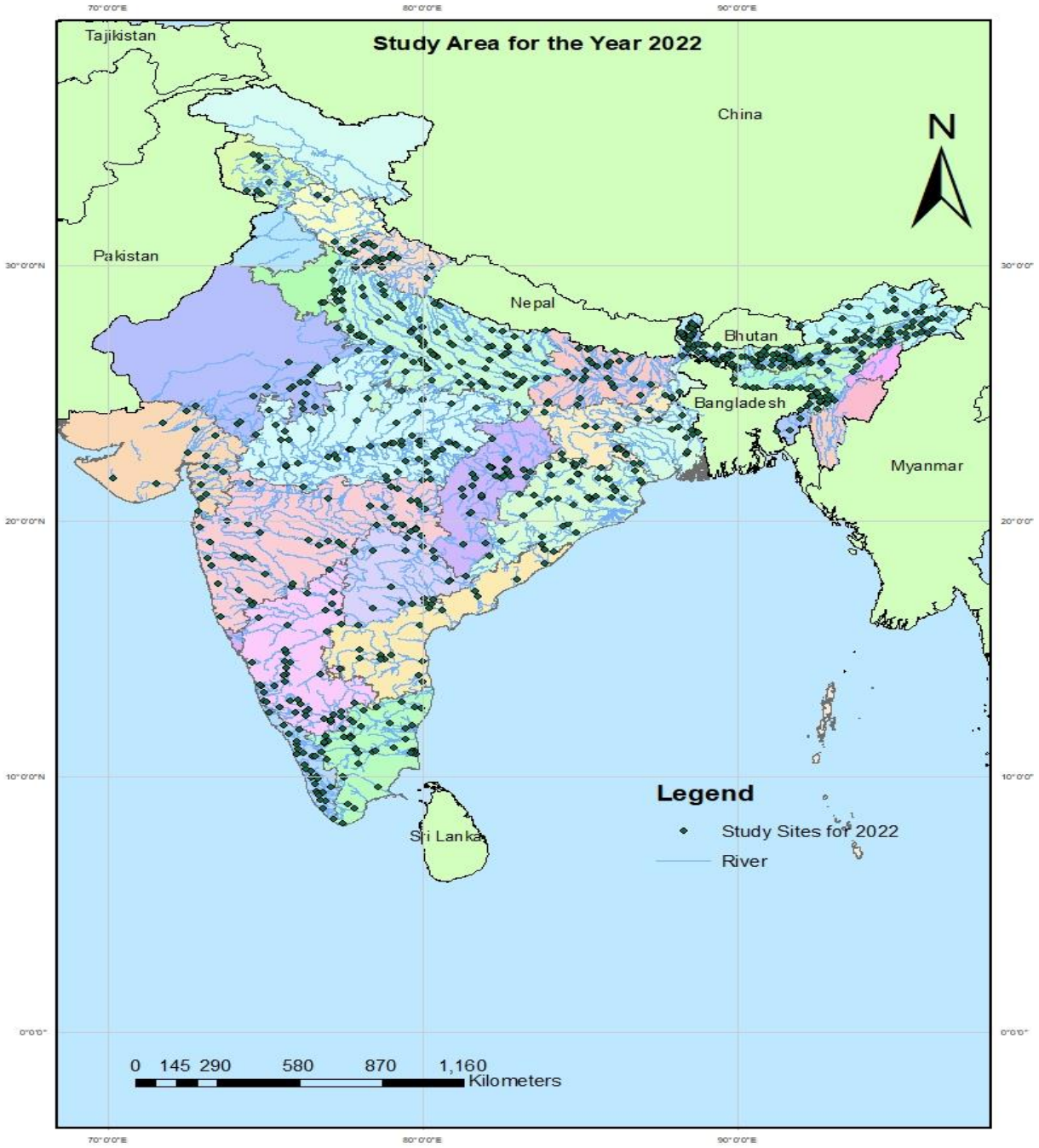


Fig 10: Study area of 776 Water Quality (WQ) Monitoring stations on important rivers of India in year 2022.

6.2 Water Quality Standard in India

Central Pollution Control Board (CPCB) has identified water quality requirements in terms of certain chemical characteristics, known as primary water quality criteria (Table 5). Based on this classification, natural water has been categorized as Class-A Drinking Water Source without conventional treatment but after disinfection; Class-B Outdoor bathing (Organized); Class-C Drinking water source after conventional treatment and disinfection; Class-D Propagation of Wild life and Fisheries; Class-E Irrigation, Industrial Cooling, Controlled Waste disposal. Further BIS vide document BIS 10500:2012 has recommended water quality standards for drinking water (Table 6).

Table 5: Designated Best Uses of Water by CPCB

Designated Best Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6 mg/L or more 4. Biochemical Oxygen Demand 5 days 20 °C, 2 mg/L or less
Outdoor bathing (Organised)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C, 3 mg/L or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 and 9 3. Dissolved Oxygen 4 mg/L or more 4. Biochemical Oxygen Demand 5 days 20 °C, 3mg/L or less
Propagation of Wild life and Fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4 mg/l or more 3. Free Ammonia (as N) 1.2 mg/L or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm, maximum 2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2 mg/L
	Below -E	Not meeting any of the A, B, C, D & E criteria

Table 6: Drinking Water Quality Standards, BIS: 10500, 2012

S. No.	Characteristic	Requirement (Acceptable Limit)	Permissible limit in the absence of Alternate source
Essential Characteristics			
1	Colour, Hazen units, Max	5	15
2	Odour	Agreeable	Agreeable
3	Taste	Agreeable	Agreeable
4	Turbidity NTU, Max	1	5
5	pH Value	6.5 -8.5	No relaxation
6	Total Hardness (as $CaCO_3$) mg/L, Max.	200	600
7	Iron (as Fe), mg/L, Max	1.0	No relaxation
8	Chlorides (as Cl), mg/L, Max	250	1000
9	Residual free chlorine, mg/L, Minimum	0.2	1.0
Desirable Characteristics			
10	Total Dissolved solids, mg/L, Max	500	2000
11	Calcium (as Ca) mg/L, Max.	75	200
12	Magnesium (as Mg) mg/L, Max	30	100
13	Copper (as Cu), mg/L, Max	0.05	1.5
14	Manganese (as Mn) mg/L, Max	0.1	0.3
15	Sulphates (as SO_4), mg/L, Max	200	400
16	Nitrate (as NO_3) mg/L, Max.	45	No relaxation
17	Fluorides (as F), mg/L, Max	1.0	1.5
18	Ammonia (as total ammonia-N) mg/L	0.5	No relaxation
19	Mercury (as Hg), mg/L, Max	0.001	No relaxation
20	Cadmium (as Cd), mg/L, Max	0.003	No relaxation
21	Selenium (as Se), mg/L, Max	0.01	No relaxation
22	Total Arsenic (as As), mg/L, Max	0.01	No relaxation
23	Cyanides (as CN), mg/L, Max	0.05	No relaxation
24	Lead (as Pb), mg/L, Max	0.01	No relaxation
25	Zinc (as Zn), mg/L, Max	5	15
26	Anionic detergents (as MBAS), mg/L, Max	0.2	1
27	Total Chromium (as Cr), mg/L, Max	0.05	No relaxation
28	Polynuclear aromatic hydrocarbons (as PAH), mg/L, Max	-	-
29	Mineral oil, mg/L, Max	0.5	No relaxation
30	Pesticides mg/L, Max	Absent	0.001
33	Alkalinity mg/L, Max	200	600
34	Aluminum (as Al) mg/L, Max	0.03	0.2
35	Boron mg/L, Max	0.5	1.0

MINISTRY OF ENVIRONMENT AND FORESTS NOTIFICATION

New Delhi, the 25th September, 2000

Primary Water Quality Criteria for Bathing Waters:

In a water body or its part, water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose. Among the various types of uses there is one use that demands highest level of water quality or purity and that is termed as "Designated Best Use" in that stretch of water body. Based on this, water quality requirements have been specified for different uses in terms of primary water quality criteria. The primary water quality criteria for bathing water are specified along with the rationale.

Table 7: PRIMARY WATER QUALITY CRITERIA FOR BATHING WATER

(Water used for organised outdoor bathing)

CRITERIA		RATIONALE
1.Faecal Coliform MPN/100 ml	500 (desirable) 2500 (Maximum Permissible)	To ensure low sewage contamination. Faecal coliform and faecal streptococci are considered as they reflect the bacterial pathogenicity. The desirable and permissible limits are suggested to allow for fluctuation in environmental conditions such as seasonal change, changes in flow conditions etc.
2. Faecal Streptococci MPN/100 ml	100 (desirable) 500 (Maximum Permissible)	
2. pH	Between 6.5 -8.5	The range provides protection to the skin and delicate organs like eyes, nose, ears etc. which are directly exposed during outdoor bathing.
3. Dissolved Oxygen	5 mg/1 or more	The minimum dissolved oxygen concentration of 5 mg/1 ensures reasonable freedom from oxygen consuming organic pollution immediately upstream which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediment.
4. Biochemical Oxygen demand 3 day,27°C	3 mg/1 or less	The Biochemical Oxygen Demand of 3 mg/1 or less of the water ensures reasonable freedom from oxygen demanding pollutants and prevent production of obnoxious gases.

6.3 Water Quality Parameters

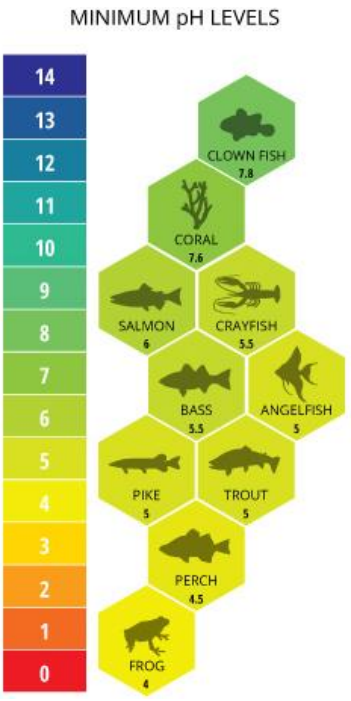
6.3.1 pH

The term pH stands for the "power of hydrogen", and it is a measure of the acidity or alkalinity of a solution. The numerical value of pH is determined by the molar concentration of hydrogen ions (H+) present in the solution. The pH scale ranges from 1 to 14, where water with a pH of 7 is considered neutral, pH values below 7 are acidic, and pH values above 7 are considered basic or alkaline (Langland & Cronin, 2003). pH value done by taking the negative logarithm of the H+ concentration (-log(H+)).

$$pH = - \log_{10}[H^+] \text{ or } \log[1/H^+]$$

pH in water can be influenced by various factors, both natural and man-made. Natural changes in pH occur due to interactions with surrounding rock, particularly carbonate forms, and other materials. Precipitation, especially acid rain, and discharges from wastewater or mining operations can also cause fluctuations in pH levels. Additionally, the concentration of carbon dioxide (CO2) in water can influence pH levels (Hickin, 1995).

The pH of water is important because it affects the health of aquatic organisms and the solubility and toxicity of chemicals and heavy metals in the water. Most aquatic creatures prefer a pH range of 6.5-9.0, though some can live in water with pH levels outside of this range. If the pH of water is too high or too low, the aquatic organisms living within it will die (EPA, 2012).



Humans can tolerate a wider range of pH levels than aquatic organisms, but there are still concerns. pH values greater than 11 can cause skin and eye irritations, as does a pH below 4. A pH value below 2.5 will cause irreversible damage to skin and organ linings. Lower pH levels increase the risk of mobilized toxic metals that can be absorbed, even by humans, and levels above 8.0 cannot be effectively disinfected with chlorine, causing other indirect risks. In addition, pH levels outside of 6.5-9.5 can damage and corrode pipes and other systems, further increasing heavy metal toxicity (Fink, 2005). Therefore, it is important to maintain the pH levels of water within the recommended range of 6.5-8.5, as per CPCB's designated best uses of water (Class A and B).

6.3.2 Electrical Conductivity (EC)

Conductivity is a measure of water's ability to conduct an electrical flow, and it is directly related to the concentration of ions present in the water (Wetzel, 2001). These ions come from dissolved salts and inorganic materials like alkalis, chlorides, sulfides, and

carbonate compounds. The more ions present in the water, the higher its conductivity (Langland & Cronin, 2003). Conversely, the fewer ions in the water, the lower its conductivity. Compounds that dissolve into ions are known as electrolytes (Palermo, 2008).

Salinity and conductivity have a strong correlation, and conductivity is used in algorithms to estimate salinity and TDS, both of which affect water quality and aquatic life. Salinity is specifically important because it affects dissolved oxygen solubility. The higher the salinity level, the lower the dissolved oxygen concentration (DWFS,2014). Temperature affects conductivity by increasing ionic mobility and the solubility of salts and minerals. This can be seen in diurnal variations as a body of water warms up due to sunlight, and conductivity increases, and then cools down at night, decreasing conductivity NSIDC. (2014).

Heavy rainfall or other severe weather events can contribute to flooding, and the effect on conductivity depends on the water body and surrounding soil. In areas with dry and wet seasons, conductivity usually drops overall during the wet season due to the dilution of the water source though the overall conductivity is lower for the season, there are often conductivity spikes as water initially enters a floodplain. If a floodplain contains nutrient-rich or mineralized soil, previously dry salt ions can enter solution as it is flooded, raising the conductivity of water (Sallenave, 2011). A sudden increase or decrease in conductivity in a body of water can indicate pollution. Agricultural runoff or a sewage leak will increase conductivity due to the additional chloride, phosphate, and nitrate ions. In both cases, the additional dissolved solids will have a negative impact on water quality (ESCT, 2013).

Most aquatic species have adapted to specific salinity levels, and salinity values outside of a normal range can result in fish kills due to changes in dissolved oxygen concentrations, osmosis regulation, and TDS toxicity (McManus & Woodson, 2012; Beskenis, 2006; Guiry, 2014).

6.3.3 Dissolved Oxygen

The amount of gaseous oxygen dissolved in water is known as dissolved oxygen, which enters the river water through diffusion from the atmosphere and as a by-product of aquatic plants' photosynthesis (Wetzel, 2001). The presence of dissolved oxygen in the aquatic habitat is crucial for the survival of organisms living in water bodies, including fish and invertebrates. Animals require oxygen to survive, and fish, for instance, can't survive for long in water with less than 5 mg/L of dissolved oxygen (EPA, 2014). Most aquatic plants, fish and zooplankton need oxygen in water in order to breathe. Good oxygen levels are critical for the health of a river system. Slow flowing, polluted river water is often associated with low oxygen conditions, which cannot support much life.

The low level of dissolved oxygen in water indicates contamination and is an important factor in determining water quality, pollution control, and treatment processes. The level of dissolved oxygen in natural and wastewater depends on the physical, chemical, and biochemical activities occurring in water bodies. Oxygen is considered poorly soluble in

water, and its solubility is related to temperature and pressure. The introduction of organic waste, especially domestic and animal sewage, industrial waste from paper mills, leather manufacturing, slaughterhouse sewage, and crop wastewater, significantly reduces the DO in river water. The wastes from these industries cause oxygen demand, and they're broken down and decomposed by bacteria into oxygen. Most oxygen-demanding waste is organic.

Low oxygen in water can be fatal to fish and other organisms living in water. A minimum of about 4 mg/L of DO is required for the survival of living organisms in water. Oxygen-depleting substances reduce the available DO. During the summer months, the rate of biological oxidation is significantly increased, yet the DO concentration is at its minimum due to higher temperatures. The DO concentration, temperature, and photosynthesis rate are interdependent and vary diurnally. The decrease in the DO concentration during nights due to the inhibition of photosynthetic activity and the increase in DO concentration due to active photosynthesis of microalgae during the daytime have been observed (Saba et al., 2017).

6.3.4 Biochemical oxygen Demand

Biochemical Oxygen Demand (BOD) is a crucial parameter that quantifies the amount of dissolved oxygen required by aerobic biological organisms to break down organic materials within a river water sample (Armiento, 2016). Diverse sources contribute to BOD, encompassing municipal and industrial wastewater discharges, agricultural runoff, and leachate from landfills. Within rivers, oxygen consumption arises from a combination of aquatic animal respiration, decomposition processes, and various chemical reactions. Wastewater discharged from sewage treatment plants often contains organic substances, which are decomposed by microorganisms, consuming oxygen in the process. Additionally, stormwater runoff from farmland or urban streets, feedlots, and malfunctioning septic systems can introduce oxygen-consuming wastewater.

Several factors influence BOD, including the type and quantity of organic material present, temperature, pH, dissolved oxygen concentration, and the presence of bacteria.

CPCB has recommended a concentration of 3.0 mg/l of biochemical oxygen demand for outdoor bathing. Water having above 3.0 mg/l BOD concentration is not suitable for outdoor bathing. In pristine conditions, rivers generally exhibit a 5-day carbonaceous BOD below 1 mg/L. In moderately polluted scenarios, BOD values fall within the range of 2 to 8 mg/L. Rivers cross the threshold into severe pollution when BOD values exceed 8 mg/L (Grover and Wats, 2013).

The impact of high BOD on the aquatic ecosystem is significant because it can lead to the death of aquatic life. The high levels of BOD can deplete the dissolved oxygen levels in the water, which can cause fish and other aquatic life to suffocate. Additionally, the high levels of BOD can cause the water to become cloudy and murky, making it difficult for aquatic life to thrive.

6.3.5 Total Hardness

The definition of water hardness is based on the measured content of divalent metal cations, with dissolved calcium (Ca++) and magnesium (Mg++) being the two primary divalent cations found in most waters. In natural water sources, calcium and magnesium are typically bound to bicarbonate, sulfate or chloride. The main sources of water hardness are sedimentary rocks, seepage and runoff from soils. Generally, hard waters originate from areas with thick topsoil and limestone formations, with groundwater tending to be harder than surface water. The two main industrial sources of water hardness are the inorganic chemical and mining industries. (Sawyer & McCarty, 1967; Biesecker & George, 1972).

To classify water hardness, general guidelines are as follows: 0 to 60 mg/L as $CaCO_3$ is considered soft water; 61 to 120 mg/L as moderately hard water; 120 to 180 mg/L as hard water; and more than 180 mg/L as very hard water.

The hardness of water is harmful to the boilers and hot water pipes as the deposition of salts occur, which can reduce their efficiency. The hard water is not good for washing as it is difficult for hard water to form lather with soap (Ramya et al 2015). The World Health Organisation states that hard water has no known adverse health effects (Akram, 2018). There are no serious health effects associated with drinking hard water. However solid water acts as a dietary supplement as it contains calcium and magnesium that strengthens bones and teeth (Sengupta, 2013). Hard water contains high concentration of dissolved minerals therefore millions of people think that these dissolved minerals have positive effects on the health of its drinkers ((Sawyer & McCarty, 1967; Biesecker & George, 1972).

6.3.6 Nitrate

Nitrate is a compound that can be found in the environment naturally and synthetically under various conditions. The amount of nitrogen present or both nitrogen and oxygen are used to measure nitrate in drinking water, which is the principal form of combined nitrogen that is present in natural waters. It serves as a nutrient that stimulates plant growth. However, excessive amounts of nitrogen may lead to the proliferation of macrophytes or phytoplankton. Nitrates can be contributed to freshwater through the discharge of sewage and industrial waste, as well as run-off from agricultural fields. Nitrate is the final product of the oxidation of ammonia. Effluents such as sewage contain high levels of ammonia, which can increase nitrate concentrations in receiving waters. High levels of nitrate in river waters may indicate pollution, even though this form of nitrogen can be used as a source of nutrients for plants and encourage plant proliferation (Hamzaraj et al., 2014).

The standard for nitrate in drinking water is 10 mg/L nitrate as N or 45 mg/L nitrate-NO_3. Nitrate in drinking water can cause Methemoglobinemia or blue baby syndrome, which is a significant health problem associated with nitrate.

6.3.7 Fluoride

Fluoride is a natural element that is commonly found in water sources, soil, and various foods. It is the 13th most abundant element, commonly occurring in the minerals fluorspar (CaF_2), cryolite (Na_3AlF_6) and fluorapatite ($3Ca_3(PO_4)_2$ $Ca(F,Cl)_2$) while industrial wastes, use of extensive fertilizers and brick kilns are examples of the anthropogenic sources (Cotton & Wilkinson, 1988; Mackay & Mackay, 1989).

Fluoride is beneficial for dental health because it helps strengthen tooth enamel and makes teeth more resistant to acid attacks from bacteria and sugars. However, excessive fluoride intake can lead to health issues (CPHA, 1979). The maximum permissible limit of Fluoride as per IS 10500-2012 for drinking water is 1.5 mg/L. Excessive exposure to fluoride during tooth development, especially in childhood, can lead to a cosmetic issue known as dental fluorosis. This condition results in changes in tooth enamel color and, in more severe cases, pitting or mottling of the teeth. Prolonged exposure to very high levels of fluoride, usually through drinking water with concentrations well above recommended levels, can lead to skeletal fluorosis. This condition affects the bones and joints and can cause pain and limited mobility (Hussain et al., 2010).

6.3.8 Chloride

Chloride (Cl^-) ion is a major inorganic anion found in water and wastewater, occurring naturally in all types of water. It is widely distributed in nature, mainly as the sodium (NaCl) and potassium (KCl) salts, and constitutes about 0.05% of the lithosphere (NRCC, 1977). The greatest amount of chloride found in the environment is in the oceans. The salty taste produced by chloride concentrations is variable and dependent on the chemical composition of water. The presence of chloride in river water can be attributed to various sources, such as the dissolution of salts in soil, discharge of effluents from chemical industries, sewage discharge, contamination from refuse leachates, and sea water intrusion in coastal areas. Each of these sources leads to local contamination of river water. Chloride concentration serves as an indicator of sewage pollution in fresh water regions, with the discharge of domestic sewage being the most significant source of chlorides in the waters.

Chloride is an essential element and the main extracellular anion in the body. It is a highly mobile ion involved in maintaining proper osmotic pressure, water balance, and acid–base balance. Small amounts of chlorides are required for normal cell functions in plant and animal life. Fish and aquatic communities cannot survive in high levels of chlorides. The World Health Organization (WHO), Bureau of Indian Standard, and other regulatory bodies provide guidelines for safe levels of chloride in drinking water, typically below 250 milligrams per liter (mg/L) (WHO, 1979).

High chloride concentrations in water can affect the aesthetic quality of the water, imparting a salty taste. While this doesn't pose a direct health risk, it can lead to consumer dissatisfaction with the water's taste and smell. Individuals with certain health conditions, such as hypertension (high blood pressure) or cardiovascular diseases, may

need to monitor their salt intake, including chloride. High chloride levels in water can contribute to increased sodium intake. Excessive chloride in water can have negative effects on aquatic ecosystems, particularly in freshwater environments, and can harm aquatic life, including fish and other organisms sensitive to changes in water quality (CNHW, 1983).

6.3.9 Boron

Boron is an element that naturally occurs in the earth's crust and can be found in fruits, vegetables, and some water sources. People encounter boron through food, water, and consumer products containing this element. Boron tends to bind to oxygen, forming a group of compounds known as borates (e.g., borax and boric acid). Once released into the environment, boron does not break down. It enters the environment through both natural processes, such as weathering of soils and rocks, and human-made activities, including manufacturing plants that utilize boron, such as glass manufacturing and coal-burning power plants.

Boron is essential for the normal growth of all plants, but the required amount is relatively low. If boron exceeds a specific tolerance level, depending on the crop, it may lead to injury. The range between boron deficiency and toxicity for many crops is narrow. To sustain an adequate supply of boron, at least 0.02 ppm of boron in irrigation water may be necessary, while to avoid toxicity, boron levels in irrigation water should ideally be lower than 0.3 ppm. Higher boron concentrations may require an evaluation of the intended crop's boron tolerance. Although boron toxicity is not a widespread issue, it can be a crucial parameter for assessing irrigation water quality. Interestingly, plants grown in soils high in lime may tolerate higher boron levels than those grown in non-calcareous soils.

Boron is weakly adsorbed by soils, meaning its actual root-zone concentration may not vary directly with the degree of boron concentration in the irrigation water during plant growth. Symptoms of boron injury may include characteristic leaf 'burning,' chlorosis, and necrosis, although some boron-sensitive species may not exhibit obvious symptoms. Boron toxicity symptoms typically appear on older leaves as yellowing, spotting, or drying of leaf tissues at the tips and edges. This drying and chlorosis often progress toward the center of the leaf, between the veins, as boron accumulates over time (Ayers and Westcot, 1985).

6.3.10 Free Ammonia

Ammonia is a commonly found pollutant in aquatic environments around the world (CEPA, 1999; Camargo & Alonso, 2006). Ammonia occurs naturally in water bodies, arising from the microbiological decomposition of nitrogenous compounds in organic matter. Fish and other aquatic organisms also excrete ammonia. Ammonia may also be discharged directly into water bodies by some industrial processes or as a component of domestic sewage or animal slurry. Ammonia can also arise in waters from the decay of discharged organic waste. Natural (unpolluted) waters contain relatively small amounts of ammonia, usually < 0.02mg/L as N. The presence of ammonia in freshwater has

been associated with the acidification of rivers and lakes, eutrophication, and direct toxicity to aquatic organisms (CEPA, 1999; Camargo & Alonso, 2006; Baker et al., 1991). Ammonia exists in aqueous solutions in two forms, ionized (NH_4^+) and unionized (NH_3) and the unionized fraction is toxic to freshwater fish at very low concentration. The relative proportions of ionized and unionized ammonia in water depend on temperature and pH and to a lesser extent on salinity. The concentration of unionized ammonia becomes greater with increasing temperatures and pH and with decreasing salinity.

The toxicity of this compound on aquatic organisms will depend on the chemical form of ammonia, pH, and temperature. Furthermore, it will depend on the time of exposure (Francis-Floyd, 2009). This compound damages the gills, liver, kidney, spleen and other organ tissues of fish, therefore causing breathing difficulties (Benli et al., 2008; Schram et al., 2010). This may lead to physiological alterations and, eventually, exhaustion or death (Schram et al., 2010). Ammonia can cause cell damage and can also affect the antioxidant defence system, thus altering the levels of oxidative stress in fish (EPA, 2013; Sinha et al., 2014). Ammonia can also alter fish behaviour. Fish exposure to sub-lethal concentrations of ammonia can reduce swimming activity (Wicks et al., 2002), foraging behaviour (Tudorache, 2008), and the ability to flee from predators (Tudorache, 2008; McKenzie, 2009).

6.3.11 Sodium Absorption Ratio (S.A.R.)

The sodium adsorption ratio (SAR) is a crucial parameter for managing soil quality in agriculture. It determines the suitability of irrigation water by analyzing the concentrations of different cations, including the primary alkaline and earth alkaline cations in the water. The SAR indicates the relative proportion of sodium to other cations in the water, which affects the soil structure's potential for degradation. If the soil contains excessive sodium, it can lead to sodicity, causing soil structure degradation and higher erosion rates. The SAR value is significant as it predicts the potential for sodium accumulation in the soil. Higher SAR values indicate a higher risk of soil problems due to sodium accumulation, such as decreased permeability and soil structure degradation. Sodic soils, resulting from excessive sodium, can also lead to poor water infiltration, drainage problems, and decreased crop yields (Laxmi et al., 2022).

6.3.12 Total Coliforms (TC) and Faecal Coliforms (FC)

Coliforms are one of the most useful indicator organisms which are easily detectable. Total Coliforms represent a group of 16 species of bacteria that are found in soil, vegetation, animal wastes and human sewage. Their presence gives an idea about the pollution level of the water bodies. Coliforms are called indicators because their presence give an indication of the possibility of presence of other microorganisms including harmful pathogens. Faecal coliforms represents a sub category of TC with 6 species including the harmful E.Coli bacteria. These are determined by the Most Probable Number (MPN) method. MPN method is a statistical, multi-step assay consisting of presumptive, confirmed and completed phases.

CHAPTER – 7

7.1 Result and Discussion

7.1.1 pH

The pH value is expressed as the ratio of $[H^+]$ to $[OH^-]$ (hydroxide ion concentration). Hence, if the $[H^+]$ is greater than $[OH^-]$, the solution is acidic. Conversely, if the $[OH^-]$ is greater than the $[H^+]$, the solution is basic. At 7 pH, the ratio of $[H^+]$ to $[OH^-]$ is equal and, therefore, the solution is neutral. As shown in the equation below, pH is a logarithmic function. A change of one pH unit represents a 10-fold change in concentration of hydrogen ion. In a neutral solution, the $[H^+] = 1 \times 10^{-7}$ mol/L. This represents a pH of 7. BIS (Bureau of Indian Standard) has recommended a desirable limit of 6.5 – 8.5 of pH in drinking water. The limit prescribed by CPCB for class-A; Drinking water source without conventional treatment but after disinfections, class B: Outdoor bathing Organized, class D: Propagation of wild life and fisheries all are defined from 6.5 to 8.5.

The pH levels of water samples collected from various monitoring stations across different rivers in India were analyzed during pre-monsoon, monsoon, and post-monsoon seasons. The data were compared with the Bureau of Indian Standard (BIS) recommended desirable limit of 6.5 – 8.5 for pH in drinking water.

Acidic

During the pre-monsoon period, 2 water quality monitoring stations like Kharkhana (Myntdu) and Ranikor (Kynshi) recorded pH values ranging from 4.12 to 5.77, indicative of acidic conditions. This variation suggests localized influences on pH levels, possibly linked to specific geographical or anthropogenic factors in those regions. In the monsoon season, 1 monitoring station experienced acidic pH conditions-Kharkhana (Myntdu) with pH 5.03. The persistence of acidic conditions during the monsoon season could be attributed to increased organic matter influx, runoff from terrestrial sources, or other climatic factors influencing the water chemistry. Post-monsoon observations revealed pH 4.24 at 1 monitoring station Kharkhana (Myntdu). This continued variability underscores the dynamic nature of water quality, with pH levels responding to ongoing environmental changes even after the monsoon period.

Alkaline

During the premonsoon, 11 water quality monitoring stations consistently recorded alkaline conditions with pH values ranging from 8.54 to 8.80. These monitoring stations maintained alkaline pH levels, indicative of factors such as geological influences, mineral dissolution, or anthropogenic activities contributing to elevated pH. Notably, 4 monitoring stations retained their alkaline pH values (8.51 to 8.75) during the monsoon season, suggesting a certain degree of stability in alkalinity despite potential dilution effects from increased precipitation. This resilience in alkaline conditions could be

associated with buffering capacities, geological characteristics, or the nature of surrounding land use. During the post-monsoon season, 8 monitoring stations continued to exhibit alkaline conditions (pH 8.53 to 8.82), indicating the persistence of elevated pH levels even after the monsoon period. The stability of alkaline conditions in these locations suggests a sustained influence of geological and environmental factors contributing to elevated pH levels.

The highest number of water quality monitoring stations exceeding the acceptable pH limit was 13 during the pre-monsoon season, followed by 5 monitoring stations during the monsoon season and 9 monitoring stations during the post-monsoon period.

Comparision between 2021 & 2022:

In both 2021 and 2022, a noteworthy pattern emerged in the pH data across different seasons. In 2021, the pre-monsoon season exhibited the highest number of water quality monitoring stations exceeding the acceptable pH limit, with 15 monitoring stations, followed by 5 monitoring stations during the monsoon season and 4 monitoring stations during the post-monsoon period. This trend persisted in 2022, where the pre-monsoon season again recorded the highest number, with 13 monitoring stations surpassing the acceptable pH limit, followed by 5 monitoring stations during the monsoon season and 9 monitoring stations during the post-monsoon period. The recurring prominence of elevated pH levels during the pre-monsoon season suggests a commonality in the environmental factors influencing water quality during this period in both years. The lean season characteristics, such as lower water flow and reduced dilution capacity, may contribute to the accumulation of pollutants and substances affecting pH.

In both 2021 and 2022, 3 water quality monitoring stations Elunuthi Mangalam (Noyyal), Kamalapuram (Papagani) and Kharkhana (Myntdu recorded pH levels exceeding acceptable limits in rivers located in Tamil Nadu, Andhra Pradesh and Meghalaya.

The hot spot study and GIS map for pH parameter are given below in Table 8 and figure 11.

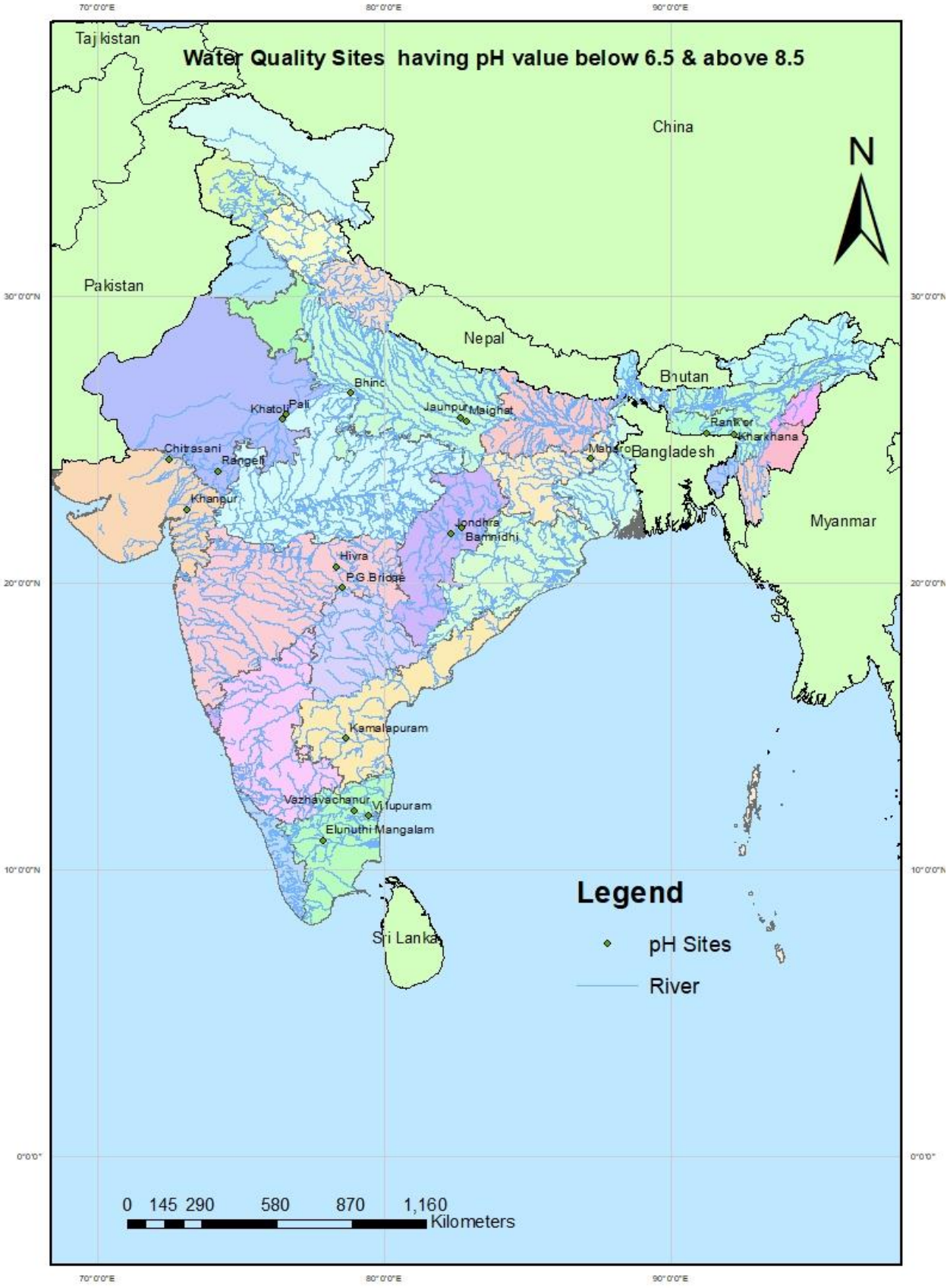
Table 08: Monitoring stations having pH value above 8.5 & below 6.5 in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post-M
1	Bamnidhi	Hasdeo	MD, Burla	Chhattisgarh	Janjgir-Champa	-	-	8.68
2	Bhind	Kunwari	LYD, Agra	M.P.	Bhind	8.64	-	-
3	Chitrasani	Balaram	MD, Gandhinagar	Gujarat	Banaskantha	*	-	8.57
4	Elunuthi Mangalam	Noyyal	SRD, Coimbatore	Tamil Nadu	Erode	8.54	8.51	-
5	Hivra	Wardha	WD, Nagpur	Maharashtra	Wardha	8.55	-	-
6	Jaunpur	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	8.57	-	-
7	Jondhra	Seonath	MD, Burla	Chhattisgarh	Bilaspur	8.80	-	-
8	Kamalapuram	Papagani	HD, Chennai	A.P.	Kadapa	8.66	8.75	8.68
9	Khanpur	Mahi	MD, Gandhinagar	Gujarat	Anand	-	-	8.70
10	Kharkhana	Myntdu	MID, Shillong	Meghalaya	West Jaintia Hills	4.12	5.03	4.24
11	Khatoli	Parwati	CD, Jaipur	Rajasthan	Kota	8.55	-	-
12	Maharo	Mayurakshi	Damodar Division, Asansol	Jharkhand	Dumka	-	-	8.82
13	Maighat	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	8.62	-	-
14	P.G. Bridge	Penganga	WD, Nagpur	Maharashtra	Yavatmal	8.57	-	-
15	Pali	Chambal	CD, Jaipur	Rajasthan	Sawaimadhopur	8.69	-	8.53
16	Rangeli	Som	MD, Gandhinagar	Rajasthan	Dungarpur	-	-	8.62
17	Ranikor	Kynshi	MID, Shillong	Meghalaya	SW Khasi Hills	5.77	*	*
18	Vazhavachanur	Ponnaiyar	HD, Chennai	Tamil Nadu	Thiruvannamalai	-	8.60	-
19	Villupuram	Ponnaiyar	HD, Chennai	Tamil Nadu	Villupuram	8.70	8.70	8.66

(-) means No Hotspot.

(*) means river dry/data not available.

Figure: 11 Water Quality Monitoring stations having pH value below 6.5 & above 8.5 (2022)



7.1.2 Electrical Conductivity (EC)

Conductivity (specific conductance) of an electrolytic solution is a measure of its ability to conduct electricity. The SI unit of conductivity is siemens per meter (S/m). In many cases, conductivity is linked directly to the total dissolved solids (T.D.S.). High quality deionized water has a conductivity of about 5.5 µS/m, typical drinking water in the range of 5-50 mS/m, while sea water about 5 S/m (i.e., sea water's conductivity is one million times higher than that of deionized water). Resistance, R, is proportional to the distance, l, between the electrodes and is inversely proportional to the cross-sectional area. Writing ρ (rho) for the specific resistance (or resistivity) and the specific conductance, κ (kappa) is the reciprocal of the specific resistance.

The conductivity or conductance of a solution is the reciprocal of its resistance and is given of units of µmhos, mhos, or Siemens (all are reciprocal ohms). Resistivity as the inverse of conductivity is defined as the measure of the ability of a solution to resist an electric current flow. The conductivity measurement is directly affected by the number of dissolved ions in the solution and will increase as the quantity and mobility of ions increases. The higher the conductivity reading, the better ability the solution has to conduct electricity. Conversely, the lower the conductivity reading, the poorer ability the solution has to conduct electricity.

BIS has recommended a drinking water standard for total dissolved solids a limit of 500mg/l (corresponding to about EC of 750 µS/cm at 25^0C) that can be extended to a TDS of 2000mg/l (corresponding to about 3000 µS/cm at 25^0C) in case of no alternate source. Water having TDS more than 2000 mg/litre are not suitable for drinking uses. The limit prescribed by CPCB for conductivity as class-E Irrigation, Industrial Cooling, Controlled Waste disposal is less than 2250 µS/cm at 25^0C.

Seven (07) water quality monitoring stations exceeded the conductivity 2250 µS/cm, during the pre-monsoon, monsoon and post monsoon season. At the Elunuthi Mangalam WQ monitoring station at Noyyal River of Tamil Nadu, a slight decrease in EC from the pre-monsoon to monsoon season suggests a positive change in water quality. At water quality Monitoring station Luwara (Shetrunji River), Gujarat, substantial fluctuations in EC values across seasons observed, with the highest 5076 µS/cm during the pre-monsoon season due to the flushing of the sea water. At B.P.M. (Bamni) water quality monitoring station on Wardha River in Maharashtra state, significant increase in EC during the monsoon and post-monsoon seasons may be attributed to factors such as runoff from precipitation and changes in the river flow.

Comparision between 2021 & 2022:

In both 2021 and 2022, the assessment of electrical conductivity (EC) during different seasons highlighted consistent trends across water quality monitoring stations. There are 3 water quality monitoring stations common in the years 2021 and 2022, where the conductivity observed is above the acceptable limit. At Elunuthi Mangalam (Noyyal River), the slight decrease in conductivity from 2021 to 2022 suggests a potential improvement in water quality. In Luwara (Shetrunji River), minimal variation in

conductivity between the two years indicates a stable water quality situation. At Varanavasi (Maruthaiyar River), the substantial decrease in conductivity may indicate a positive shift in water quality from 2021 to 2022. Remaining monitoring stations, A.P. Puram (Chittar), B.P.M. (Bamni) (Wardha), Dhansa (Sahibi), and Kopergaon (Godavari) exceeded the acceptable limit only during 2022, while Durvesh (Vaitarna) and Wadakbal (Sina) exceeded the acceptable limit only during 2021.

During the pre-monsoon period in both years, an average electrical conductivity (EC) greater than 2250 µS/cm was observed at thre monitoring stations: Elunuthi Mangalam (Noyyal), Luwara (Shetrunji), and Varanavasi (Maruthaiyar), situated in Tamil Nadu and Gujarat. Similarly, in year 2021, Durvesh (Vaitarna) and Wadakbal (Sina), situated in Maharashtra and Vautha (Sabarmati) in Gujarat; and A.P. Puram (Chittar) in Tamil Nadu, as well as Kopergaon (Godavari) situated in Maharashtra in 2022, observed electrical conductivity greater than 2250 µS/cm.

Specifically, in the monsoon season of 2021, a single monitoring station in Tamil Nadu (Elunuthi Mangalam) exhibited elevated EC values, while in 2022, this pattern persisted with 4 monitoring stations in Gujarat (Luwara), Maharashtra (B.P.M. (Bamni), Delhi (Dhansa) and Tamil Nadu (Elunuthi Mangalam). Similarly, during the post-monsoon season of both years, an average EC greater than 2250 µS/cm was identified at 1 monitoring station in Gujarat (Luwara) in 2021 and 3 monitoring stations in Gujarat (Luwara), Maharashtra (B.P.M. (Bamni)) and Tamil Nadu (Varanavasi) in 2022.

The highest average conductivity was observed, at Durvesh on the Vaitarna River in the state of Maharashtra, is 16,435 µS/cm in 2021, and it is attributed to the backflushing of seawater. When seawater backflushes into a river, it raises the salinity levels of the river water.

The hot spot study and GIS map for EC parameter are given below in Table 9 and figure 12.

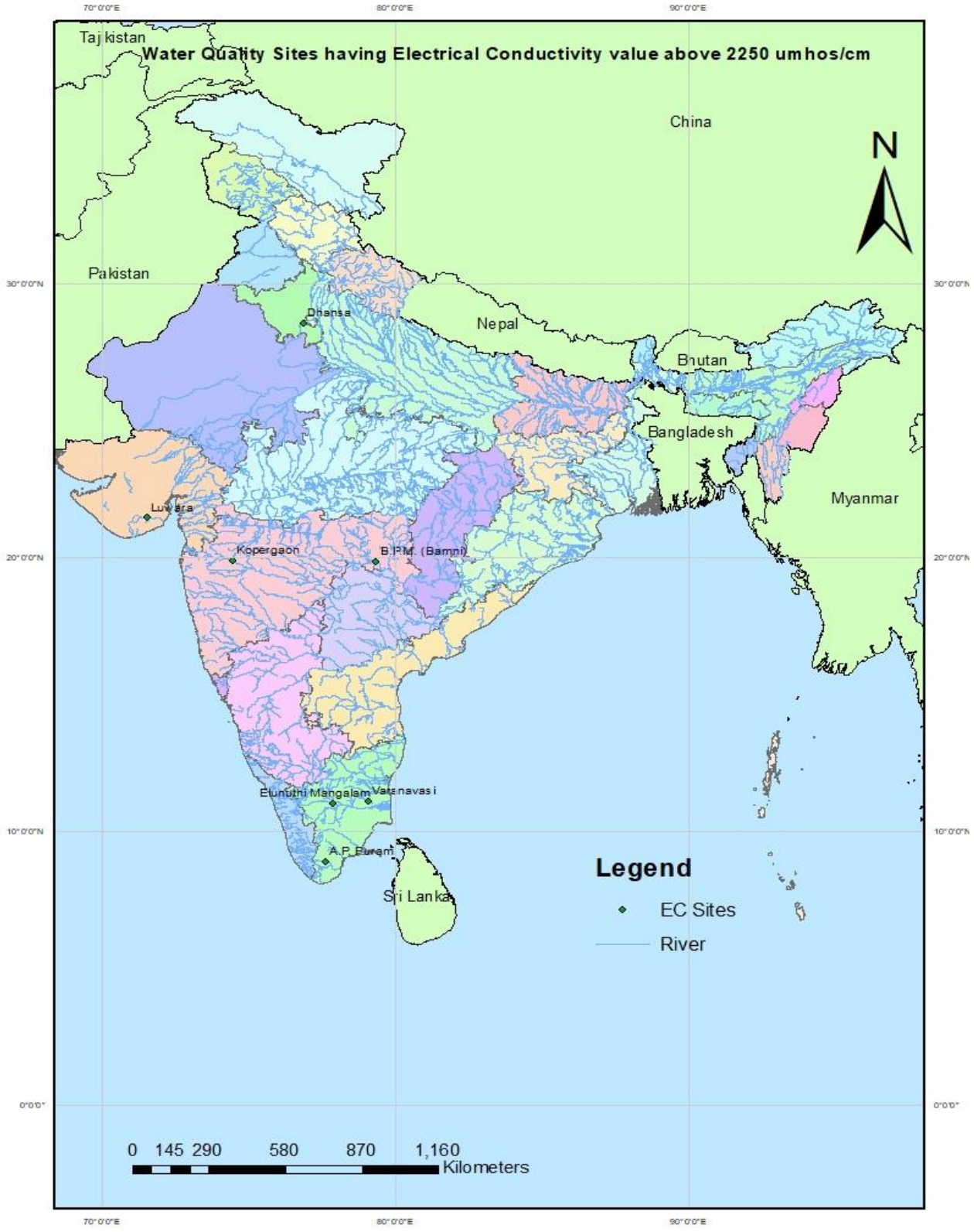
Table 09: Monitoring stations having Electrical Conductivity (EC) >2250 µS/cm in River Water 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	A.P. Puram	Chittar	SRD, Coimbatore	Tamil Nadu	Tirunelveli	2546	*	*
2	B.P.M. (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	*	3181	3898
3	Dhansa	Sahibi	UYD, New Delhi	Delhi	South West Delhi	*	2582	*
4	Elunuthi Mangalam	Noyyal	SRD, Coimbatore	Tamil Nadu	Erode	2407	2251	-
5	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	3584	-	-
6	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	5076	2288	4414
7	Varanavasi	Maruthaiyar	SRD, Coimbatore	Tamil Nadu	Ariyalur	2353	-	2318

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 12: Water Quality Monitoring stations having electrical Conductivity value greater than 2250µmhos/cm (2022)



7.1.3 Ammonia as N (NH_3-N)

Ammonia is a colour-less gas with a strong pungent odour. It is easily liquefied and solidified and is very soluble in water. One volume of water will dissolve 1,300 volumes of NH_3. Ammonia will react with water to form a weak base. Ammonia pungent gaseous compound of hydrogen and nitrogen that is highly soluble in water. It is a biologically active compound found in most waters as a normal biological degradation product of nitrogenous organic matter (protein). It also may find its way to ground and surface waters through discharge of industrial process wastes containing ammonia and fertilizers.

Ammonia is used in fertilizers either as the compound itself or as ammonium salts such as sulphate and nitrate. Large quantities of ammonia are used in the production of nitric acid, urea and nitrogen compounds. It is used in the production of ice and in refrigerating plants. "Household ammonia" is an aqueous solution of ammonia. It is used to remove carbonate from hard water. Since ammonia is a decomposition product from urea and protein, it is found in domestic wastewater. Aquatic life and fish also contribute to ammonia levels in a stream. Ammonia is the preferred nitrogen-containing nutrient for plant growth. Ammonia can be converted to nitrite (NO_2) and nitrate (NO_3) by bacteria, and then used by plants. Nitrate and ammonia are the most common forms of nitrogen in aquatic systems. Nitrate predominates in unpolluted waters. Nitrogen can be an important factor controlling algal growth when other nutrients, such as phosphate, are abundant. If phosphate is not abundant it may limit algal growth rather than nitrogen. Ammonia is excreted by animals and produced during decomposition of plants and animals, thus returning nitrogen to the aquatic system. Ammonia is also one of the most important pollutants because it is relatively common but can be toxic, causing lower reproduction and growth, or death. The neutral, unionized form (NH3) is highly toxic to fish and other aquatic life.

The primary agricultural sources include accidental releases of ammonia-rich fertilizer during transport (because of vehicle accident, faulty hose connections, and human error); and livestock waste. The limit prescribed by CPCB for Ammonia (as N) in class-D: Propagation of Wild life and Fisheries is 1.2 mg/l or less. The hot spot study and GIS map for ammonia parameter are given below in Table 8 and figure 11.

During the pre-monsoon season, 23 water quality monitoring stations in Delhi, Gujarat, Haryana, Jharkhand, Odisha, Tamil Nadu, and Uttar Pradesh reported average ammonia values exceeding 1.2 mg/l. Similarly, in the monsoon season, 26 monitoring stations in Delhi, Gujarat, Haryana, Jharkhand, Maharashtra, Odisha, Tamil Nadu, and Uttar Pradesh displayed elevated average ammonia values. The post-monsoon season maintained this trend, with 25 water quality monitoring stations in Delhi, Gujarat, Haryana, Maharashtra, Odisha, Tamil Nadu, and Uttar Pradesh showing persistently elevated average ammonia levels.

Comparision between 2021 & 2022:

In both 2021 and 2022, concerning water quality, alarming trends of ammonia were observed across various rivers. In 2021, 21 monitoring monitoring stations situated along 7 rivers, including Brahmani, Dhadhar, Hindon, Hindon Cut, Ponnaiyar, Sabarmati and Yamuna, surpassed the permissible limit of 1.2 mg/L for Ammonia. The following year, in 2022, the issue persisted and intensified, with 28 water quality monitoring stations along 11 rivers, such as Brahmani, Hindon, Hindon Cut, Kanhan, Kharkhai, Mula Mutha, Ponnaiyar, Sabari, Sabarmati, Wardha, and Yamuna, exceeding the established threshold for Ammonia concentration at 1.2 mg/L. In both 2021 and 2022, 6 rivers—Brahmani, Hindon, Hindon Cut, Ponnaiyar, Sabarmati and Yamuna—exhibited consistently elevated ammonia levels beyond the acceptable limit of 1.2 mg/L. The primary contributors to this phenomenon were identified as industrial discharges, agricultural runoff, and urban wastewater. Untreated or inadequately treated effluents released from industrial activities, coupled with urban areas contributing to increased ammonia levels, were found to be significant factors impacting the water quality of these rivers.

The hot spot study and GIS map for ammonia parameter are given below in Table 10 and figure 13.

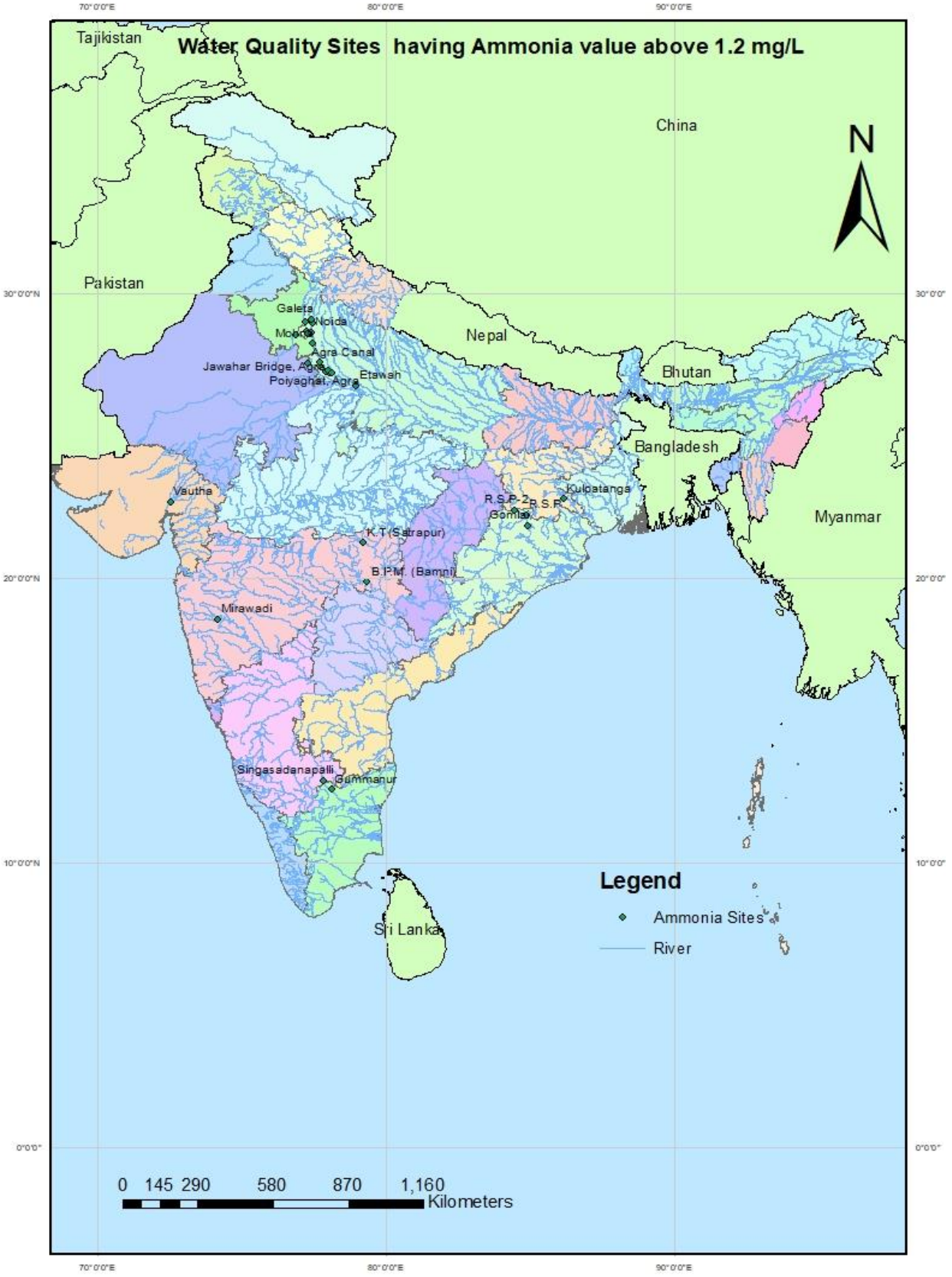
Table 10: Monitoring stations having Ammonia (NH_3)> 1.2 mg/l in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	Agra Canal	Yamuna	UYD, New Delhi	Delhi	South Delhi	10.19	7.43	7.98
2	B.P.M. (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	*	1.64	2.61
3	Baghpat	Yamuna	UYD, New Delhi	U.P.	Baghpat	1.84	-	-
4	Baleni	Yamuna	UYD, New Delhi	U.P.	Baghpat	4.64	1.38	1.82
5	Chilla Gaon	Hindon Cut	UYD, New Delhi	Delhi	East Delhi	34.48	11.31	10.46
6	Delhi Railway Bridge	Yamuna	UYD, New Delhi	Delhi	North Delhi	21.16	9.95	14.09
7	Dhansa	Sahibi	UYD, New Delhi	Delhi	SW Delhi	*	18.49	*
8	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	7.60	1.30	3.87
9	Galeta	Hindon	UYD, New Delhi	U.P.	Baghpat	10.17	7.69	8.44
10	Gokul Barrage II Mathura D/S	Yamuna	UYD, New Delhi	U.P.	Mathura	10.60	7.52	7.49
11	Gomlai	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	6.78	1.93	3.63
12	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	1.60	4.96	8.10
13	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	9.74	3.03	8.03
14	K.T.(Satrapur)	Kanhan	WD, Nagpur	Maharashtra	Nagpur	*	1.79	2.62
15	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	8.04	3.33	7.57
16	Kulpatanga	Kharkai	ERD, Bhubaneswar	Jharkhand	East Singhbhum	2.39	3.27	-
17	Mirawadi	Mula Mutha	UKD, Pune	Maharashtra	Pune	*	-	5.48
18	Mohna	Yamuna	UYD, New Delhi	Haryana	Faridabad	16.51	17.42	14.31
19	Noida	Yamuna	UYD, New Delhi	U.P.	Gautam Budh Nagar	20.25	19.65	16.34
20	Okhla Barrage	Yamuna	UYD, New Delhi	Delhi	South Delhi	12.55	10.46	10.15
21	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	9.96	3.09	7.79
22	R.S.P	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	27.10	38.71	25.53
23	R.S.P-1	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	20.60	18.85	18.45
24	R.S.P-2	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	6.90	14.18	5.52
25	Singasadanapalli	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	32.39	17.62	23.74
26	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	13.36	7.78	2.71
27	Vrindawan Bridge (Mathura U/S)	Yamuna	UYD, New Delhi	U.P.	Mathura	*	11.91	12.07
28	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	9.33	3.68	8.55

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 13: Water Quality monitoring stations having ammonia value above 1.2 mg/L (2022)



7.1.4 Fluoride (F^-)

Fluorine is a fairly common element but it does not occur in the elemental state in nature because of its high reactivity. Fluorine is the most electronegative and reactive of all elements that occur naturally within many types of rock. It exists in the form of fluorides in a number of minerals of which fluorspar, cryolite, fluorite and fluorapatite are the most common. Fluorite (CaF_2) is a common fluoride mineral. Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Most of the fluorides are sparingly soluble and are present in ground water in small amounts. The occurrence of fluoride in natural water is affected by the type of rocks, climatic conditions, nature of hydro geological strata and time of contact between rock and the circulating ground water. Presence of other ions, particularly bicarbonate and calcium ions also affect the concentration of fluoride in ground water. It is well known that small amounts of fluoride (less than 1.0 mg/l) have proven to be beneficial in reducing tooth decay. Community water supplies commonly are treated with NaF or fluorosilicates to maintain fluoride levels ranging from 0.8 to 1.2 ppm to reduce the incidence of dental carries.

However, high concentrations such as 1.5 mg/l of F and above have resulted in staining of tooth enamel while at still higher levels of fluoride ranging between 5.0 and 10 mg/l, further pathological changes such as stiffness of the back and difficulty in performing natural movements may take place.

BIS has recommended an upper desirable limit of 1.0 mg/l of F as desirable concentration of fluoride in drinking water, which can be extended to 1.5 mg/l of fluoride in case no alternative source of water is available. River/ground Water having fluoride concentration of more than 1.5 mg/l are not suitable for drinking purposes. During the pre-monsoon, monsoon and post-monsoon seasons, the average values of fluoride of all water quality monitoring stations were observed within the permissible limit.

Seven (07) water quality monitoring stations, namely Avarankuppam (Palar), Kamalapuram (Papagani), Lingdem (HS) (Talangchu), R.S.P (Brahmani), R.S.P-1 (Brahmani), Singavaram (Chitravathi), and Thoppur (Thoppaiyar), recorded fluoride concentrations exceeding the acceptable limits. In the pre-monsoon season, 3 water quality monitoring stations—Odisha (R.S.P), Sikkim (Lingdem (HS)), and Tamil Nadu (Avarankuppam)—recorded average fluoride concentrations exceeding 1.5 mg/l. The monsoon season of 2022 exhibited a further increase, with 4 water quality Monitoring stations in Odisha (R.S.P), Sikkim (Lingdem (HS)), Andhra Pradesh (Singavaram and Kamalapuram), surpassing the acceptable limit. Post-monsoon data for the year 2022 reflected a continued rise in average fluoride levels, with 5 water quality Monitoring stations in Odisha (R.S.P & R.S.P-1), Sikkim (Lingdem (HS), Andhra Pradesh (Singavaram), and Tamil Nadu (Thoppur), maintaining concentrations above the established threshold of 1.5 mg/l.

Comparision between 2021 & 2022:

Two water quality monitoring stations were common in both the years 2021 and 2022; Lingdem (HS) is situated in Sikkim, and R.S.P (Brahmani) is located in Odisha. The presence of fluoride in these two locations, at Talangchu (hot spring) and Brahmani River, is attributed to weathering and leaching of fluoride-bearing minerals from rocks.

The hot spot study and GIS map for fluoride parameter are given below in Table 11 and figure 14.

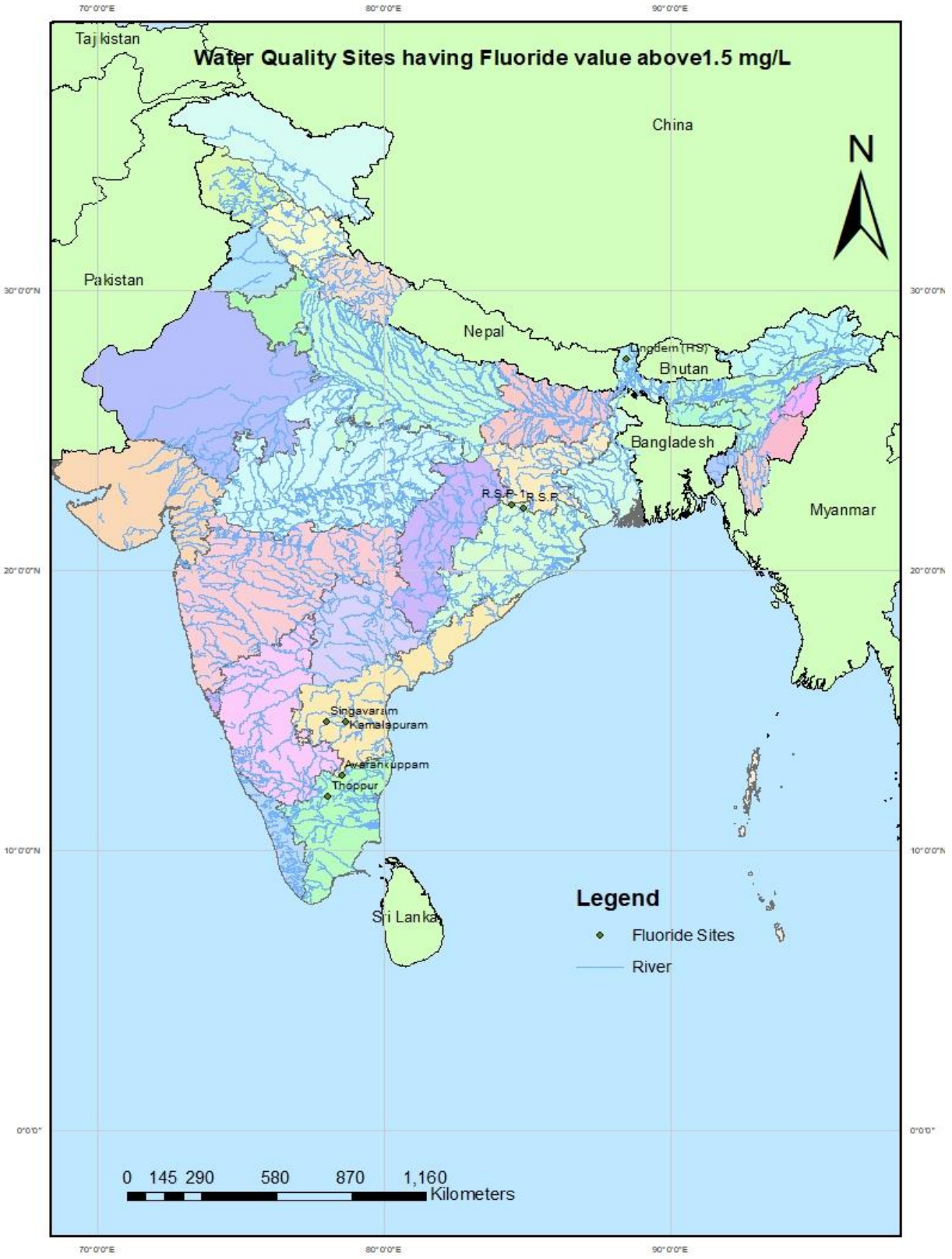
Table 11: Monitoring stations having Fluoride concentration above 1.5 mg/l in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	Avarankuppam	Palar	SRD, Coimbatore	Tamil Nadu	Vellore	1.52	-	-
2	Kamalapuram	Papagani	HD, Chennai	A.P.	Kadapa	-	1.60	-
3	Lingdem (HS)	Talangchu	SID, Gangtok	Sikkim	Mangan	5.37	6.37	5.70
4	R.S.P	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	1.86	2.09	1.83
5	R.S.P-1	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	-	1.58
6	Singavaram	Chitravathi	HD, Chennai	A.P.	Anantapur	-	1.85	1.60
7	Thoppur	Thoppaiyar	SRD, Coimbatore	Tamil Nadu	Salem	*	-	1.54

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 14: Water Quality Monitoring stations having fluoride value above 1.5 mg/L (2022)



7.1.5 Total Hardness

The acceptable limit according to Indian Standard Drinking Water-Specification, IS 10500: 2012 is 200 mg/l and the permissible limit in the absence of alternate source is 600 mg/l.

The analysis of the total hardness parameter results for 3 different monitoring stations, namely B.P.M. (Bamni) on Wardha, Maharashtra, Kopergaon on Godavari, Maharashtra, and Luwara on Shetrunji, Gujarat showed that the total hardness values were obtained for the pre-monsoon, monsoon, and post-monsoon seasons. For the B.P.M. (Bamni) monitoring station in the Wardha river, Maharashtra, the total hardness value was recorded as 653.84 during the monsoon season. However, the total hardness value did not exceed the acceptable limit during post-monsoon season. At the Kopergaon monitoring station in Godavari River, Maharashtra, and Luwara monitoring station in Shetrunji river, Gujarat, the total hardness value was recorded as 776.41 mg/L and 740.83 mg/L, respectively, during the pre-monsoon season. Nevertheless, during the monsoon and post-monsoon seasons, the total hardness value did not exceed the acceptable limit.

Comparision between 2021 & 2022:

In 2021, four (04) WQ monitoring stations, namely Durvesh on Vaitarna, Maharashtra; Varanavasi on Maruthaiyar, Tamil Nadu; Wadakbal on Sina, Maharashtra and Luwara on Shetrunji, Gujarat showed total hardness values above the permissible limit of the BIS 10500:2012 during pre-monsoon season. Similarly, in 2022, Three (03) stations, specifically B.P.M. (Bamni) (Wardha river), Kopergaon (Godavari River) and Luwara (Shetrunji river) recorded total hardness levels above the permissible thresholds.

One water quality monitoring station was identified in both 2021 and 2022: Luwara (Shetrunji river) in Gujarat.

The hot spot study and GIS map for Total Hardness are given below in Table 12 and figure 15.

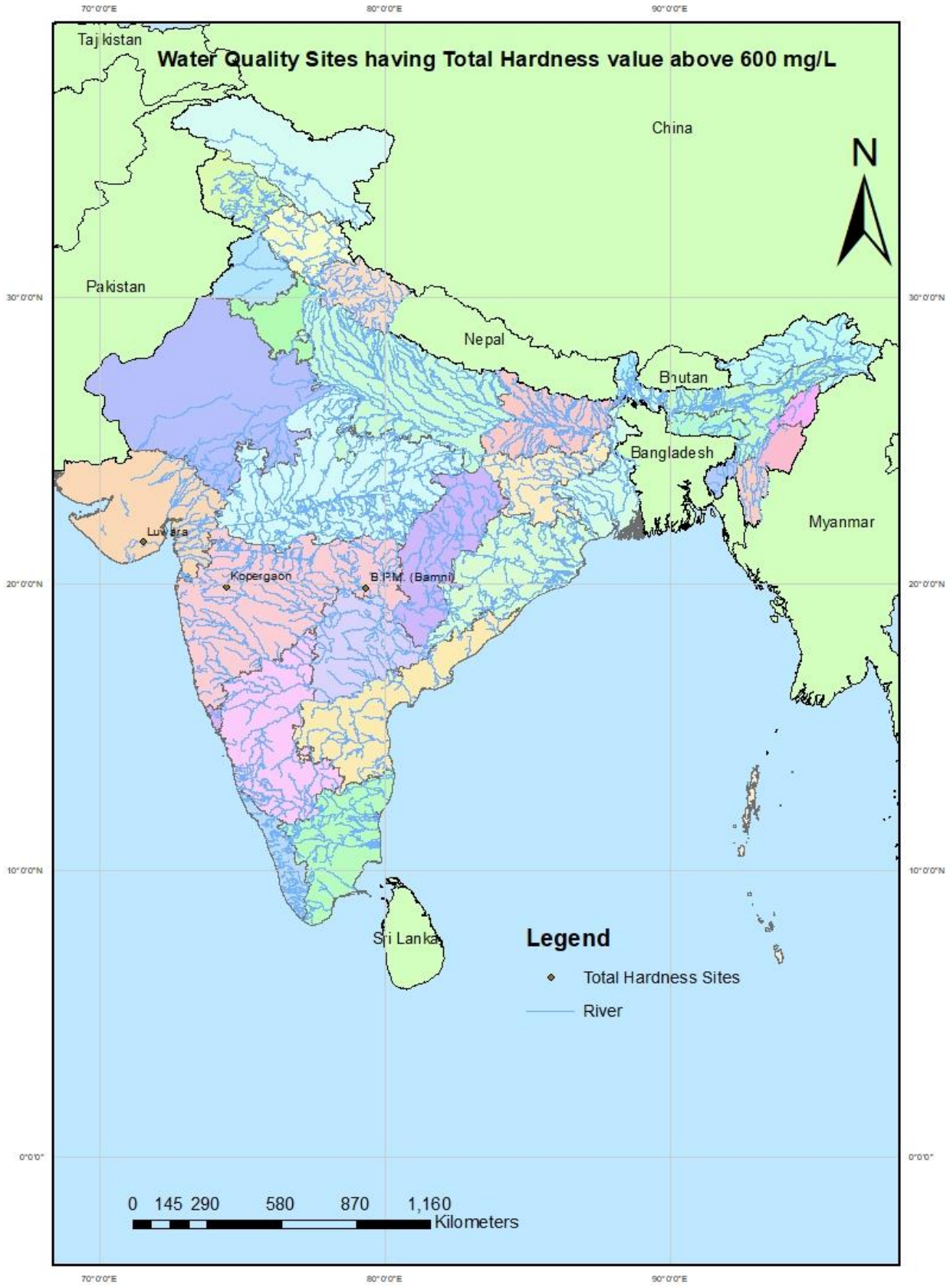
Table 12: Monitoring stations having Total hardness concentration above 600 mg/l in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	B.P.M. (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	*	653.84	-
2	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	776.41	-	-
3	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	740.83	-	-

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 15: Water Quality Monitoring stations having total hardness value above 600 mg/L (2022)



7.1.6 Chloride (Cl-)

Chloride is one of the major inorganic anions in water and wastewater. Chloride ions occur naturally in all types of water. The salty taste produced by chloride concentrations is variable and dependent on the chemical composition of water. The acceptable limit according to Indian Standard Drinking Water-Specification, IS 10500: 2012 is 250 mg/l and the permissible limit in the absence of alternate source is 1000 mg/l. Some waters containing 250 mg Cl-/l may have a detectable salty taste if the cation is sodium. On the other hand, the typical salty taste may be absent in water containing as much as 1000

One (01) water quality monitoring station Luwara exceeded the acceptable limit and the chloride level was measured at 1507.43 mg/L before the monsoon season (pre-monsoon) and 1204.59 mg/L after the monsoon season (post-monsoon), indicating a significant decrease in chloride concentration.

Comparision between 2021 & 2022:

During the pre-monsoon season of both 2021 and 2022, the Chloride concentration slightly increased from 1349 to 1507.43 mg/L at the Luwara (Shetrunji) monitoring station in Gujarat. This analysis highlights the consistency of elevated Chloride levels in the pre-monsoon season across the two years, particularly in the Gujarat region. The results of the study indicated that the chloride concentration levels in the rivers varied across different regions and seasons.

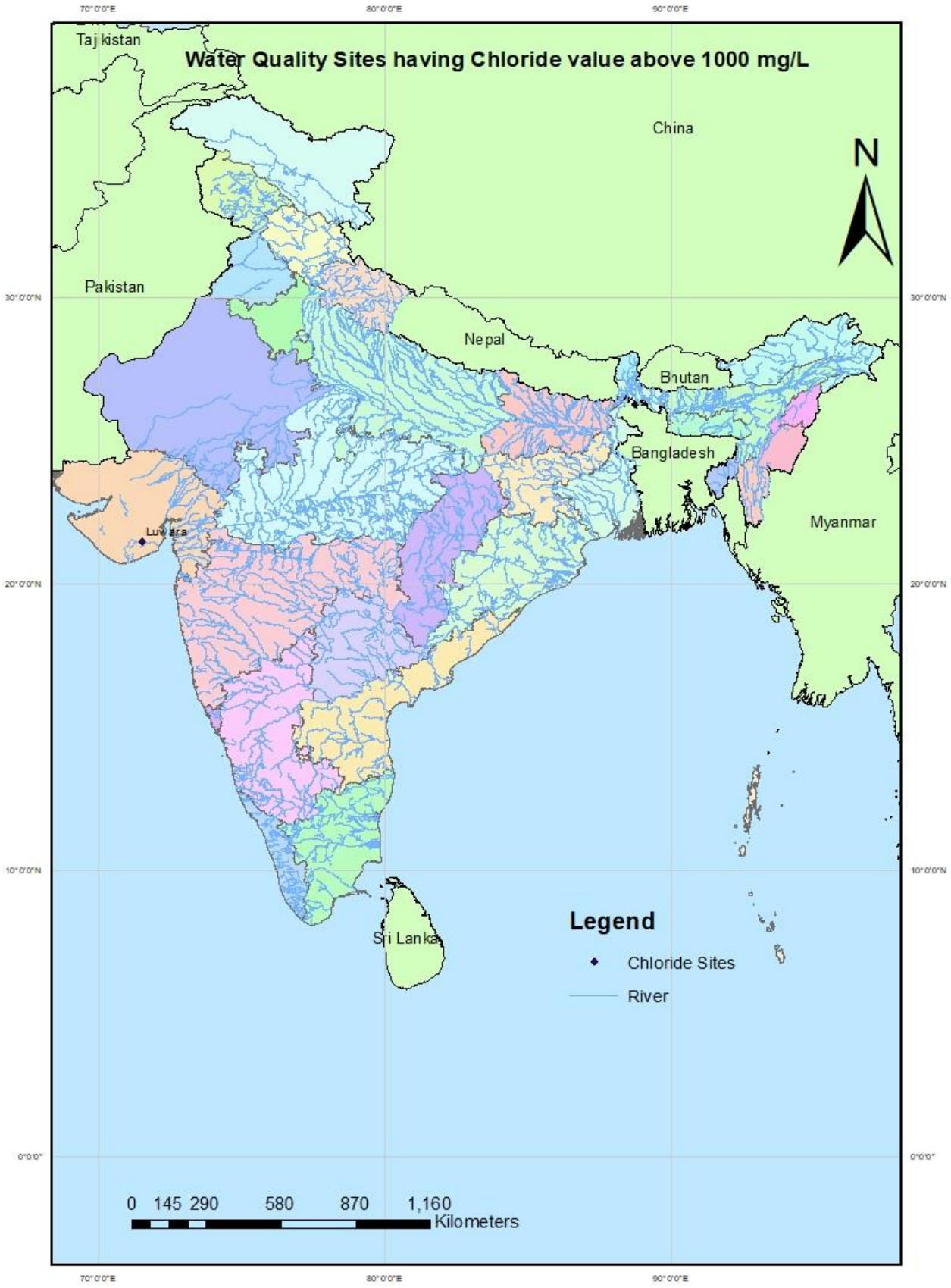
The hot spot study and GIS map for chloride are given below in Table 13 and figure 16.

Table 13: Monitoring stations having Chloride (Cl-) > 1000 mg/l in River Water in 2022

S.No	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	1507.43	-	1204.59

(-) means No Hotspot.

Figure 16: Water Quality Monitoring stations having chloride value above 1000 mg/L (2022)



7.1.7 Boron (B)

Boron, a chemical element found in the earth's crust, is a crucial component of various natural and industrial processes. It naturally occurs in fruits, vegetables, and water sources, often forming compounds known as borates. These compounds, including borax and boric acid, are extensively utilized in the manufacturing of glass, ceramics, soaps, detergents, cosmetics, medications, and pesticides. Boron is usually a minor constituent of river water. Considered an essential micronutrient for plants, boron also shows indications of being vital for animals and humans. It enters the environment through natural processes like weathering of soils and rocks, as well as human activities such as glass manufacturing and coal-burning power plants.

The Central Pollution Control Board (CPCB) sets a limit of 2 mg/l for boron in specific classes, including irrigation and industrial cooling. The limit prescribed by CPCB for Boron (B) in class-E: Irrigation, Industrial Cooling, Controlled Waste disposals is not greater than 2 mg/l. Monitoring stations during pre-monsoon, monsoon and post-monsoon seasons consistently report average boron values within the permissible limit, highlighting efforts to manage and control boron levels in various water sources.

7.1.8 Nitrate

Nitrogen occurs in water as nitrite (NO_2^-) or nitrate (NO_3^-) anions and in cationic form as ammonium (NH_4^+) and at intermediate oxidation states as a part of organic solutes. Nitrate, the end product of nitrification is generally recorded in natural waters at levels higher than the other nitrogenous parameters. Nitrate serves as a useful indicator of organic pollution of aquatic environments. Natural source of nitrate in rivers include igneous rock, land drains and plant and animal debris. The anthropogenic contribution is enhanced by municipal and industrial wastewater. The oxidation of organic nitrogen by the bacteria in the presence of oxygen produces nitrates. Nitrates are widely used in fertilisers, explosives, food preservatives and as oxidising agents in chemical industries etc. Nitrate is also produced in the soil by the fixation of atmospheric nitrogen (bacteria synthesis). The sources of NO_3^- in natural waters are domestic sewage, agricultural runoffs, decayed animals, vegetables and leachate from refuse dumps.

During the pre-monsoon season, 25 water quality monitoring stations in Chhattisgarh, Gujarat, Odisha, Tamil Nadu, and Uttar Pradesh recorded average Nitrate as N values exceeding 10.16 mg/l (45 mg/L as NO_3^-), indicating a widespread and worsening issue. The monsoon season of 2022 witnessed a substantial rise, with 79 water quality monitoring stations in Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Odisha, Uttar Pradesh, West Bengal and Telangana exhibiting average nitrate levels beyond the recommended limit. Post-monsoon data for the same year underscored a persistent trend, with 17 water quality monitoring stations in Andhra Pradesh, Chhattisgarh, Karnataka, Maharashtra, Odisha, Telangana and Uttar Pradesh maintaining consistently elevated average Nitrate as N levels.

Comparision between 2021 & 2022:

During the pre-monsoon season of 2021, 14 water quality Monitoring stations exceeded the acceptable limit, whereas in 2022, the number of monitoring stations increased to 25. Similarly, in the monsoon season of 2021, 18 monitoring stations exceeded the acceptable limit, but in 2022, the number of water quality monitoring stations increased to 79. The comparison of pre-monsoon and monsoon seasons between 2021 and 2022 reveals a significant escalation in the number of water quality monitoring stations exceeding acceptable limits. This indicates a worsening trend in water quality, raising serious concerns about nitrate contamination in Rivers.

The hot spot study and GIS map for nitrate are given below in Table 14 and figure 17.

Table 14: Monitoring stations having Nitrate ($NO_3^{--}N$) > 10.16 mg/l (45mg/l as Nitrate) in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	Adityapur	Kharkai	ERD, Bhubaneswar	Jharkhand	Saraikela Kharsawan	-	16.79	-
2	Anakapali	Sarada	ERD, Bhubaneswar	A.P.	Visakhapatnam	-	19.14	-
3	Anandapur	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	-	14.05	-
4	Andhiyar Khore	Hamp	MD, Burla	Chhattisgarh	Bemetara	17.24	13.29	12.68
5	Aradei	Aradei	ERD, Bhubaneswar	Odisha	Keonjhar	-	18.69	-
6	Balighat	Burhabalang	ERD, Bhubaneswar	Odisha	Balasore	-	14.09	-
7	Bamnidhi	Hasdeo	MD, Burla	Chhattisgarh	Janjgir-Champa	20.84	10.93	-
8	Bareilly	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	-	11.37	-
9	Baridhi	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	13.31	-
10	Baripada	Burhabalang	ERD, Bhubaneswar	Odisha	Mayurbhanj	-	17.43	-
11	Bhitaura	Ganga	MGD-2, Lucknow	U.P.	Fatehpur	-	12.88	-
12	Bido	Brahmani	ERD, Bhubaneswar	Odisha	Dhenkanal	-	12.03	-
13	Bolani	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	26.35	-
14	Bonaigarh	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	26.21	-
15	Boudh	Mahanadi	MD, Burla	Odisha	Boudh	14.07	-	-
16	Champa Road Bridge	Hasdeo	MD, Burla	Chhattisgarh	Janjgir-Champa	14.04	11.82	-
17	Champua	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	-	14.24	-
18	Chandrika Devi (Lko U/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	-	14.41	-
19	Dameracherla	Musi	LKD, Hyderabad	Telangana	Nalgonda	*	-	11.52
20	Dhaneta	Kitcha/Bahgul	MGD-2, Lucknow	U.P.	Bareilly	10.16	15.69	-
21	Domuhani	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	18.55	-
22	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	11.56	14.99	13.33
23	Gatora	Arpa	MD, Burla	Chhattisgarh	Bilaspur	22.45	13.78	-
24	Gatora-1	Arpa	MD, Burla	Chhattisgarh	Bilaspur	27.41	18.39	-
25	Gatora-2	Arpa	MD, Burla	Chhattisgarh	Bilaspur	29.87	17.62	-
26	GH.Rd.Bridge	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	21.64	-
27	Ghatshila	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	21.11	-
28	Gomlai	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	26.20	-
29	Gomti Nagar (Lko D/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	-	16.07	-
30	Gopiballavpur	Subarnarekha	ERD, Bhubaneswar	West Bengal	Jhargram	-	16.05	-

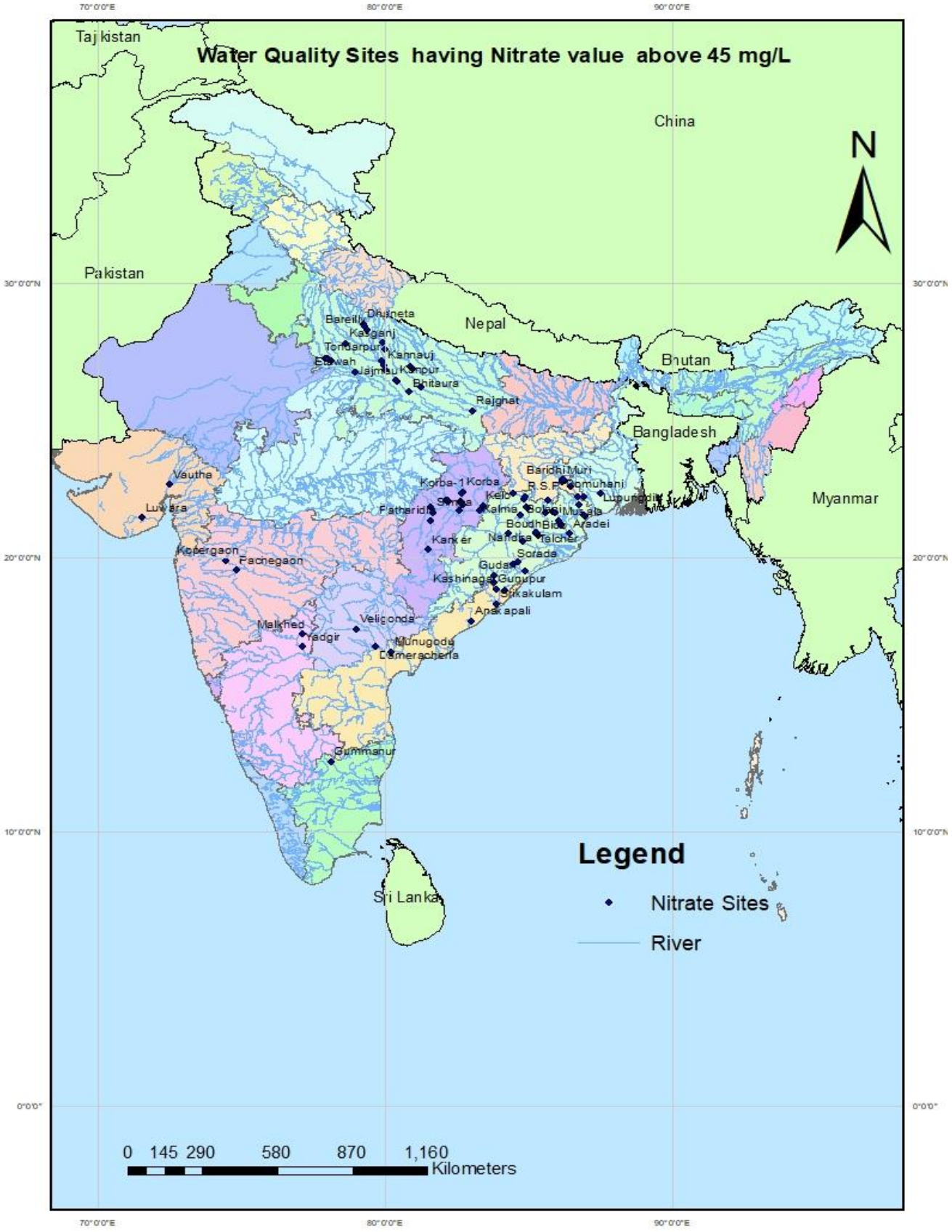
S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
31	Govindpur(NH-5)	Burhabalang	ERD, Bhubaneswar	Odisha	Balasore	-	16.12	-
32	Gudari	Vamsadhara	ERD, Bhubaneswar	Odisha	Rayagada	13.97	16.75	-
33	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	13.71	-	-
34	Gunupur	Vamsadhara	ERD, Bhubaneswar	Odisha	Rayagada	-	19.94	-
35	Indupur	Brahmani	ERD, Bhubaneswar	Odisha	Kendrapara	-	14.61	-
36	Jajmau	Ganga	MGD-2, Lucknow	U.P.	Kanpur	-	10.93	-
37	Jamshedpur	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	17.00	-
38	Jamsolaghat	Subarnarekha	ERD, Bhubaneswar	Odisha	Mayurbhanj	-	15.47	-
39	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	-	15.14	10.53
40	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	17.24	14.61	-
41	Kalma	Mahanadi	MD, Burla	Chhattisgarh	Janjgir-Champa	11.98	11.47	-
42	Kamalanga	Brahmani	ERD, Bhubaneswar	Odisha	Angul	-	12.61	-
43	Kanker	Dhudh	MD, Burla	Chhattisgarh	Kanker	10.87	-	-
44	Kannauj	Kali	MGD-2, Lucknow	U.P.	Kannauj	-	11.50	10.55
45	Kanpur	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	-	10.60	-
46	Kasganj	Kali	MGD-2, Lucknow	U.P.	Etah	-	13.27	-
47	Kashinagar	Vamsadhara	ERD, Bhubaneswar	Odisha	Gajapati	-	15.80	-
48	Katri Umrauli	Ganga	MGD-2, Lucknow	U.P.	Kannauj	-	10.84	-
49	Kelo	Kelo	MD, Burla	Chhattisgarh	Raigarh	11.33	-	-
50	Kenduapada	Kanijhari	ERD, Bhubaneswar	Odisha	Keonjhar	-	16.60	-
51	Keonjhar	Aradei	ERD, Bhubaneswar	Odisha	Keonjhar	-	18.21	-
52	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	*	-	18.46
53	Korba	Hasdeo	MD, Burla	Chhattisgarh	Korba	10.41	-	-
54	Korba-1	Hasdeo	MD, Burla	Chhattisgarh	Korba	15.10	-	-
55	Kulpatanga	Kharkai	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	20.00	-
56	Kusei	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	-	14.13	-
57	Lucknow	Gomti	MGD-2, Lucknow	U.P.	Lucknow	-	14.39	-
58	Lupungdih	Subarnarekha	ERD, Bhubaneswar	Jharkhand	Saraikela Kharsawan	-	19.13	-
59	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	12.94	-	-
60	Madhabarida	Badanadi	ERD, Bhubaneswar	Odisha	Ganjam	-	23.80	-
61	Madhya Bharat Paper Ltd (MBPL)	Hasdeo	MD, Burla	Chhattisgarh	Janjgir-Champa	14.87	12.40	-
62	Malkhed	Kangna	LKD, Hyderabad	Karnataka	Gulbarga	*	-	11.77
63	Mehandipur	Ganga	MGD-2, Lucknow	U.P.	Kannauj	-	10.28	11.47
64	Melliaputty	Mahendratanaya	ERD,	A.P.	Srikakulam	-	18.40	10.35

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
			Bhubaneswar					
65	Munugodu	Edduvagu	LKD, Hyderabad	A.P.	Guntur	*	-	11.14
66	Muri	Subarnarekha	ERD, Bhubaneswar	Jharkhand	Ranchi	-	15.29	-
67	Musala	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	-	16.09	-
68	Nandira	Brahmani	ERD, Bhubaneswar	Odisha	Angul	-	13.01	-
69	Pachegaon	Pravara	UGD, Hyderabad	Maharashtra	Ahmednagar	*	-	14.69
70	Patharidih	kharun	MD, Burla	Chhattisgarh	Raipur	20.71	14.59	16.40
71	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	-	14.82	-
72	Prakash Ind Ltd (PIL)	Hasdeo	MD, Burla	Chhattisgarh	Janjgir-Champa	20.02	11.59	-
73	Purunagarh	Brahmani	ERD, Bhubaneswar	Odisha	Deogarh	-	12.31	-
74	Purushottampur	Rushikulya	ERD, Bhubaneswar	Odisha	Ganjam	-	18.61	-
75	R.S.P	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	20.47	-
76	R.S.P-1	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	19.03	-
77	R.S.P-2	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	14.41	-
78	Raebareli	Sai	MGD-2, Lucknow	U.P.	Raebareli	-	13.21	-
79	Rajghat	Subarnarekha	ERD, Bhubaneswar	Odisha	Mayurbhanj	-	13.78	-
80	Seorinarayan	Mahanadi	MD, Burla	Chhattisgarh	Janjgir-Champa	12.01	10.58	-
81	Shahjahanpur	Khannaut	MGD-2, Lucknow	U.P.	Shahjahanpur	-	12.07	-
82	Simga	Seonath	MD, Burla	Chhattisgarh	Raipur	12.96	-	11.95
83	Sorada	Rushikulya	ERD, Bhubaneswar	Odisha	Ganjam	-	22.70	10.52
84	Srikakulam	Nagavali	ERD, Bhubaneswar	A.P.	Srikakulam	-	21.88	-
85	Swampatana	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	-	15.79	-
86	Talcher	Brahmani	ERD, Bhubaneswar	Odisha	Angual	-	11.78	-
87	Tihar Khera	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	10.79	15.83	-
88	Tikarapara	Mahanadi	MD, Burla	Odisha	Angul	-	20.59	-
89	Tondarpur	Sukheta	MGD-2, Lucknow	U.P.	Hardoi	-	10.46	-
90	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	-	11.87	-
91	Veligonda	Musi	LKD, Hyderabad	Telangana	Nalgonda	*	13.77	26.06
92	Yadgir	Bhima	LKD, Hyderabad	Karnataka	Yadgir	*	-	11.56
93	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	15.90	13.46	11.47

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 17: Water Quality Monitoring stations having nitrate value above 45 mg/L (10.16 mg/L as Nitrate-N) (2022)



7.1.9 Dissolved Oxygen

Dissolved oxygen (DO) is a critical factor in maintaining the health of aquatic ecosystems, serving as a primary indicator when assessing the suitability of river water to support aquatic life. Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land. Fish and crustaceans obtain oxygen for respiration through their gills, while plant life and phytoplankton require dissolved oxygen for respiration when there is no light for photosynthesis. Microbes such as bacteria and fungi also require dissolved oxygen. These organisms use DO to decompose organic material at the bottom of a body of water. Microbial decomposition is an important contributor to nutrient recycling. However, if there is an excess of decaying organic material (from dying algae and other organisms), in a body of water with infrequent or no turnover (also known as stratification), the oxygen at lower water levels will get used up quicker. The variations in dissolved oxygen observed may also be because of time of the day when it is measured. In aquatic ecosystems, the DO usually occur maximum in the afternoon and minimum during night or when the sunlight is less.

CPCB has recommended 5.0 mg/l concentration of dissolved oxygen for outdoor bathing in Class B. Water having below 5.0 mg/l DO concentration is not suitable for out-door bathing in river.

The pre-monsoon season recorded 79 water quality monitoring stations across Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal reporting average DO values below 5.0 mg/l. In the monsoon season, 96 water quality monitoring stations in Andhra Pradesh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh and West Bengal displayed similar findings. Finally, in the post-monsoon season, 41 water quality monitoring stations across Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, Telangana, Uttar Pradesh, and West Bengal recorded average DO values below 5.0 mg/l.

Comparision between 2021 & 2022:

Comparing the dissolved oxygen (DO) levels in water quality monitoring stations between the fall seasons of 2021 and 2022 reveals a concerning trend. In 2021, during the pre-monsoon season, 97 water quality monitoring stations across various states reported average DO values below 5.0 mg/l. This pattern persisted into the monsoon season, where 138 monitoring stations registered similar low DO values. The post-monsoon season of 2021 continued to reflect this worrisome trend, with 83 water quality monitoring stations maintaining DO values below 5.0 mg/l. Transitioning to 2022, the pre-monsoon season recorded a decrease, albeit modest, with 79 water quality monitoring stations reporting average DO values below 5.0 mg/l. However, during the monsoon season of 2022, the situation escalated, as 96 water quality monitoring stations displayed findings consistent with the previous year. The post-monsoon season

of 2022 further emphasized the persistence of low DO levels, with 41 water quality monitoring stations across various states recording average DO values below the recommended threshold of 5.0 mg/l.

Overall, this comparative analysis highlights the fact that although there is a decrease in the number of water quality monitoring stations reporting low DO levels during the pre-monsoon season of 2022, the situation appears to be improving the water quality of river during the monsoon season and post-monsoon season of 2022. The hot spot study and GIS map for DO parameter are given below in Table 15 and figure 18.

Table 15: Monitoring stations having Dissolved Oxygen (DO) <5.0 mg/l in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	A.B.Road Crossing	Parwati	CD, Jaipur	M.P.	Guna	-	-	3.56
2	Adityapur	Kharkai	ERD, Bhubaneswar	Jharkhand	Saraikela Kharsawan	4.01	4.68	4.56
3	Agra Canal	Yamuna	UYD, New Delhi	Delhi	South Delhi	0.98	0.54	1.45
4	Anakapali	Sarada	ERD, Bhubaneswar	A.P.	Visakhapatnam	4.09	4.85	4.95
5	Anandapur	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	4.23	4.65	-
6	B.P.M. (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	-	2.85	4.43
7	Baghpat	Yamuna	UYD, New Delhi	Uttar Pradesh	Baghpat	-	4.67	-
8	Baleni	Yamuna	UYD, New Delhi	Uttar Pradesh	Baghpat	0.00	0.35	0.00
9	Balighat	Burhabalang	ERD, Bhubaneswar	Odisha	Balasore	4.79	4.65	-
10	Banpur	Mathabhanga/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	1.85	1.84	2.26
11	Bareilly	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	-	3.88	-
12	Baridhi	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	3.32	3.96	-
13	Basti	Kwano	MGD-1, Lucknow	U.P.	Basti	4.47	3.53	-
14	Basti D/S	Kwano	MGD-1, Lucknow	U.P.	Basti	4.55	3.05	-
15	Basti U/S	Kwano	MGD-1, Lucknow	U.P.	Basti	4.96	3.15	-
16	Bido	Brahmani	ERD, Bhubaneswar	Odisha	Dhenkanal	4.97	4.16	-
17	Bigod	Banas	CD, Jaipur	Rajasthan	Bhilwara	3.55	4.47	-
18	Bolani	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	4.07	3.84	-
19	Bonaigarh	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	-	4.62	-
20	Chapra	Jalangi/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	-	4.07	-
21	Chilla Gaon	Hindon Cut	UYD, New Delhi	Delhi	East Delhi	0.39	1.07	1.26
22	Chotabekra	Barak	MID, Shillong	Manipur	Jiribam	-	4.30	-
23	Dadri	Sahibi	UYD, New Delhi	Haryana	Jhajjar	-	3.98	-
24	Dameracherla	Musi	LKD, Hyderabad	Telangana	Nalgonda	4.31	4.29	-
25	Delhi Railway Bridge	Yamuna	UYD, New Delhi	Delhi	North Delhi	0.36	0.89	0.91
26	Dhansa	Sahibi	UYD, New Delhi	Delhi	South West Delhi	-	2.80	-
27	Domuhani	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	4.38	4.20	-
28	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	4.14	2.83	3.51
29	Galeta	Hindon	UYD, New Delhi	U.P.	Baghpat	0.00	0.00	0.00
30	Gatora-1	Arpa	MD, Burla	Chhattisgarh	Bilaspur	4.63	-	-
31	Gatora-2	Arpa	MD, Burla	Chhattisgarh	Bilaspur	4.24	-	4.95
32	GH.Rd.Bridge	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	4.79	4.30	-

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
33	Ghatshila	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	-	4.44	-
34	Gokul Barrage II Mathura D/S	Yamuna	UYD, New Delhi	U.P.	Mathura	2.31	1.57	2.67
35	Gomlai	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	4.78	4.82	-
36	Gomti Nagar (Lko D/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	-	1.64	3.96
37	Gopiballavpur	Subarnarekha	ERD, Bhubaneswar	West Bengal	Jhargram	4.56	4.22	-
38	Govindpur(NH-5)	Burhabalang	ERD, Bhubaneswar	Odisha	Balasore	4.47	4.54	-
39	Gudari	Vamsadhara	ERD, Bhubaneswar	Odisha	Rayagada	4.39	4.77	-
40	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	4.55	4.78	-
41	Gunupur	Vamsadhara	ERD, Bhubaneswar	Odisha	Rayagada	4.39	4.39	-
42	Hanskhali	Churni/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	3.40	2.33	2.97
43	Indupur	Brahmani	ERD, Bhubaneswar	Odisha	Kendrapara	4.08	4.55	-
44	Jamshedpur	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	4.05	4.06	-
45	Jaraikela	Koel	ERD, Bhubaneswar	Odisha	Sundergarh	4.68	4.60	-
46	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	2.80	2.47	3.87
47	Jenapur	Brahmani	ERD, Bhubaneswar	Odisha	Jajpur	-	4.67	-
48	K.T.(Satrapur)	Kanhan	WD, Nagpur	Maharashtra	Nagpur	-	0.60	0.00
49	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	2.75	2.53	3.30
50	Kamalanga	Brahmani	ERD, Bhubaneswar	Odisha	Angul	-	4.49	-
51	Kasganj	Kali	MGD-2, Lucknow	U.P.	Etah	3.30	2.54	-
52	Kashinagar	Vamsadhara	ERD, Bhubaneswar	Odisha	Gajapati	4.55	4.61	-
53	Keesara	Munneru	LKD, Hyderabad	A.P.	Krishna	-	4.29	-
54	Kenduapada	Kanijhari	ERD, Bhubaneswar	Odisha	Keonjhar	4.81	4.52	-
55	Keonjhar	Aradei	ERD, Bhubaneswar	Odisha	Keonjhar	4.69	4.40	-
56	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	1.30	4.75	-
57	Kulpatanga	Kharkai	ERD, Bhubaneswar	Jharkhand	East Singhbhum	3.61	4.65	-
58	Kusei	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	4.83	4.63	4.58
59	Lucknow	Gomti	MGD-2, Lucknow	U.P.	Lucknow	-	2.06	2.89
60	Lupungdih	Subarnarekha	ERD, Bhubaneswar	Jharkhand	Saraikela Kharsawan	2.80	4.15	-
61	Madhabarida	Badanadi	ERD, Bhubaneswar	Odisha	Ganjam	3.98	-	-
62	Madhira	Wyra	LKD, Hyderabad	Telangana	Khammam	4.34	3.94	-
63	Mandawara	Chambal	CD, Jaipur	Rajasthan	Kota	4.37	-	-
64	Manderial	Chambal	CD, Jaipur	Rajasthan	Karauli	0.00	-	-

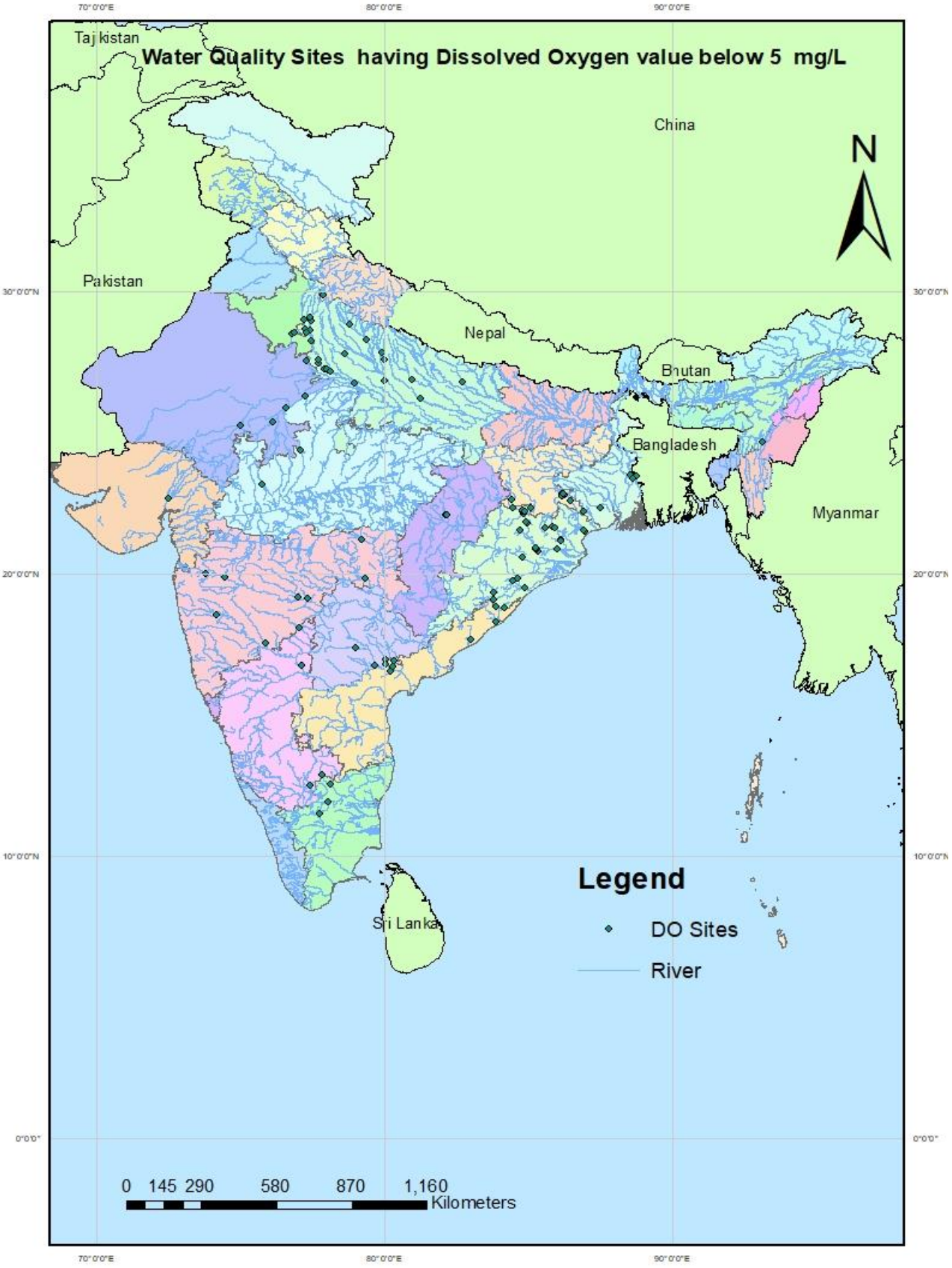
S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
65	Melliaputty	Mahendratanaya	ERD, Bhubaneswar	A.P.	Srikakulam	4.31	4.05	4.88
66	Mirawadi	Mula Mutha	UKD, Pune	Maharashtra	Pune	-	4.62	4.66
67	Mohna	Yamuna	UYD, New Delhi	Haryana	Faridabad	1.22	1.79	0.56
68	Moradabad	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	-	2.83	3.75
69	Munugodu	Edduvagu	LKD, Hyderabad	A.P.	Guntur	-	4.59	-
70	Muri	Subarnarekha	ERD, Bhubaneswar	Jharkhand	Ranchi	4.29	4.38	-
71	Nanded	Godavari	UGD, Hyderabad	Maharashtra	Nanded	0.85	-	4.60
72	Nandira	Brahmani	ERD, Bhubaneswar	Odisha	Angul	-	4.56	-
73	Nashik	Godavari	UGD, Hyderabad	Maharashtra	Nasik	3.07	2.95	1.85
74	Noida	Yamuna	UYD, New Delhi	U.P.	Gautam Budh Nagar	0.50	0.00	0.00
75	Okhla Barrage	Yamuna	UYD, New Delhi	Delhi	South Delhi	1.02	1.11	0.48
76	Paleru Bridge	Paleru	LKD, Hyderabad	A.P.	Krishna	-	4.23	-
77	Pali	Chambal	CD, Jaipur	Rajasthan	Sawai-madhopur	0.00	-	-
78	Panposh	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	4.41	4.16	-
79	Panposh-1	Sankh	ERD, Bhubaneswar	Odisha	Sundergarh	4.80	4.36	-
80	Panposh-2	Koel	ERD, Bhubaneswar	Odisha	Sundergarh	-	4.47	-
81	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	2.20	2.90	4.76
82	Purna	Purna	UGD, Hyderabad	Maharashtra	Parbhani	3.55	-	-
83	Purunagarh	Brahmani	ERD, Bhubaneswar	Odisha	Deogarh	4.06	3.77	-
84	Purushottampur	Rushikulya	ERD, Bhubaneswar	Odisha	Ganjam	4.33	4.74	-
85	R.S.P	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	3.16	2.32	4.46
86	R.S.P-1	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	4.17	3.40	-
87	R.S.P-2	Brahmani	ERD, Bhubaneswar	Odisha	Sundergarh	4.04	3.53	-
88	Raebareli	Sai	MGD-2, Lucknow	U.P.	Raebareli	-	3.83	-
89	Roorkee D/S	Solani	HGD, Haridwar	Uttarakhand	Haridwar	0.98	-	-
90	Saigaon	Manjira	UGD, Hyderabad	Karnataka	Bidar	4.19	4.71	-
91	Shahjahanpur	Khannaut	MGD-2, Lucknow	U.P.	Shahjahanpur	-	4.68	-
92	Singasadanapalli	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	0.45	0.00	0.00
93	Sorada	Rushikulya	ERD, Bhubaneswar	Odisha	Ganjam	4.68	4.30	4.50
94	Srikakulam	Nagavali	ERD, Bhubaneswar	A.P.	Srikakulam	4.28	4.83	-
95	Swampatana	Baitarani	ERD, Bhubaneswar	Odisha	Keonjhar	4.76	-	-
96	T Bekuppe	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	2.98	4.09	4.61
97	Talcher	Brahmani	ERD, Bhubaneswar	Odisha	Angual	-	4.68	-
98	Thevur	Sarabenga	SRD, Coimbatore	Tamil Nadu	Salem	-	4.01	-
99	Thoppur	Thoppaiyar	SRD, Coimbatore	Tamil Nadu	Salem	-	4.03	4.63
100	Tikarapara	Mahanadi	MD, Burla	Odisha	Angul	4.27	-	-

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
101	Tilga	Sankh	ERD, Bhubaneswar	Jharkhand	Simdega	4.89	4.26	-
102	Tondarpur	Sukheta	MGD-2, Lucknow	U.P.	Hardoi	-	-	4.46
103	Ujjain	Shipra	CD, Jaipur	M.P.	Ujjain	-	3.37	3.51
104	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	0.00	0.91	1.00
105	Veligonda	Musi	LKD, Hyderabad	Telangana	Nalgonda	2.08	2.58	2.06
106	Vrindawan Bridge (Mathura U/S)	Yamuna	UYD, New Delhi	U.P.	Mathura	-	1.83	1.84
107	Wadakbal	Sina	UKD, Pune	Maharashtra	Solapur	-	4.06	4.78
108	Wadenapally	Krishna	LKD, Hyderabad	Telangana	Nalgonda	4.34	-	-
109	Yadgir	Bhima	LKD, Hyderabad	Karnataka	Yadgir	4.56	4.88	-
110	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	2.44	2.47	3.17

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 18: Water Quality Monitoring stations having Dissolved Oxygen below 5.0 mg/L (2022)



7.1.10 Biochemical Oxygen Demand

Biochemical oxygen demand is the amount of dissolved oxygen needed (i.e., demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period (Kaiser, 1998). Biochemical oxygen demand (BOD) holds unique significance in assessing the pollution of river water caused by wastewater discharge from sources such as sewage, industries, and agricultural fields. This parameter is important for river pollution control management and assessing the self-purifying capacity of the river. BOD serves as a comprehensive indicator of river water quality, reflecting the impact of various human activities on the ecosystem and providing essential information for pollution control and environmental management.

The pre-monsoon season witnessed 93 water quality monitoring stations across Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand reporting average BOD values exceeding 3.0 mg/l. In the monsoon season, 123 water quality monitoring stations in Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal displayed similar findings. Finally, in the post-monsoon season, 85 water quality monitoring stations in Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal recorded average BOD values exceeding 3.0 mg/l.

Comparision between 2021 & 2022:

The comparison of Biochemical Oxygen Demand (BOD) values in Indian river water between 2021 and 2022 highlights concerning trends. In 2021, pre-monsoon and monsoon seasons saw elevated BOD levels at 90 and 101 water quality monitoring stations, respectively. During post-monsoon season, 67 monitoring stations maintained BOD values above 3.0 mg/l. Transitioning to 2022, troublingly, pre-monsoon and monsoon seasons recorded 93 and 123 monitoring stations with BOD values surpassing 3.0 mg/l. The distressing trend continued in the post-monsoon season, with 85 monitoring stations exhibiting elevated BOD levels. In the year 2022, the number of water quality monitoring stations increased during the pre-monsoon and post-monsoon seasons compared to 2021, indicating a deterioration in the water quality of the rivers.

The hot spot study and GIS map for biochemical oxygen demand are given below in Table 16 and figure 19.

Table 16: Monitoring stations having biochemical oxygen Demand (BOD) > 3.0 mg/l in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	A.B.Road Crossing	Parwati	CD, Jaipur	M.P.	Guna	*	15.15	22.41
2	A.P. Puram	Chittar	SRD, Coimbatore	Tamil Nadu	Tirunelveli	4.59	*	*
3	A.P.M.(Ashti)	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	*	5.20	3.63
4	Agra Canal	Yamuna	UYD, New Delhi	Delhi	South Delhi	34.10	32.01	26.33
5	Akbarpur	Chhoti sarju	MGD-3, Varanasi	U.P.	Ambedkar Nagar	4.46	3.56	3.90
6	Aklera	Parwan	CD, Jaipur	Rajasthan	Jhalawar	*	9.33	8.89
7	Allahabad	Ganga	MGD-3, Varanasi	U.P.	Prayagraj	3.49	3.37	3.30
8	Ambgaon	Chulband	WD, Nagpur	Maharashtra	Bhandara	11.21	-	*
9	Ankinghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	3.49	3.58	-
10	Asthi	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	8.21	-	-
11	Auraiya	Yamuna	LYD, Agra	U.P.	Auraiya	7.60	6.07	6.11
12	B.P.M. (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	*	50.67	21.43
13	Baghpat	Yamuna	UYD, New Delhi	Uttar Pradesh	Baghpat	9.90	16.03	15.61
14	Bakhari	Wainganga	WD, Nagpur	M.P.	Seoni	-	5.21	3.13
15	Baleni	Yamuna	UYD, New Delhi	Uttar Pradesh	Baghpat	38.68	26.91	22.97
16	Bamni(Nagpur)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	7.65	5.79	3.33
17	Banpur	Mathabhanga/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	3.50	5.52	4.59
18	Bansi	Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	3.04	5.24	-
19	Baranwada	Banas	CD, Jaipur	Rajasthan	Sawai-madhopur	*	14.60	7.06
20	Bareilly	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	8.51	10.07	-
21	Baridhi	Subarnarekha	ERD, Bhubaneswar	Jharkhand	East Singhbhum	12.80	-	-
22	Barod	Kalisindh	CD, Jaipur	Rajasthan	Kota	-	6.43	-
23	Basti	Kwano	MGD-1, Lucknow	U.P.	Basti	8.04	8.79	-
24	Basti D/S	Kwano	MGD-1, Lucknow	U.P.	Basti	8.83	9.18	3.55
25	Basti U/S	Kwano	MGD-1, Lucknow	U.P.	Basti	7.03	8.49	4.41
26	Bhadana Village D/s of Kota City	Chambal/Parwati	CD, Jaipur	Rajasthan	Kota	*	11.10	*
27	Bhind	Kunwari	LYD, Agra	M.P.	Bhind	3.44	4.68	3.39
28	Bhitaura	Ganga	MGD-2, Lucknow	U.P.	Fatehpur	4.91	4.83	-
29	Bhitoor	Ganga	MGD-2, Lucknow	U.P.	Kanpur	4.31	3.67	3.06
30	Bigod	Banas	CD, Jaipur	Rajasthan	Bhilwara	-	17.69	8.30
31	Birdghat	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	4.39	4.97	3.18
32	Chandrika Devi (Lko U/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	3.41	4.70	3.54
33	Chapra	Jalangi/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	-	4.45	-
34	Chilla Gaon	Hindon Cut	UYD, New Delhi	Delhi	East Delhi	44.92	27.52	28.52
35	Chittorgarh	Gambhiri	CD, Jaipur	Rajasthan	Chittorgarh	*	18.24	*
36	D/S (Ashti)	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	*	3.07	4.23

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
37	Dadri	Sahibi	UYD, New Delhi	Haryana	Jhajjar	*	22.60	*
38	Daund	Bhima	UKD, Pune	Maharashtra	Pune	*	-	3.75
39	Delhi Railway Bridge	Yamuna	UYD, New Delhi	Delhi	North Delhi	32.71	28.86	25.51
40	Dhaneta	Kitcha/Bahgul	MGD-2, Lucknow	U.P.	Bareilly	3.96	4.33	4.00
41	Dhansa	Sahibi	UYD, New Delhi	Delhi	South West Delhi	*	20.87	*
42	Dhareri	Chambal	CD, Jaipur	M.P.	Ujjain	*	12.12	*
43	Elunuthi Mangalam	Noyyal	SRD, Coimbatore	Tamil Nadu	Erode	5.52	4.70	-
44	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	33.46	21.26	30.48
45	Fatehgarh	Ganga	MGD-2, Lucknow	U.P.	Farrukhabad	-	-	3.96
46	Galeta	Hindon	UYD, New Delhi	U.P.	Baghpat	46.07	27.87	22.71
47	Ganguwala	Yamuna	UYD, New Delhi	H.P.	Sirmaur	-	4.94	-
48	Gatora-2	Arpa	MD, Burla	Chhattisgarh	Bilaspur	4.52	-	-
49	Ghazipur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	3.13	3.61	3.97
50	Gokul Barrage II Mathura D/S	Yamuna	UYD, New Delhi	U.P.	Mathura	27.09	29.78	26.12
51	Gomti Nagar (Lko D/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	18.27	18.21	3.69
52	Gorakhpur D/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	3.79	4.80	3.56
53	Gorakhpur U/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	-	4.13	3.39
54	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	9.77	20.19	7.44
55	Hamirpur	Yamuna	LYD, Agra	U.P.	Hamirpur	4.63	-	4.66
56	Hanskhali	Churni/ Bhagirathi	LGD-3, Berhampore	West Bengal	Nadia	-	3.83	-
57	Hathi Khana	Ganga	MGD-2, Lucknow	U.P.	Fatehgarh	3.90	4.78	4.19
58	Huvinhedgi	Krishna	LKD, Hyderabad	Karnataka	Raichur	-	-	5.93
59	Jajmau	Ganga	MGD-2, Lucknow	U.P.	Kanpur	5.03	4.04	-
60	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	32.61	25.03	16.01
61	Jhalawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	13.46	*
62	K.T.(Satrapur)	Kanhan	WD, Nagpur	Maharashtra	Nagpur	*	62.00	73.33
63	Kachlabridge	Ganga	MGD-2, Lucknow	U.P.	Badaun	-	5.35	3.18
64	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	41.67	23.97	18.76
65	Kalanaur	Yamuna	UYD, New Delhi	U.P.	Saharanpur	12.03	13.34	4.14
66	Kalpi	Yamuna	LYD, Agra	U.P.	Jalaun	5.29	-	4.17
67	Karnal	Yamuna	UYD, New Delhi	Haryana	Karnal	5.57	11.76	9.15
68	Kasganj	Kali	MGD-2, Lucknow	U.P.	Etah	11.63	14.48	4.18
69	Katri Umrauli	Ganga	MGD-2, Lucknow	U.P.	Kannauj	4.78	3.75	-
70	Kaziupura	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	4.92	4.17	3.56
71	Keolari	Wainganga	WD, Nagpur	M.P.	Seoni	-	3.33	-
72	Khatoli	Parwati	CD, Jaipur	Rajasthan	Kota	-	9.34	-
73	Kokiwada	Pench	WD, Nagpur	M.P.	Chhindwara	3.23	4.30	-
74	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	12.70	3.09	-
75	Kota-By Pass	Chambal	CD, Jaipur	Rajasthan	Kota	*	11.63	*

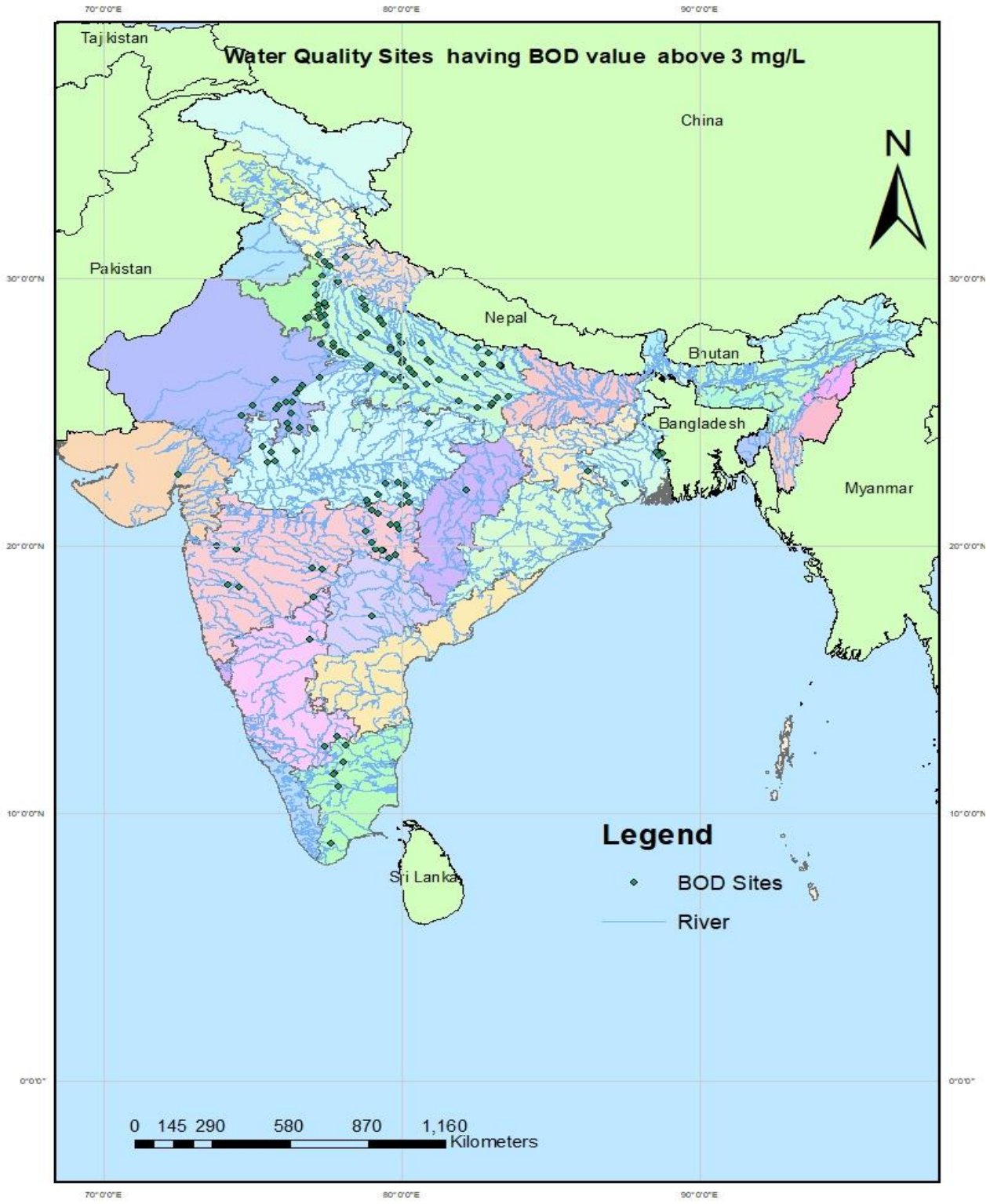
S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
	Hanging Road Bridge u/s ok Kota City							
76	Kumhari	Wainganga	WD, Nagpur	M.P.	Balaghat	4.41	12.01	4.97
77	Lalpur	Sengar	LYD, Agra	U.P.	Kanpur Dehat	-	3.78	-
78	Lodhikheda	Jam	WD, Nagpur	M.P.	Chhindwara	19.60	4.67	6.07
79	Lucknow	Gomti	MGD-2, Lucknow	U.P.	Lucknow	22.27	19.27	4.90
80	Lupungdih	Subarnarekha	ERD, Bhubaneswar	Jharkhand	Saraikela Kharsawan	14.30	-	3.12
81	Magardhara	Wainganga	WD, Nagpur	M.P.	Balaghat	9.19	20.87	-
82	Mahalgaon	Wainganga	WD, Nagpur	Maharashtra	Gondia	-	4.37	-
83	Mahidpur	Shipra	CD, Jaipur	M.P.	Ujjain	*	19.46	*
84	Mandawara	Chambal	CD, Jaipur	Rajasthan	Kota	23.29	9.43	5.93
85	Manderial	Chambal	CD, Jaipur	Rajasthan	Karauli	*	9.80	5.92
86	Mawi	Yamuna	UYD, New Delhi	U.P.	Shamli	9.88	15.48	13.76
87	Mirawadi	Mula Mutha	UKD, Pune	Maharashtra	Pune	*	3.45	3.73
88	Mirzapur	Ganga	MGD-3, Varanasi	U.P.	Mirzapur	3.74	3.55	3.38
89	Mohna	Yamuna	UYD, New Delhi	Haryana	Faridabad	29.42	26.81	25.10
90	Moradabad	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	13.50	13.11	4.94
91	Mungoli	Penganga	WD, Nagpur	Maharashtra	Yavatmal	6.07	13.40	3.10
92	Nanded	Godavari	UGD, Hyderabad	Maharashtra	Nanded	13.62	-	8.94
93	Nandgaon	Wunna	WD, Nagpur	Maharashtra	Wardha	14.40	15.92	-
94	Nashik	Godavari	UGD, Hyderabad	Maharashtra	Nasik	4.74	-	5.09
95	Naugaon	Yamuna	UYD, New Delhi	Uttarakhand	Uttarakashi	-	7.41	-
96	Noida	Yamuna	UYD, New Delhi	U.P.	Gautam Budh Nagar	32.77	29.07	25.06
97	Okhla Barrage	Yamuna	UYD, New Delhi	Delhi	South Delhi	31.18	27.62	26.46
98	Pali	Chambal	CD, Jaipur	Rajasthan	Sawai-madhopur	*	13.39	-
99	Palla	Yamuna	UYD, New Delhi	Delhi	North West Delhi	12.93	17.18	10.94
100	Parmat Ghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur	3.56	3.75	-
101	Parsohan Ghat	Budhi Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	3.94	5.31	-
102	Patala	Wardha	WD, Nagpur	Maharashtra	Chandrapur	4.51	5.24	-
103	Patansaongi	Chandrabhaga	WD, Nagpur	Maharashtra	Nagpur	3.78	-	-
104	Pauni	Wainganga	WD, Nagpur	Maharashtra	Bhandara	6.81	-	-
105	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	31.34	30.46	10.47
106	Purna	Purna	UGD, Hyderabad	Maharashtra	Parbhani	4.19	-	-
107	Raebareli	Sai	MGD-2, Lucknow	U.P.	Raebareli	13.31	12.17	-
108	Rajegaon	Pranhita	WD, Nagpur	M.P.	Balaghat	-	6.32	-
109	Ramakona	Kanhan	WD, Nagpur	M.P.	Chhindwara	3.68	8.29	-
110	Regauli	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	3.27	3.41	-
111	Renukaji	Giri	UYD, New Delhi	H.P.	Sirmaur	-	6.26	5.58
112	Roorkee D/S	Solani	HGD, Haridwar	Uttarakhand	Haridwar	*	16.01	20.90
113	Saidpur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	3.70	-	3.22
114	Saigaon	Manjira	UGD, Hyderabad	Karnataka	Bidar	4.22	-	-

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
115	Sakhara	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	6.09	-	-
116	Sakmur	Wardha	WD, Nagpur	Maharashtra	Chandrapur	8.31	12.11	-
117	Salawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	11.15	7.66
118	Sangod	Parwan	CD, Jaipur	Rajasthan	Kota	*	11.51	-
119	Sarangpur	Kalisindh	CD, Jaipur	M.P.	Rajgarh	*	13.21	*
120	Satna	Tons	MGD-3, Varanasi	M.P.	Satna	3.73	-	3.61
121	Satrapur	Kanhan	WD, Nagpur	Maharashtra	Nagpur	19.24	9.83	-
122	Seohara	Ramganga	MGD-2, Lucknow	U.P.	Bijnaur	3.74	3.70	-
123	Shahjahanpur	Khannaut	MGD-2, Lucknow	U.P.	Shahjahanpur	*	12.96	5.52
124	Singasadanapalli	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	50.77	35.35	31.70
125	Sitapur	Sarayan	MGD-2, Lucknow	U.P.	Sitapur	3.21	4.15	-
126	Sultanpur	Gomti	MGD-3, Varanasi	U.P.	Sultanpur	4.48	3.05	3.17
127	T Bekuppe	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	17.51	12.38	11.02
128	Tal	Chambal	CD, Jaipur	M.P.	Ratlam	*	16.89	*
129	Thevur	Sarabenga	SRD, Coimbatore	Tamil Nadu	Salem	-	4.10	-
130	Thoppur	Thoppaiyar	SRD, Coimbatore	Tamil Nadu	Salem	*	6.42	-
131	Tihar Khera	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	4.73	5.21	3.29
132	Tondarpur	Sukheta	MGD-2, Lucknow	U.P.	Hardoi	*	4.58	5.73
133	Tonk	Banas	CD, Jaipur	Rajasthan	Tonk	*	15.13	*
134	U/S (Bamni)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	*	12.85	3.63
135	Ujjain	Shipra	CD, Jaipur	M.P.	Ujjain	*	24.05	20.88
136	Urachikottai	Cauvery	SRD, Coimbatore	Tamil Nadu	Erode	-	4.90	-
137	V S Bridge	Ganga	MGD-3, Varanasi	U.P.	Varanasi	3.64	3.49	3.48
138	Varanasi	Ganga	MGD-3, Varanasi	U.P.	Varanasi	4.07	3.46	3.41
139	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	23.28	12.72	25.17
140	Veligonda	Musi	LKD, Hyderabad	Telangana	Nalgonda	19.94	20.15	12.95
141	Vrindawan Bridge (Mathura U/S)	Yamuna	UYD, New Delhi	U.P.	Mathura	*	29.85	24.53
142	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	35.94	27.13	17.54
143	Yashwant Nagar	Giri	UYD, New Delhi	H.P.	Simaur	4.77	9.16	11.25

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 19: Water Quality Monitoring stations having Biochemical Oxygen Demand above 3.0 mg/L (2022)



7.1.11 Total Coliform

Coliform organisms serve as indicators of water pollution, and they are commonly rod-shaped bacteria. Due to the challenge of isolating and identifying pathogenic bacteria in wastes and polluted waters, which are typically present in lower numbers, total coliforms are employed as a general indicator for potential contamination with pathogenic organisms. Notably, many coliform bacteria inhabit the soil, potentially serving as the source for those found in water, especially river water. Total coliform encompasses all types of coliforms in river water, whether pathogenic or non-pathogenic. Within various waterborne pathogens, a diverse range of minimum infectious dose levels exists for causing human infections.

The standard method involves determining the most probable number (MPN) of coliforms in the water sample. Coliform organisms are widely recognized as suitable microbial indicators of drinking water quality due to their ease of detection and enumeration in water. The coliform group primarily consists of species from genera such as Citrobacter, Enterobacter, Escherichia, Klebsiella, including faecal coliforms. Although coliform organisms may not be directly linked to the presence of viruses in drinking water, the coliform test remains essential for monitoring the microbial quality of public water supplies. This bacterial group is present in large numbers throughout all seasons, possibly attributed to the addition of sewage and various forms of waste, higher concentrations of suspended particles, and the dark coloration of receiving water.

During the pre-monsoon season, 235 water quality monitoring stations across Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand reported average TC values exceeding 500 MPN/100 ml. In the monsoon season, 247 water quality monitoring stations in Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand displayed similar findings. Finally, in the post-monsoon season, 171 water quality monitoring stations in Delhi, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand recorded average TC values exceeding 500 MPN/100 ml.

Comparision between 2021 & 2022:

The water quality data collected during the pre-monsoon, monsoon, and post-monsoon seasons of 2022 indicates a positive trend in terms of total coliforms (TC) levels in Indian rivers. The slight increase in the number of water quality monitoring stations with elevated TC levels during the pre-monsoon season of 2022, the decrease in the number of monitoring stations during the monsoon season, and the reduction in the number of monitoring stations with elevated TC levels during the post-monsoon season of 2022, indicates that efforts to control the primary sources of total coliforms in Indian rivers have been somewhat successful. The fact that low Biological Oxygen Demand (BOD) stretches tend to have high levels of total coliforms and faecal coliforms underlines the importance of continued efforts to improve water quality in Indian rivers. The positive

trend observed in the water quality data of 2022 is a step in the right direction towards ensuring the health and well-being of all those who depend on Indian rivers for their water needs.

The hot spot study and GIS map for total coliforms parameter are given below in Table 17 and figure 20.

Table 17: Monitoring stations having Total Coliform (TC) 500 MPN in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	A.B.Road Crossing	Parwati	CD, Jaipur	M.P.	Guna	*	115500	47500
2	A.P. Puram	Chittar	SRD, Coimbatore	Tamil Nadu	Tirunelveli	3300	*	*
3	Abu Road	Banas	MD, Gandhinagar	Rajasthan	Sirohi	16000	16000	*
4	Akbarpur	Chhoti sarju	MGD-3, Varanasi	U.P.	Ambedkar Nagar	8866.667	8266.667	9333.333
5	Akkihebbal	Hemavati	CD, Bangalore	Karnataka	Mandya	1202.5	24553.33	18333.33
6	Aklera	Parwan	CD, Jaipur	Rajasthan	Jhalawar	*	48545.45	42666.67
7	Alanthurai	Noyyal	SRD, Coimbatore	Tamil Nadu	Coimbatore	30725	54050	30800
8	Allahabad	Ganga	MGD-3, Varanasi	U.P.	Prayagraj	10466.67	8000	7966.667
9	Ambarampalayam	Bharathapuzha	SRD, Coimbatore	Tamil Nadu	Coimbatore	14206.67	12000	21483.33
10	Ambasamudram	Vaigai	SRD, Coimbatore	Tamil Nadu	Theni	30180	7416.667	42650
11	Ambgaon	Chulband	WD, Nagpur	Maharashtra	Bhandara	1474.667	4452.222	*
12	Ankinghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	6140	6383.333	*
13	Arjunwad	Krishna	UKD, Pune	Maharashtra	Kolhapur	*	64663.64	16766.67
14	Arnota	Uttangan	LYD, Agra	U.P.	Agra	*	3600	-
15	Asthi	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	2827.333	3326.667	7383.333
16	Auraiya	Yamuna	LYD, Agra	U.P.	Auraiya	76453.33	32353.33	67483.33
17	Avarankuppam	Palar	SRD, Coimbatore	Tamil Nadu	Vellore	4300	35550	50150
18	Ayodhya	Ghaghra	MGD-1, Lucknow	U.P.	Ayodhya	3857.143	4016.667	*
19	Badalapur	Ulhas	UKD, Pune	Maharashtra	Thane	23466.67	93000	318000
20	Baghpat	Yamuna	UYD, New Delhi	U.P.	Baghpat	870666.7	446466.7	509666.7
21	Bakhari	Wainganga	WD, Nagpur	M.P.	Seoni	2109.333	9186.667	1833.333
22	Baleni	Yamuna	UYD, New Delhi	U.P.	Baghpat	878666.7	1570000	1550000
23	Balrampur	Rapti	MGD-1, Lucknow	U.P.	Gonda	3735.714	4116.667	*
24	Baluaghat	Ganga	MGD-3, Varanasi	U.P.	Varanasi	12006.67	6680	7816.667
25	Bamni(Nagpur)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	3048.667	7006.667	2450
26	Banda	Ken	LYD, Agra	U.P.	Banda	15988	2548.182	2181.667
27	Bangapani	Gauri Ganga	MGD-1, Lucknow	Uttarakhand	Pithoragarh	2953.333	3009.091	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
28	Bansi	Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	4206.667	4625	*
29	Baranwada	Banas	CD, Jaipur	Rajasthan	Sawai-madhopur	*	170300	117600
30	Bareilly	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	19893.33	19700	*
31	Barod	Kalisindh	CD, Jaipur	Rajasthan	Kota	58888.89	73583.33	34500
32	Basantpur(Ganga)	Ganga	MGD-2, Lucknow	U.P.	Bijnaur	5720	5941.667	*
33	Basoda	Betwa	LYD, Agra	M.P.	Vidisha	3100	2350	3383.333
34	Basti	Kwano	MGD-1, Lucknow	U.P.	Basti	6728.571	6825	*
35	Basti D/S	Kwano	MGD-1, Lucknow	U.P.	Basti	6740	7050	*
36	Basti U/S	Kwano	MGD-1, Lucknow	U.P.	Basti	5893.333	6066.667	*
37	Bawapuram	Tungabhadra	LKD, Hyderabad	A.P.	Kurnool	3500	*	*
38	Belne Bridge	Gad	CD, Bangalore	Maharashtra	Sindhudurg	621.6667	40606.67	30450
39	Bendrahalli	Suvarnavathi	CD, Bangalore	Karnataka	Chamarajanagar	1700	60266.67	62166.67
40	Bhadana Village D/s of Kota City	Chambal/Parwati	CD, Jaipur	Rajasthan	Kota	*	76727.27	*
41	Bhadrachelam	Godavari	LGD, Hyderabad	Telangana	Khammam	5400	*	*
42	Bhatpalli	Peddavagu	WD, Nagpur	Telangana	Asifabad	2415.333	4914.286	4633.333
43	Bhind	Kunwari	LYD, Agra	M.P.	Bhind	6892.857	13920	13400
44	Bhitaura	Ganga	MGD-2, Lucknow	U.P.	Fatehpur	6193.333	6291.667	*
45	Bhitoor	Ganga	MGD-2, Lucknow	U.P.	Kanpur	7940	8383.333	*
46	Bigod	Banas	CD, Jaipur	Rajasthan	Bhilwara	*	198166.7	102833.3
47	Biligundulu	Cauvery	SRD, Coimbatore	Tamil Nadu	Krishnagiri	5493.333	9300	16216.67
48	Birdghat	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	6100	6350	*
49	Byladahalli	Haridra	CD, Bangalore	Karnataka	Davanagere	-	26220	25500
50	Chandrika Devi (Lko U/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	13560	13683.33	*
51	Chilla Gaon	Hindon Cut	UYD, New Delhi	Delhi	East Delhi	1700000	*	*
52	Chindnar	Indravathi	LGD, Hyderabad	Chhattisgarh	Dantewada	2800	*	*
53	Chittorgarh	Gambhiri	CD, Jaipur	Rajasthan	Chittorgarh	*	132500	*
54	Cholachagudda	Malaprabha	CD, Bangalore	Karnataka	Bagalkot	*	49707.14	37666.67
55	Chopan	Sone	MGD-3, Varanasi	U.P.	Sonbhadra	4193.333	4433.333	6066.667
56	Chunchunkatte	Cauvery	CD, Bangalore	Karnataka	Mysore	*	17480	55666.67
57	Dabri	Ramganga	MGD-2, Lucknow	U.P.	Shahjahanpur	10950	10908.33	*
58	Dadri	Sahibi	UYD, New Delhi	Haryana	Jhajjar	*	1196364	*
59	Dameracherla	Musi	LKD, Hyderabad	Telangana	Nalgonda	790	*	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
60	Daund	Bhima	UKD, Pune	Maharashtra	Pune	*	79000	160000
61	Delhi Railway Bridge	Yamuna	UYD, New Delhi	Delhi	North Delhi	15093333	10324667	11766667
62	Deongaon Bridge	Bhima	LKD, Hyderabad	Karnataka	Bijapur	790	*	*
63	Deosugar	Krishna	LKD, Hyderabad	Karnataka	Raichur	1400	*	*
64	Derol Bridge	Sabarmati	MD, Gandhinagar	Gujarat	Sabarkantha	*	11000	*
65	Dhalegaon	Godavari	UGD, Hyderabad	Maharashtra	Parbhani	1400	*	*
66	Dhaneta	Kitcha/Bahgul	MGD-2, Lucknow	U.P.	Bareilly	8464.286	8600	*
67	Dhansa	Sahibi	UYD, New Delhi	Delhi	South West Delhi	*	828888.9	*
68	Dhareri	Chambal	CD, Jaipur	M.P.	Ujjain	*	332500	*
69	Dholpur	Chambal	LYD, Agra	Rajasthan	Dholpur	9506.667	8128.667	18183.33
70	Duddhi	Kanhar	MGD-3, Varanasi	U.P.	Sonbhadra	6080	3860	6950
71	Elgin Bridge	Ghaghra	MGD-1, Lucknow	U.P.	Barabanki	3460	3716.667	*
72	Elunuthi Mangalam	Noyyal	SRD, Coimbatore	Tamil Nadu	Erode	15026.67	62666.67	42833.33
73	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	581428.6	290666.7	516666.7
74	Faizabad U/S	Ghaghra	MGD-1, Lucknow	U.P.	Faizabad	3713.33	3958.333	*
75	Fatehgarh	Ganga	MGD-2, Lucknow	U.P.	Farrukhabad	5666.667	9700	*
76	Gaisabad	Bearma	LYD, Agra	M.P.	Damoh	*	2121	1270
77	Galeta	Hindon	UYD, New Delhi	U.P.	Baghpat	31533333	4919333	32333333
78	Gandhavayal	Gandhayar	SRD, Coimbatore	Tamil Nadu	Coimbatore	32666.67	44420	21166.67
79	Gandlapet	Peddavagu	UGD, Hyderabad	Telangana	Nizamabad	5400	*	*
80	Ganguwala	Yamuna	UYD, New Delhi	H.P.	Sirmaur	1690.667	27800	14333.33
81	Ganod	Bhadar	MD, Gandhinagar	Gujarat	Rajkot	10500	14500	*
82	Garhakota	Sonar	LYD, Agra	M.P.	Sagar	*	3923.333	4900
83	Garhmukteshwar	Ganga	MGD-2, Lucknow	U.P.	Hapur	5320	5416.667	*
84	Garrauli	Dhasan	LYD, Agra	M.P.	Chhatarpur	1586	2105.455	1610
85	Ghat	Sarju	MGD-1, Lucknow	Uttarakhand	Pithoragarh	2764.286	2781.818	*
86	Ghazipur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	10373.33	7413.333	8183.333
87	Gokak	Ghataprabha	CD, Bangalore	Karnataka	Belgaum	*	39866.67	16250
88	Gokul Barrage II Mathura D/S	Yamuna	UYD, New Delhi	U.P.	Mathura	1611333	2694200	2633333
89	Gomti Nagar (Lko D/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	88186.67	94258.33	*
90	Gorakhpur D/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	6100	6508.333	*
91	Gorakhpur U/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	4864.286	5333.333	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
92	GR Bridge	Godavari	UGD, Hyderabad	Maharashtra	Parbhani	2200	*	*
93	Gudam Bridge	Pranhita	WD, Nagpur	Maharashtra	Gadchiroli	*	1329.091	5445
94	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	27337.5	43866.67	57833.33
95	Halia	Halia	LKD, Hyderabad	Telangana	Nalgonda	1400	*	*
96	Hamirpur	Yamuna	LYD, Agra	U.P.	Hamirpur	32533.33	8306.667	32316.67
97	Haralahalli	Tungabhadra	CD, Bangalore	Karnataka	Haveri	1487.5	14746.67	16416.67
98	Hariharapura	Tunga	CD, Bangalore	Karnataka	Chikamagalur	-	23393.33	27833.33
99	Haripur	Tons	UYD, New Delhi	Uttarakhand	Dehradun	6097.778	13060	10150
100	Hathi Khana	Ganga	MGD-2, Lucknow	U.P.	Fatehgarh	9707.143	10025	*
101	Hivra	Wardha	WD, Nagpur	Maharashtra	Wardha	1667.333	2887.333	3400
102	Hogenakkal	Chinnar	SRD, Coimbatore	Tamil Nadu	Dharmapuri	*	102125	39500
103	Holehonnur	Bhadra	CD, Bangalore	Karnataka	Shimoga	2696.25	13013.33	54833.33
104	Honnali	Tungabhadra	CD, Bangalore	Karnataka	Davanagere	1278.75	22533.33	34183.33
105	Hoovinahole	Swarnamukhi	CD, Bangalore	Karnataka	Chitradurga	*	68185.71	15000
106	Huvinhedgi	Krishna	LKD, Hyderabad	Karnataka	Raichur	1400	*	*
107	Jagdalpur	Indravathi	LGD, Hyderabad	Chhattisgarh	Bastar	5400	*	*
108	Jajmau	Ganga	MGD-2, Lucknow	U.P.	Kanpur	17893.33	17300	*
109	Jaunpur	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	9260	6713.333	8033.333
110	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	690666.7	330000	211666.7
111	Jhalawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	827800	*
112	Jhansi Mirjapur Highway Road Bridge	Betwa	LYD, Agra	U.P.	Hamirpur	6166.667	5340	14316.67
113	K M Vadi	Cauvery/ Lakshmanthirth	CD, Bangalore	Karnataka	Mysore	2200	55073.33	59166.67
114	Kabirganj	Sharda	MGD-1, Lucknow	U.P.	Pilibhit	3746.66	4050	*
115	Kachlabridge	Ganga	MGD-2, Lucknow	U.P.	Badaun	6546.667	6516.667	*
116	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	716666.7	370000	256666.7
117	Kalanaur	Yamuna	UYD, New Delhi	U.P.	Saharanpur	81666.67	121785.7	31333.33
118	Kalpi	Yamuna	LYD, Agra	U.P.	Jalaun	35246.67	9566.667	34566.67
119	Kannauj	Kali	MGD-2, Lucknow	U.P.	Kannauj	12706.67	12750	*
120	Kanpur	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	17726.67	17100	*
121	Karad	Krishna	UKD, Pune	Maharashtra	Satara	*	81000	10100
122	Karnal	Yamuna	UYD, New	Haryana	Karnal	200333.3	35133.33	149833.3

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
			Delhi					
123	Kasganj	Kali	MGD-2, Lucknow	U.P.	Etah	10426.67	10783.33	*
124	Katri Umrauli	Ganga	MGD-2, Lucknow	U.P.	Kannauj	8520	8833.333	*
125	Kaziupura	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	10700	10766.67	*
126	Keesara	Munneru	LKD, Hyderabad	A.P.	Krishna	790	*	*
127	Keolari	Wainganga	WD, Nagpur	M.P.	Seoni	683.3333	6015.333	676.6667
128	Khanpur	Mahi	MD, Gandhinagar	Gujarat	Anand	18693.33	2600	*
129	Khatoli	Parwati	CD, Jaipur	Rajasthan	Kota	18000	103200	66500
130	Kodumudi	Cauvery	SRD, Coimbatore	Tamil Nadu	Erode	8826.667	20246.67	16300
131	Koggedoddi	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	1323.75	40260	32500
132	Kokiwada	Pench	WD, Nagpur	M.P.	Chhindwara	3874	3286.667	693.3333
133	Kollegal	Cauvery	CD, Bangalore	Karnataka	Chamarajanagar	1682.5	51132	22666.67
134	Konta	Sabari	LGD, Hyderabad	Chhattisgarh	Bastar	1400	*	*
135	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	5400	*	*
136	Kora	Rind	LYD, Agra	U.P.	Fatehpur	4335.714	3803.333	4010
137	Kota-By Pass Hanging Road Bridge u/s ok Kota City	Chambal	CD, Jaipur	Rajasthan	Kota	*	55727.27	*
138	Kudige	Cauvery	CD, Bangalore	Karnataka	Kodagu	1491.25	17586.67	36333.33
139	Kudlur	Palar	SRD, Coimbatore	Karnataka	Chamarajanagar	12220	22553.85	50200
140	Kuldahbridge	Sone	MGD-3, Varanasi	M.P.	Sidhi	5086.667	5900	8683.333
141	Kumhari	Wainganga	WD, Nagpur	M.P.	Balaghat	-	1590.667	-
142	Kuppelur	Kumudavathi	CD, Bangalore	Karnataka	Haveri	1700	24800	29833.33
143	Kurundwad	Krishna	UKD, Pune	Maharashtra	Kolhapur	*	16191.67	6500
144	Lakkavalli	Bhadra	CD, Bangalore	Karnataka	Chikamagalur	667.875	18740	42966.67
145	Lakshmanapatti	Kodaganar	SRD, Coimbatore	Tamil Nadu	Dindigul	12766.67	14660	43166.67
146	Lalpur	Sengar	LYD, Agra	U.P.	Kanpur Dehat	6838	9245	4700
147	Lodhikheda	Jam	WD, Nagpur	M.P.	Chhindwara	8235.333	10186.67	9550
148	Lucknow	Gomti	MGD-2, Lucknow	U.P.	Lucknow	84006.67	84708.33	*
149	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	17613.33	32666.67	*
150	M H Halli	Hemavati	CD, Bangalore	Karnataka	Hassan	1278.75	14326.67	24800
151	Madhira	Wyra	LKD, Hyderabad	Telangana	Khammam	2800	*	*
152	Madla	Ken	LYD, Agra	M.P.	Panna	*	1498.182	1946.667
153	Magardhara	Wainganga	WD, Nagpur	M.P.	Balaghat	5323.333	5906.667	5090

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
154	Mahalgaon	Wainganga	WD, Nagpur	Maharashtra	Gondia	2922	1542	1051.667
155	Mahidpur	Shipra	CD, Jaipur	M.P.	Ujjain	*	134800	*
156	Maighat	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	8440	6946.667	6716.667
157	Malkhed	Kangna	LKD, Hyderabad	Karnataka	Gulbarga	790	*	*
158	Mancherial	Godavari	UGD, Hyderabad	Telangana	Mancherial	1400	*	*
159	Mandawara	Chambal	CD, Jaipur	Rajasthan	Kota	54769.23	79000	94500
160	Manderial	Chambal	CD, Jaipur	Rajasthan	Karauli	*	132545.5	69833.33
161	Mangaon	Kal	UKD, Pune	Maharashtra	Raigad	*	55666.67	9000
162	Mantralayam	Tungabhadra	LKD, Hyderabad	A.P.	Kurnool	2200	*	*
163	Marella	Gundlakamma	LKD, Hyderabad	A.P.	Prakasam	790	*	*
164	Marol	Varada	CD, Bangalore	Karnataka	Haveri	5400	27769.23	4100
165	Mataji	Mahi	MD, Gandhinagar	M.P.	Ratlam	18016.67	15000	*
166	Mawi	Yamuna	UYD, New Delhi	U.P.	Shamli	129866.7	1029333	1231667
167	Mehandipur	Ganga	MGD-2, Lucknow	U.P.	Kannauj	5135.714	10450	*
168	Mejaroad	Tons	MGD-3, Varanasi	U.P.	Prayagraj	6980	4073.333	2950
169	Mirawadi	Mula Mutha	UKD, Pune	Maharashtra	Pune	*	100609.1	136666.7
170	Mirzapur	Ganga	MGD-3, Varanasi	U.P.	Mirzapur	8586.667	8753.333	8516.667
171	Mohana	Betwa	LYD, Agra	U.P.	Jalaun	5446.667	3896	13006.67
172	Mohna	Yamuna	UYD, New Delhi	Haryana	Faridabad	844000	1092667	1566667
173	Moradabad	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	21206.67	20033.33	*
174	Mungoli	Penganga	WD, Nagpur	Maharashtra	Yavatmal	-	4111.333	1486.667
175	Munugodu	Edduvagu	LKD, Hyderabad	A.P.	Guntur	790	*	*
176	Muradpur	Vashishti	UKD, Pune	Maharashtra	Ratnagiri	2175	19593.33	5000
177	Murappanadu	Tambraparani	SRD, Coimbatore	Tamil Nadu	Tuticorin	6486.667	7520	10600
178	Musiri	Cauvery	SRD, Coimbatore	Tamil Nadu	Thiruchirapalli	17760	12106.67	17666.67
179	Muthankera	Kabini	CD, Bangalore	Kerala	Wayanad	2314.125	32133.33	24833.33
180	Nagothane	Amba	UKD, Pune	Maharashtra	Raigad	-	52000	5000
181	Nallamaranpatty	Amaravathi	SRD, Coimbatore	Tamil Nadu	Karur	2800	16018.18	12983.33
182	Nanded	Godavari	UGD, Hyderabad	Maharashtra	Nanded	2400	*	*
183	Nandgaon	Wunna	WD, Nagpur	Maharashtra	Wardha	2154.667	7151.333	8450
184	Nashik	Godavari	UGD, Hyderabad	Maharashtra	Nasik	5400	*	*
185	Naugaon	Yamuna	UYD, New Delhi	Uttarakhand	Uttarakashi	8572.727	29142.86	10060
186	Neemsar	Gomti	MGD-2, Lucknow	U.P.	Sitapur	8250	8433.333	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
187	Nellithurai	Bhavani	SRD, Coimbatore	Tamil Nadu	Coimbatore	*	32000	*
188	Noida	Yamuna	UYD, New Delhi	U.P.	Gautam Budh Nagar	50466667	38746667	81166667
189	Nowrangpur	Indravathi	LGD, Hyderabad	Odisha	Nowrangpur	1700	*	*
190	Odenthurai	Kallar	SRD, Coimbatore	Tamil Nadu	Coimbatore	24933.33	51066.67	57833.33
191	Okhla Barrage	Yamuna	UYD, New Delhi	Delhi	South Delhi	945000	*	*
192	Orai Rath marg Road Bridge, Chikasi	Betwa	LYD, Agra	U.P.	Jalaun	5120	3766.667	13650
193	P.G.Bridge	Penganga	WD, Nagpur	Maharashtra	Yavatmal	945.3333	3842	795
194	Pachawali	Sindh	LYD, Agra	M.P.	Shivpuri	2975	1390	1700
195	Pachegaon	Pravara	UGD, Hyderabad	Maharashtra	Ahmednagar	2800	*	*
196	Padardibadi	Mahi	MD, Gandhinagar	Rajasthan	Dungarpur	16326.67	14516.67	*
197	Pali	Chambal	CD, Jaipur	Rajasthan	Sawai-madhopur	*	116153.8	47166.67
198	Paliakalan	Sharda	MGD-1, Lucknow	U.P.	Lakhimpur Khiri	3553.333	3908.333	*
199	Palla	Yamuna	UYD, New Delhi	Delhi	North West Delhi	167066.7	1172000	398166.7
200	Paramkudi	Vaigai	SRD, Coimbatore	Tamil Nadu	Ramanathapuram	*	27942.86	10383.33
201	Pargaon	Bhima	UKD, Pune	Maharashtra	Pune	*	79436.36	88500
202	Parmat Ghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur	11606.67	12191.67	*
203	Parsohan Ghat	Budhi Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	4226.667	4325	*
204	Patala	Wardha	WD, Nagpur	Maharashtra	Chandrapur	3004	5386.667	2243.333
205	Patansaongi	Chandrabhaga	WD, Nagpur	Maharashtra	Nagpur	3955.556	8515.385	9466.667
206	Pathagudem	Indravathi	LGD, Hyderabad	Chhattisgarh	Bijapur	1700	*	*
207	Pauni	Wainganga	WD, Nagpur	Maharashtra	Bhandara	3580	3464.286	8033.333
208	Perur	Godavari	UGD, Hyderabad	Telangana	Mulugu	1700	*	*
209	Phulgaon	Bhima	UKD, Pune	Maharashtra	Pune	*	93000	*
210	Poanta	Yamuna	UYD, New Delhi	H.P.	Simaur	25733.33	55000	14666.67
211	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	620000	404000	193333.3
212	Polavaram	Godavari	LGD, Hyderabad	A.P.	West Godavari	1400	*	*
213	Pratap pur	Yamuna	LYD, Agra	U.P.	Prayagraj	15293	6140	4200
214	Pratapgarh	Sai	MGD-3, Varanasi	U.P.	Pratapgarh	8433.333	5800	8166.667
215	Purna	Purna	UGD, Hyderabad	Maharashtra	Parbhani	2200	*	*
216	Raebareli	Sai	MGD-2, Lucknow	U.P.	Raebareli	11600	12041.67	*
217	Rajamundry	Godavari	LGD, Hyderabad	A.P.	East Godavari	3500	*	*
218	Rajapur	Yamuna	LYD, Agra	U.P.	Chitrakoot	15360	6362	4800
219	Rajegaon	Pranhita	WD, Nagpur	M.P.	Balaghat	2348	1829.333	1921.667

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
220	Rajghat (Agra)	Betwa	LYD, Agra	U.P.	Lalitpur	1475.714	891.5385	1733.333
221	Ramakona	Kanhan	WD, Nagpur	M.P.	Chhindwara	2731.333	9666.667	10550
222	Rangeli	Som	MD, Gandhinagar	Rajasthan	Dungarpur	18573.33	5465	*
223	Regauli	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	4133.333	4416.667	*
224	Renukaji	Giri	UYD, New Delhi	H.P.	Sirmaur	2504	28893.33	14366.67
225	Sahijana	Betwa	LYD, Agra	U.P.	Hamirpur	9722.667	5500	13650
226	Saidpur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	8633.333	9020	8300
227	Saigaon	Manjira	UGD, Hyderabad	Karnataka	Bidar	2400	*	*
228	Sakhara	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	5362.667	4648.571	6216.667
229	Sakleshpura	Hemavati	CD, Bangalore	Karnataka	Hassan	800	36386.67	38333.33
230	Sakmur	Wardha	WD, Nagpur	Maharashtra	Chandrapur	2032.667	2384.615	1071.667
231	Salawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	1045000	745000
232	Saloora	Manjira	UGD, Hyderabad	Telangana	Nizamabad	5400	*	*
233	Samdoli	Warna	UKD, Pune	Maharashtra	Sangli	*	26145.45	4333.333
234	Sangam(LGD)	Kinnerasani	LGD, Hyderabad	Telangana	Bhadradri Kothagudem	9200	*	*
235	Sangod	Parwan	CD, Jaipur	Rajasthan	Kota	*	94363.64	94500
236	Saradaput	Sabari	LGD, Hyderabad	Chhattisgarh	Malkangiri	1700	*	*
237	Sarangpur	Kalisindh	CD, Jaipur	M.P.	Rajgarh	*	137600	*
238	Sarati	Nira	UKD, Pune	Maharashtra	Pune	*	32841.67	90000
239	Satna	Tons	MGD-3, Varanasi	M.P.	Satna	6826.667	4146.667	8166.667
240	Satrapur	Kanhan	WD, Nagpur	Maharashtra	Nagpur	4500	10680	5516.667
241	Savandapur	Bhavani	SRD, Coimbatore	Tamil Nadu	Erode	16693.33	15278.57	38316.67
242	Seohara	Ramganga	MGD-2, Lucknow	U.P.	Bijnaur	5540	5741.667	*
243	Seondha	Sindh	LYD, Agra	M.P.	Datia	1834.167	1235	1806.667
244	Sevanur	Chittar	SRD, Coimbatore	Tamil Nadu	Erode	21750	45600	22500
245	Shahjahanpur	Khannaut	MGD-2, Lucknow	U.P.	Shahjahanpur	6928.571	7091.667	*
246	Shahzadpur	Ganga	MGD-3, Varanasi	U.P.	Kaushambi	8380	7173.333	5833.333
247	Shastri Bridge	Ganga	MGD-3, Varanasi	U.P.	Prayagraj	8980	7993.333	7850
248	Shimoga	Tunga	CD, Bangalore	Karnataka	Shimoga	*	13608.33	33166.67
249	Singasadanapalli	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	2912267	6733333	1781667
250	Sitapur	Sarayan	MGD-2, Lucknow	U.P.	Sitapur	7286.667	7433.333	*
251	Suddakallu	Dindi	LKD, Hyderabad	Telangana	Mahaboob Nagar	1400	*	*
252	Sultanpur	Gomti	MGD-3, Varanasi	U.P.	Sultanpur	8773.333	7073.333	8383.333

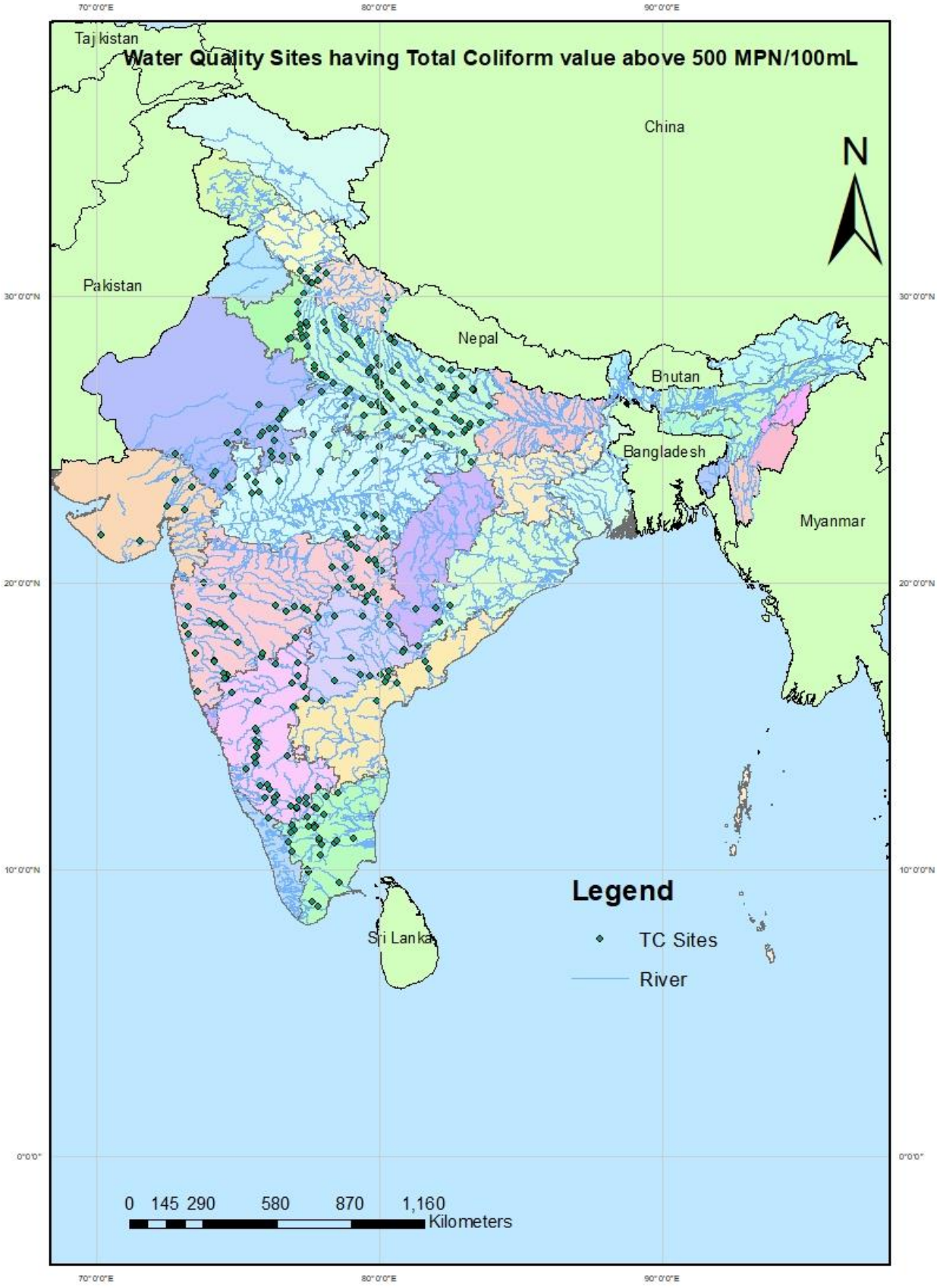
S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
253	T Bekuppe	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	9912.5	160126.7	59833.33
254	T K Halli	Shimsha	CD, Bangalore	Karnataka	Mandya	3375	52045.33	71666.67
255	T Narsipura	Kabini	CD, Bangalore	Karnataka	Mysore	2286.25	61220	54500
256	T.Ramapuram	Hagari	LKD, Hyderabad	Karnataka	Bellary	1400	*	*
257	Takali	Bhima	UKD, Pune	Maharashtra	Solapur	*	52875	50000
258	Tal	Chambal	CD, Jaipur	M.P.	Ratlam	*	112600	*
259	Tanda D/S	Ghaghra	MGD-1, Lucknow	U.P.	Ambedkar Nagar	3826.667	4058.333	*
260	Tanda U/S	Ghaghra	MGD-1, Lucknow	U.P.	Ambedkar Nagar	3333.333	3391.667	*
261	Tandalaiputhur	Ayyar	SRD, Coimbatore	Tamil Nadu	Thiruchirapalli	4100	45400	39666.67
262	Terwad	Panchganga	UKD, Pune	Maharashtra	Kolhapur	*	40750	75666.67
263	Thengumarahada	Bhavani / Moyar	SRD, Coimbatore	Tamil Nadu	Nilgiris	7746.667	48566.67	29980
264	Theni	Vagai/Suruliar	SRD, Coimbatore	Tamil Nadu	Theni	18980	51250	43166.67
265	Thevur	Sarabenga	SRD, Coimbatore	Tamil Nadu	Salem	4850	33666.67	46500
266	Thimmanahalli	Yagachi	CD, Bangalore	Karnataka	Hassan	898.75	34333.33	25833.33
267	Thoppur	Thoppaiyar	SRD, Coimbatore	Tamil Nadu	Salem	*	39600	42400
268	Tihar Khera	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	14173.33	14550	*
269	Tondarpur	Sukheta	MGD-2, Lucknow	U.P.	Hardoi	7866.667	7916.667	*
270	Tonk	Banas	CD, Jaipur	Rajasthan	Tonk	*	151428.6	*
271	Tuini	Tons	UYD, New Delhi	Uttarakhand	Dehradun	1234.667	28066.67	13300
272	Turtipar	Ghaghra	MGD-1, Lucknow	U.P.	Ballia	3333.333	3925	*
273	Udi	Chambal	LYD, Agra	U.P.	Etawah	8320	5968.667	10483.33
274	Ujjain	Shipra	CD, Jaipur	M.P.	Ujjain	*	181272.7	104500
275	Urachikottai	Cauvery	SRD, Coimbatore	Tamil Nadu	Erode	15666.67	19626.67	11000
276	V S Bridge	Ganga	MGD-3, Varanasi	U.P.	Varanasi	8233	8293	7317
277	Varanasi	Ganga	MGD-3, Varanasi	U.P.	Varanasi	10366.67	8120	8333.333
278	Varanavasi	Maruthaiyar	SRD, Coimbatore	Tamil Nadu	Ariyalur	16385.71	27600	18150
279	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	1328667	208333	-
280	Veligonda	Musi	LKD, Hyderabad	Telangana	Nalgonda	940	*	*
281	Vijayawada	Krishna	LKD, Hyderabad	A.P.	Krishna	1400	*	*
282	Vrindawan Bridge (Mathura U/S)	Yamuna	UYD, New Delhi	U.P.	Mathura	*	4332000	4466667
283	Wadakbal	Sina	UKD, Pune	Maharashtra	Solapur	*	84600	113333.3
284	Wadenapally	Krishna	LKD, Hyderabad	Telangana	Nalgonda	940	*	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
285	Wairagarh	Khobragadi	WD, Nagpur	Maharashtra	Gadchiroli	765	4093	3316.667
286	Warunji	Koyna	UKD, Pune	Maharashtra	Satara	*	83800	16333.33
287	Watrak Nr Vautha	Watrak	MD, Gandhinagar	Gujarat	Kheda	*	21816.67	*
288	Yadgir	Bhima	LKD, Hyderabad	Karnataka	Yadgir	1400	*	*
289	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	502857.1	393333.3	293333.3
290	Yashwant Nagar	Giri	UYD, New Delhi	H.P.	Simaur	12273.33	32133.33	13300
291	Yelli	Godavari	UGD, Hyderabad	Maharashtra	Nanded	3500	*	*

(-) means No Hotspot.

(*) means river dry/data not available.

Figure 20: Water Quality Monitoring stations having Total Coliform above 500 MPN/100ml (2022)



7.1.12 Faecal Coliform

The faecal coliform groups of microorganisms typically originate from the feces of humans and other animals. They are more specific, referring to coliforms residing in the intestinal tract of both humans and many other animals. The intestinal tracts of humans contain numerous coliform bacteria, with each person discharging 100 to 400 billion faecal coliforms daily. Coliform bacteria such as Escherichia coli serve as crucial indicators of pollution resulting from faecal material of human and animal origin.

Detecting all waterborne faecal pathogens proves challenging. Pathogens are relatively scarce in water, posing difficulties in direct and time-consuming monitoring. Instead, monitoring faecal coliform levels is preferred due to the observed correlation.

Various indicators of faecal contamination are commonly employed to identify faecal coliform in river water. The abundance of these indicators is assumed to correlate with the density of pathogenic microorganisms originating from faecal sources. Consequently, it serves as an indication of the sanitary risk associated with various water utilizations.

During pre-monsoon season, 199 water quality monitoring stations across Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand reported average FC values exceeding 500 MPN/100 ml. In the monsoon season, 241 water quality monitoring stations in Andhra Pradesh, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand displayed similar findings. Finally, in the post-monsoon season, 158 water quality monitoring stations in Andhra Pradesh, Delhi, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand recorded average FC values exceeding 500 MPN/100 ml.

Comparision between 2021 & 2022:

Between 2021 and 2022, there was a marginal increase (174 to 199) in the number of water quality monitoring stations with elevated FC levels during the pre-monsoon season. During the monsoon season of 2021 and 2022, 240 & 241 number of monitoring stations above the acceptable limit respectively, which is almost same. The post-monsoon season of 2022 (158 monitoring stations) also displayed a reduction in the number of monitoring stations with elevated FC levels compared to the post-monsoon season of 2021 (186 monitoring stations). The comparison between 2021 and 2022 suggests some variations in the trends of Faecal Coliforms across different seasons. While the pre-monsoon season of 2022 showed a slight increase in the number of monitoring stations with elevated FC levels, both the monsoon and post-monsoon seasons displayed some improvement compared to the corresponding seasons in 2021.

The hot spot study and GIS map for faecal coliform are given below in Table 18 and figure 21.

Table 18: Monitoring stations having Faecal Coliforms (FC) 500 MPN in River Water in 2022

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
1	A.B.Road Crossing	Parwati	CD, Jaipur	M.P.	Guna	*	15333	12500
2	A.P. Puram	Chittar	SRD, Coimbatore	Tamil Nadu	Tirunelveli	680	*	*
3	Abu Road	Banas	MD, Gandhinagar	Rajasthan	Sirohi	1633	2400	-
4	Akbarpur	Chhoti sarju	MGD-3, Varanasi	U.P.	Ambedkar Nagar	4767	4273	4917
5	Akkihebbal	Hemavati	CD, Bangalore	Karnataka	Mandya	-	5993	2567
6	Aklera	Parwan	CD, Jaipur	Rajasthan	Jhalawar	*	9600	8300
7	Alanthurai	Noyyal	SRD, Coimbatore	Tamil Nadu	Coimbatore	885	1820	2700
8	Allahabad	Ganga	MGD-3, Varanasi	U.P.	Prayagraj	5673	4080	4083
9	Ambarampalayam	Bharathapuzha	SRD, Coimbatore	Tamil Nadu	Coimbatore	640	667	2080
10	Ambasamudram	Vaigai	SRD, Coimbatore	Tamil Nadu	Theni	1032	580	2093
11	Ambgaon	Chulband	WD, Nagpur	Maharashtra	Bhandara	-	2442	*
12	Ankinghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	3120	3208	*
13	Arjunwad	Krishna	UKD, Pune	Maharashtra	Kolhapur	*	10136	2133
14	Arnota	Uttangan	LYD, Agra	U.P.	Agra	*	2000	*
15	Asthi	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	753	1016	1565
16	Auraiya	Yamuna	LYD, Agra	U.P.	Auraiya	51513	18619	40083
17	Avarankuppam	Palar	SRD, Coimbatore	Tamil Nadu	Vellore	648	2799	8163
18	Ayodhya	Ghaghra	MGD-1, Lucknow	U.P.	Ayodhya	1914	1950	*
19	Badalapur	Ulhas	UKD, Pune	Maharashtra	Thane	4167	15487	40567
20	Baghpat	Yamuna	UYD, New Delhi	U.P.	Baghpat	51800	32987	87333
21	Bakhari	Wainganga	WD, Nagpur	M.P.	Seoni	621	2533	957
22	Baleni	Yamuna	UYD, New Delhi	U.P.	Baghpat	52387	191333	151667
23	Balrampur	Rapti	MGD-1, Lucknow	U.P.	Gonda	1857	2075	*
24	Baluaghat	Ganga	MGD-3, Varanasi	U.P.	Varanasi	6640	3393	4350
25	Bamni(Nagpur)	Wardha	WD, Nagpur	Maharashtra	Chandrapur	799	2574	1312
26	Banda	Ken	LYD, Agra	U.P.	Banda	9930	1496	1090
27	Bangapani	Gauri Ganga	MGD-1, Lucknow	Uttarakhand	Pithoragarh	1547	1573	*
28	Bansi	Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	2193	2358	*
29	Baranwada	Banas	CD, Jaipur	Rajasthan	Sawai-madhopur	*	11140	7240
30	Bareilly	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	10207	10017	*
31	Barod	Kalisindh	CD, Jaipur	Rajasthan	Kota	10233	5433	4333

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
32	Basantpur(Ganga)	Ganga	MGD-2, Lucknow	U.P.	Bijnaur	2900	2992	*
33	Basoda	Betwa	LYD, Agra	M.P.	Vidisha	2218	1377	2098
34	Basti	Kwano	MGD-1, Lucknow	U.P.	Basti	3414	3467	*
35	Basti D/S	Kwano	MGD-1, Lucknow	U.P.	Basti	3447	3500	*
36	Basti U/S	Kwano	MGD-1, Lucknow	U.P.	Basti	3007	3033	*
37	Bawapuram	Tungabhadra	LKD, Hyderabad	A.P.	Kurnool	1700	-	-
38	Bendrahalli	Suvarnavathi	CD, Bangalore	Karnataka	Chamarajanagar	-	9233	3767
39	Bhadana Village D/s of Kota City	Chambal/Parwati	CD, Jaipur	Rajasthan	Kota	*	10927	*
40	Bhadrachelam	Godavari	LGD, Hyderabad	Telangana	Khammam	2200	*	*
41	Bhatpalli	Peddavagu	WD, Nagpur	Telangana	Asifabad	520	1676	825
42	Bhind	Kunwari	LYD, Agra	M.P.	Bhind	4384	8173	6483
43	Bhitaura	Ganga	MGD-2, Lucknow	U.P.	Fatehpur	3120	3183	*
44	Bhitoor	Ganga	MGD-2, Lucknow	U.P.	Kanpur	4133	4392	*
45	Bigod	Banas	CD, Jaipur	Rajasthan	Bhilwara	*	13050	10450
46	Biligundulu	Cauvery	SRD, Coimbatore	Tamil Nadu	Krishnagiri	-	723	503
47	Birdghat	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	3187	3267	*
48	Byladahalli	Haridra	CD, Bangalore	Karnataka	Davanagere	-	1433	1547
49	Chandrika Devi (Lko U/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	7960	7100	*
50	Chilla Gaon	Hindon Cut	UYD, New Delhi	Delhi	East Delhi	110000	*	*
51	Chindnar	Indravathi	LGD, Hyderabad	Chhattisgarh	Dantewada	1400	*	*
52	Chittorgarh	Gambhiri	CD, Jaipur	Rajasthan	Chittorgarh	*	8975	*
53	Cholachagudda	Malaprabha	CD, Bangalore	Karnataka	Bagalkot	*	2246	1547
54	Chopan	Sone	MGD-3, Varanasi	U.P.	Sonbhadra	2053	2320	3150
55	Chunchunkatte	Cauvery	CD, Bangalore	Karnataka	Mysore	*	2978	3847
56	Dabri	Ramganga	MGD-2, Lucknow	U.P.	Shahjahanpur	5800	5317	*
57	Dadri	Sahibi	UYD, New Delhi	Haryana	Jhajjar	*	127727	*
58	Daund	Bhima	UKD, Pune	Maharashtra	Pune	*	14800	45667
59	Delhi Railway Bridge	Yamuna	UYD, New Delhi	Delhi	North Delhi	2311333	4718667	2080000
60	Deosugar	Krishna	LKD, Hyderabad	Karnataka	Raichur	1100	*	*
61	Derol Bridge	Sabarmati	MD, Gandhinagar	Gujarat	Sabarkantha	*	2300	*
62	Dhalegaon	Godavari	UGD, Hyderabad	Maharashtra	Parbhani	940	*	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
63	Dhaneta	Kitcha/Bahgul	MGD-2, Lucknow	U.P.	Bareilly	4343	4467	*
64	Dhansa	Sahibi	UYD, New Delhi	Delhi	South West Delhi	*	75556	*
65	Dhareri	Chambal	CD, Jaipur	M.P.	Ujjain	*	27025	*
66	Dholpur	Chambal	LYD, Agra	Rajasthan	Dholpur	6467	4549	8350
67	Duddhi	Kanhar	MGD-3, Varanasi	U.P.	Sonbhadra	3147	1886	3983
68	Elgin Bridge	Ghaghra	MGD-1, Lucknow	U.P.	Barabanki	1727	1833	*
69	Elunuthi Mangalam	Noyyal	SRD, Coimbatore	Tamil Nadu	Erode	747	1861	7017
70	Etawah	Yamuna	LYD, Agra	U.P.	Etawah	358500	178000	311667
71	Faizabad U/S	Ghaghra	MGD-1, Lucknow	U.P.	Faizabad	1893.33	1869	*
72	Fatehgarh	Ganga	MGD-2, Lucknow	U.P.	Farrukhabad	2880	2933	*
73	Gaisabad	Bearma	LYD, Agra	M.P.	Damoh	*	1149	-
74	Galeta	Hindon	UYD, New Delhi	U.P.	Baghpat	8568667	571133	4650000
75	Gandhavayal	Gandhayar	SRD, Coimbatore	Tamil Nadu	Coimbatore	812	3919	2508
76	Gandlapet	Peddavagu	UGD, Hyderabad	Telangana	Nizamabad	2200	*	*
77	Ganguwala	Yamuna	UYD, New Delhi	H.P.	Sirmaur	-	5033	3500
78	Ganod	Bhadar	MD, Gandhinagar	Gujarat	Rajkot	1775	1800	*
79	Garhakota	Sonar	LYD, Agra	M.P.	Sagar	*	2099	2300
80	Garhmukteshwar	Ganga	MGD-2, Lucknow	U.P.	Hapur	2747	2825	*
81	Garrauli	Dhasan	LYD, Agra	M.P.	Chhatarpur	1064	1164	993
82	Ghat	Sarju	MGD-1, Lucknow	Uttarakhand	Pithoragarh	1657	1436	*
83	Ghazipur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	5740	3773	4183
84	Gokak	Ghataprabha	CD, Bangalore	Karnataka	Belgaum	*	3654	1370
85	Gokul Barrage II Mathura D/S	Yamuna	UYD, New Delhi	U.P.	Mathura	111467	325800	525000
86	Gomti Nagar (Lko D/S)	Gomti	MGD-2, Lucknow	U.P.	Lucknow	44360	48017	*
87	Gorakhpur D/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	3267	3433	*
88	Gorakhpur U/S	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	2557	2758	*
89	GR Bridge	Godavari	UGD, Hyderabad	Maharashtra	Parbhani	1400	*	*
90	Gudam Bridge	Pranhita	WD, Nagpur	Maharashtra	Gadchiroli	*	656	2035
91	Gummanur	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	553	1337	10867
92	Hamirpur	Yamuna	LYD, Agra	U.P.	Hamirpur	21360	4520	19983
93	Haralahalli	Tungabhadra	CD, Bangalore	Karnataka	Haveri	-	1691	1822
94	Hariharapura	Tunga	CD,	Karnataka	Chikamagalur	-	2304	2233

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
			Bangalore					
95	Haripur	Tons	UYD, New Delhi	Uttarakhand	Dehradun	2289	3600	9833
96	Hathi Khana	Ganga	MGD-2, Lucknow	U.P.	Fatehgarh	4871	4975	*
97	Hivra	Wardha	WD, Nagpur	Maharashtra	Wardha	595	1245	657
98	Hogenakkal	Chinnar	SRD, Coimbatore	Tamil Nadu	Dharmapuri	*	1059	5980
99	Holehonnur	Bhadra	CD, Bangalore	Karnataka	Shimoga	-	1729	3333
100	Hoovinahole	Swarnamukhi	CD, Bangalore	Karnataka	Chitradurga	*	4971	1310
101	Huvinhedgi	Krishna	LKD, Hyderabad	Karnataka	Raichur	940	*	*
102	Jagdalpur	Indravathi	LGD, Hyderabad	Chhattisgarh	Bastar	2400	*	*
103	Jajmau	Ganga	MGD-2, Lucknow	U.P.	Kanpur	9293	9583	*
104	Jaunpur	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	4860	3447	4200
105	Jawahar Bridge, Agra	Yamuna	LYD, Agra	U.P.	Agra	429333	210667	140000
106	Jhalawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	130400	*
107	Jhansi Mirjapur Highway Road Bridge	Betwa	LYD, Agra	U.P.	Hamirpur	3933	3333	7467
108	K M Vadi	Cauvery/ Lakshmanthirth	CD, Bangalore	Karnataka	Mysore	-	13167	2480
109	Kabirganj	Sharda	MGD-1, Lucknow	U.P.	Pilibhit	1907	2033	*
110	Kachlabridge	Ganga	MGD-2, Lucknow	U.P.	Badaun	3427	3425	*
111	Kailash Mandir, Near Benpur Village	Yamuna	LYD, Agra	U.P.	Agra	446667	225933	160000
112	Kalanaur	Yamuna	UYD, New Delhi	U.P.	Saharanpur	6207	8464	7583
113	Kalpi	Yamuna	LYD, Agra	U.P.	Jalaun	21413	5846	18750
114	Kannauj	Kali	MGD-2, Lucknow	U.P.	Kannauj	6647	6567	*
115	Kanpur	Ganga	MGD-2, Lucknow	U.P.	Kanpur Nagar	8993	9225	*
116	Karad	Krishna	UKD, Pune	Maharashtra	Satara	*	20960	2867
117	Karnal	Yamuna	UYD, New Delhi	Haryana	Karnal	42867	7387	12800
118	Kasganj	Kali	MGD-2, Lucknow	U.P.	Etah	5267	5483	*
119	Katri Umrauli	Ganga	MGD-2, Lucknow	U.P.	Kannauj	4367	4467	*
120	Kaziupura	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	5280	5475	*
121	Keesara	Munneru	LKD, Hyderabad	A.P.	Krishna	790	2314	*
122	Khanpur	Mahi	MD, Gandhinagar	Gujarat	Anand	2079	900	*
123	Khatoli	Parwati	CD, Jaipur	Rajasthan	Kota	4173	8350	8117

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
124	Kodumudi	Cauvery	SRD, Coimbatore	Tamil Nadu	Erode	847	1968	1130
125	Koggedoddi	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	-	7295	3900
126	Kokiwada	Pench	WD, Nagpur	M.P.	Chhindwara	849	1151	-
127	Kollegal	Cauvery	CD, Bangalore	Karnataka	Chamarajanagar	-	12304	4383
128	Konta	Sabari	LGD, Hyderabad	Chhattisgarh	Bastar	700	*	*
129	Kopergaon	Godavari	UGD, Hyderabad	Maharashtra	Ahmednagar	1400	*	*
130	Kora	Rind	LYD, Agra	U.P.	Fatehpur	2795	2294	2438
131	Kota-By Pass Hanging Road Bridge u/s ok Kota City	Chambal	CD, Jaipur	Rajasthan	Kota	*	8445	*
132	Kudige	Cauvery	CD, Bangalore	Karnataka	Kodagu	-	3774	1983
133	Kudlur	Palar	SRD, Coimbatore	Karnataka	Chamarajanagar	694	1331	1320
134	Kuldahbridge	Sone	MGD-3, Varanasi	M.P.	Sidhi	2587	3020	4533
135	Kumhari	Wainganga	WD, Nagpur	M.P.	Balaghat	-	799	-
136	Kuppelur	Kumudavathi	CD, Bangalore	Karnataka	Haveri	-	5612	4567
137	Kurundwad	Krishna	UKD, Pune	Maharashtra	Kolhapur	*	4533	2050
138	Lakkavalli	Bhadra	CD, Bangalore	Karnataka	Chikamagalur	-	1693	5333
139	Lakshmanapatti	Kodaganar	SRD, Coimbatore	Tamil Nadu	Dindigul	843	616	588
140	Lalpur	Sengar	LYD, Agra	U.P.	Kanpur Dehat	5329	5245	2600
141	Lodhikheda	Jam	WD, Nagpur	M.P.	Chhindwara	1391	2087	2373
142	Lucknow	Gomti	MGD-2, Lucknow	U.P.	Lucknow	42233	42667	-
143	Luwara	Shetrunji	MD, Gandhinagar	Gujarat	Bhavnagar	3440	6267	-
144	M H Halli	Hemavati	CD, Bangalore	Karnataka	Hassan	-	1273	1856
145	Madhira	Wyra	LKD, Hyderabad	Telangana	Khammam	1400	*	*
146	Madla	Ken	LYD, Agra	M.P.	Panna	*	905	953
147	Magardhara	Wainganga	WD, Nagpur	M.P.	Balaghat	859	2001	2532
148	Mahalgaon	Wainganga	WD, Nagpur	Maharashtra	Gondia	1089	-	-
149	Mahidpur	Shipra	CD, Jaipur	M.P.	Ujjain	*	8890	*
150	Maighat	Gomti	MGD-3, Varanasi	U.P.	Jaunpur	3933	3367	3667
151	Mancherial	Godavari	UGD, Hyderabad	Telangana	Mancherial	790	*	*
152	Mandawara	Chambal	CD, Jaipur	Rajasthan	Kota	4662	5086	5983
153	Manderial	Chambal	CD, Jaipur	Rajasthan	Karauli	*	10418	7233
154	Mangaon	Kal	UKD, Pune	Maharashtra	Raigad	*	15258	-
155	Mantralayam	Tungabhadra	LKD, Hyderabad	A.P.	Kurnool	1400	*	*

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
156	Marol	Varada	CD, Bangalore	Karnataka	Haveri	-	2874	1440
157	Mataji	Mahi	MD, Gandhinagar	M.P.	Ratlam	2725	1250	*
158	Mawi	Yamuna	UYD, New Delhi	U.P.	Shamli	16360	97333	140000
159	Mehandipur	Ganga	MGD-2, Lucknow	U.P.	Kannauj	10243	5325	*
160	Mejaroad	Tons	MGD-3, Varanasi	U.P.	Prayagraj	3587	2041	1200
161	Mirawadi	Mula Mutha	UKD, Pune	Maharashtra	Pune	*	18700	27333
162	Mirzapur	Ganga	MGD-3, Varanasi	U.P.	Mirzapur	4273	4367	4233
163	Mohana	Betwa	LYD, Agra	U.P.	Jalaun	3402	2367	6832
164	Mohna	Yamuna	UYD, New Delhi	Haryana	Faridabad	176533	143267	143333
165	Moradabad	Ramganga	MGD-2, Lucknow	U.P.	Moradabad	11293	10633	*
166	Mungoli	Penganga	WD, Nagpur	Maharashtra	Yavatmal	-	1563	855
167	Muradpur	Vashishti	UKD, Pune	Maharashtra	Ratnagiri	525	6873	2700
168	Murappanadu	Tambraparani	SRD, Coimbatore	Tamil Nadu	Tuticorin	515	611	-
169	Musiri	Cauvery	SRD, Coimbatore	Tamil Nadu	Thiruchirapalli	589	1646	1580
170	Muthankera	Kabini	CD, Bangalore	Kerala	Wayanad	-	3665	2650
171	Nagothane	Amba	UKD, Pune	Maharashtra	Raigad	*	14617	1400
172	Nallamaranpatty	Amaravathi	SRD, Coimbatore	Tamil Nadu	Karur	565	-	-
173	Nanded	Godavari	UGD, Hyderabad	Maharashtra	Nanded	1300	*	*
174	Nandgaon	Wunna	WD, Nagpur	Maharashtra	Wardha	515	2369	2183
175	Nashik	Godavari	UGD, Hyderabad	Maharashtra	Nasik	2200	*	*
176	Naugaon	Yamuna	UYD, New Delhi	Uttarakhand	Uttarakashi	2427	3900	6800
177	Neemsar	Gomti	MGD-2, Lucknow	U.P.	Sitapur	4229	4267	*
178	Nellithurai	Bhavani	SRD, Coimbatore	Tamil Nadu	Coimbatore	*	1800	*
179	Noida	Yamuna	UYD, New Delhi	U.P.	Gautam Budh Nagar	7113333	8320000	13650000
180	Nowrangpur	Indravathi	LGD, Hyderabad	Odisha	Nowrangpur	790	*	*
181	Odenthurai	Kallar	SRD, Coimbatore	Tamil Nadu	Coimbatore	773	2248	3513
182	Okhla Barrage	Yamuna	UYD, New Delhi	Delhi	South Delhi	85000	*	*
183	Orai Rath marg Road Bridge, Chikasi	Betwa	LYD, Agra	U.P.	Jalaun	3373	2465	8100
184	P.G.Bridge	Penganga	WD, Nagpur	Maharashtra	Yavatmal	-	1575	-
185	Pachawali	Sindh	LYD, Agra	M.P.	Shivpuri	2048	813	843
186	Pachegaon	Pravara	UGD, Hyderabad	Maharashtra	Ahmednagar	1700	*	*

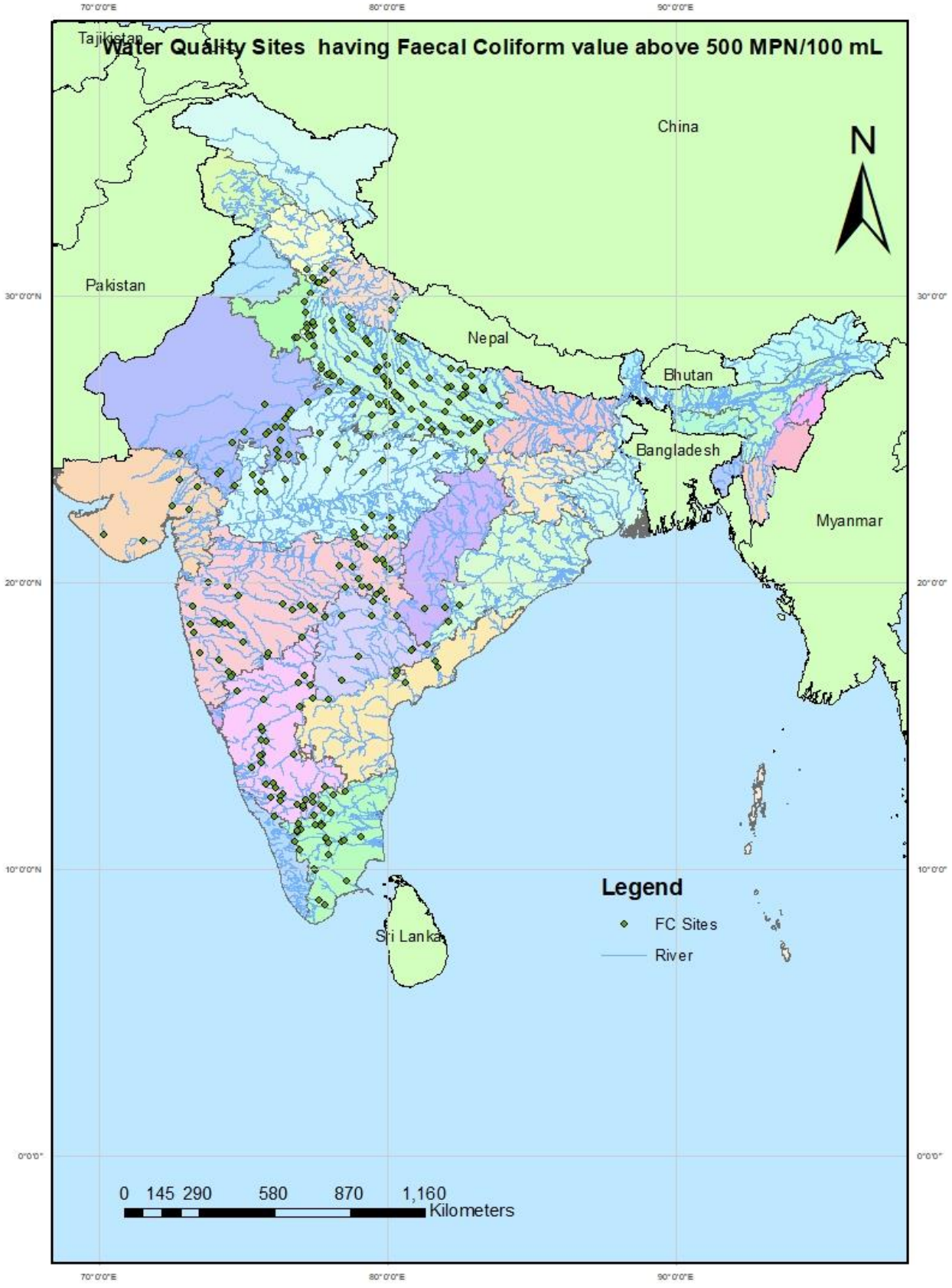
S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
187	Padardibadi	Mahi	MD, Gandhinagar	Rajasthan	Dungarpur	2160	4550	*
188	Pali	Chambal	CD, Jaipur	Rajasthan	Sawai-madhopur	*	12615	5983
189	Paliakalan	Sharda	MGD-1, Lucknow	U.P.	Lakhimpur Khiri	1833	2008	*
190	Palla	Yamuna	UYD, New Delhi	Delhi	North West Delhi	25253	163533	75000
191	Paramkudi	Vaigai	SRD, Coimbatore	Tamil Nadu	Ramanathapuram	*	627	872
192	Pargaon	Bhima	UKD, Pune	Maharashtra	Pune	*	18018	15500
193	Parmat Ghat	Ganga	MGD-2, Lucknow	U.P.	Kanpur	6040	6350	*
194	Parsohan Ghat	Budhi Rapti	MGD-1, Lucknow	U.P.	Siddarthnagar	2113	2175	*
195	Patala	Wardha	WD, Nagpur	Maharashtra	Chandrapur	836	1721	*
196	Patansaongi	Chandrabhaga	WD, Nagpur	Maharashtra	Nagpur	563	3128	2388
197	Pathagudem	Indravathi	LGD, Hyderabad	Chhattisgarh	Bijapur	1400	*	*
198	Pauni	Wainganga	WD, Nagpur	Maharashtra	Bhandara	881	1291	2550
199	Phulgaon	Bhima	UKD, Pune	Maharashtra	Pune	*	24350	*
200	Poanta	Yamuna	UYD, New Delhi	H.P.	Simaur	5793	4343	4333
201	Poiyaghat, Agra	Yamuna	LYD, Agra	U.P.	Agra	388667	243933	129833
202	Polavaram	Godavari	LGD, Hyderabad	A.P.	West Godavari	1100	*	*
203	Pratap pur	Yamuna	LYD, Agra	U.P.	Prayagraj	9431	3638	3000
204	Pratapgarh	Sai	MGD-3, Varanasi	U.P.	Pratapgarh	4333	2985	4150
205	Purna	Purna	UGD, Hyderabad	Maharashtra	Parbhani	1400	*	*
206	Raebareli	Sai	MGD-2, Lucknow	U.P.	Raebareli	6020	6308	-
207	Rajamundry	Godavari	LGD, Hyderabad	A.P.	East Godavari	2400	*	*
208	Rajapur	Yamuna	LYD, Agra	U.P.	Chitrakoot	9587	3807	2817
209	Rajegaon	Pranhita	WD, Nagpur	M.P.	Balaghat	606	682	-
210	Rajghat (Agra)	Betwa	LYD, Agra	U.P.	Lalitpur	844	-	1002
211	Ramakona	Kanhan	WD, Nagpur	M.P.	Chhindwara	654	3274	1467
212	Rangeli	Som	MD, Gandhinagar	Rajasthan	Dungarpur	1978	1344	*
213	Regauli	Rapti	MGD-1, Lucknow	U.P.	Gorakhpur	2133	2258	*
214	Renukaji	Giri	UYD, New Delhi	H.P.	Sirmaur	-	4107	3417
215	Sahijana	Betwa	LYD, Agra	U.P.	Hamirpur	5233	3155	6983
216	Saidpur	Ganga	MGD-3, Varanasi	U.P.	Ghazipur	4313	4480	3867
217	Saigaon	Manjira	UGD, Hyderabad	Karnataka	Bidar	1300	*	*
218	Sakhara	Wainganga	WD, Nagpur	Maharashtra	Gadchiroli	983	1428	1682
219	Sakleshpura	Hemavati	CD, Bangalore	Karnataka	Hassan	-	3677	6167
220	Sakmur	Wardha	WD, Nagpur	Maharashtra	Chandrapur	-	860	-

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
221	Salawad	Kalisindh	CD, Jaipur	Rajasthan	Jhalawar	*	176667	150000
222	Saloora	Manjira	UGD, Hyderabad	Telangana	Nizamabad	2200	*	*
223	Samdoli	Warna	UKD, Pune	Maharashtra	Sangli	*	9027	2133
224	Sangam(LGD)	Kinnerasani	LGD, Hyderabad	Telangana	Bhadradri Kothagudem	5400	*	*
225	Sangod	Parwan	CD, Jaipur	Rajasthan	Kota	*	9800	9900
226	Saradaput	Sabari	LGD, Hyderabad	Chhattisgarh	Malkangiri	1400	*	*
227	Sarangpur	Kalisindh	CD, Jaipur	M.P.	Rajgarh	*	14880	*
228	Sarati	Nira	UKD, Pune	Maharashtra	Pune	*	6683	8000
229	Satna	Tons	MGD-3, Varanasi	M.P.	Satna	3467	2007	4267
230	Satrapur	Kanhan	WD, Nagpur	Maharashtra	Nagpur	1938	2893	2645
231	Savandapur	Bhavani	SRD, Coimbatore	Tamil Nadu	Erode	705	4381	3397
232	Seohara	Ramganga	MGD-2, Lucknow	U.P.	Bijnaur	2807	2858	*
233	Seondha	Sindh	LYD, Agra	M.P.	Datia	1212	722	902
234	Sevanur	Chittar	SRD, Coimbatore	Tamil Nadu	Erode	1238	1019	1590
235	Shahjahanpur	Khannaut	MGD-2, Lucknow	U.P.	Shahjahanpur	3493	3650	*
236	Shahzadpur	Ganga	MGD-3, Varanasi	U.P.	Kaushambi	4213	3673	3217
237	Shastri Bridge	Ganga	MGD-3, Varanasi	U.P.	Prayagraj	4593	4067	4233
238	Shimoga	Tunga	CD, Bangalore	Karnataka	Shimoga	*	1917	3233
239	Singasadanapalli	Ponnaiyar	SRD, Coimbatore	Tamil Nadu	Krishnagiri	260013	805333	985000
240	Sitapur	Sarayan	MGD-2, Lucknow	U.P.	Sitapur	3707	3767	*
241	Suddakallu	Dindi	LKD, Hyderabad	Telangana	Mahaboob Nagar	790	*	*
242	Sultanpur	Gomti	MGD-3, Varanasi	U.P.	Sultanpur	4287	3553	4017
243	T Bekuppe	Arkavathy	CD, Bangalore	Karnataka	Ramanagara	1338	22197	4767
244	T K Halli	Shimsha	CD, Bangalore	Karnataka	Mandya	-	14087	5967
245	T Narsipura	Kabini	CD, Bangalore	Karnataka	Mysore	-	7000	16883
246	T.Ramapuram	Hagari	LKD, Hyderabad	Karnataka	Bellary	940	*	*
247	Takali	Bhima	UKD, Pune	Maharashtra	Solapur	*	8250	3300
248	Tal	Chambal	CD, Jaipur	M.P.	Ratlam	*	15280	*
249	Tanda D/S	Ghaghra	MGD-1, Lucknow	U.P.	Ambedkar Nagar	1947	2033	*
250	Tanda U/S	Ghaghra	MGD-1, Lucknow	U.P.	Ambedkar Nagar	2700	1700	*
251	Tandalaiputhur	Ayyar	SRD, Coimbatore	Tamil Nadu	Thiruchirapalli	775	3192	1558
252	Terwad	Panchganga	UKD, Pune	Maharashtra	Kolhapur	*	5658	14667

S.No.	Monitoring stations	River	CWC Division Office	State	District	Pre-M	M	Post- M
253	Thengumarahada	Bhavani / Moyar	SRD, Coimbatore	Tamil Nadu	Nilgiris	863	3001	5550
254	Theni	Vagai/Suruliar	SRD, Coimbatore	Tamil Nadu	Theni	901	3910	1163
255	Thevur	Sarabenga	SRD, Coimbatore	Tamil Nadu	Salem	565	-	3772
256	Thimmanahalli	Yagachi	CD, Bangalore	Karnataka	Hassan	-	3779	4630
257	Thoppur	Thoppaiyar	SRD, Coimbatore	Tamil Nadu	Salem	*	880	1492
258	Tihar Khera	Ramganga	MGD-2, Lucknow	U.P.	Bareilly	7207	7400	*
259	Tondarpur	Sukheta	MGD-2, Lucknow	U.P.	Hardoi	3883	3875	*
260	Tonk	Banas	CD, Jaipur	Rajasthan	Tonk	*	9143	*
261	Tuini	Tons	UYD, New Delhi	Uttarakhand	Dehradun	*	4020	3417
262	Turtipar	Ghaghra	MGD-1, Lucknow	U.P.	Ballia	2700	1967	*
263	Udi	Chambal	LYD, Agra	U.P.	Etawah	4867	3509	5750
264	Ujjain	Shipra	CD, Jaipur	M.P.	Ujjain	*	19545	19500
265	Urachikottai	Cauvery	SRD, Coimbatore	Tamil Nadu	Erode	546	4097	2658
266	V S Bridge	Ganga	MGD-3, Varanasi	U.P.	Varanasi	4127	4267	3483
267	Varanasi	Ganga	MGD-3, Varanasi	U.P.	Varanasi	5453	4127	4483
268	Varanavasi	Maruthaiyar	SRD, Coimbatore	Tamil Nadu	Ariyalur	870	584	727
269	Vautha	Sabarmati	Mahi Division	Gujarat	Ahmedabad	89133	27000	-
270	Veligonda	Musi	LKD, Hyderabad	Telangana	Nalgonda	700	*	*
271	Vijayawada	Krishna	LKD, Hyderabad	A.P.	Krishna	790	*	*
272	Vrindawan Bridge (Mathura U/S)	Yamuna	UYD, New Delhi	U.P.	Mathura	*	526133	681667
273	Wadakbal	Sina	UKD, Pune	Maharashtra	Solapur	*	27600	37000
274	Wairagarh	Khobragadi	WD, Nagpur	Maharashtra	Gadchiroli	-	2033	965
275	Warunji	Koyna	UKD, Pune	Maharashtra	Satara	*	20140	8167
276	Watrak Nr Vautha	Watrak	MD, Gandhinagar	Gujarat	Kheda	*	7850	*
277	Yadgir	Bhima	LKD, Hyderabad	Karnataka	Yadgir	790	*	*
278	Yamuna Expessway Road Bridge, Etamadpur	Yamuna	LYD, Agra	U.P.	Agra	1130000	261267	193333
279	Yashwant Nagar	Giri	UYD, New Delhi	H.P.	Simaur	2383	5780	4633
280	Yelli	Godavari	UGD, Hyderabad	Maharashtra	Nanded	2400	*	*

(-) means No Hotspot. (*) means river dry/data not available.

Figure 21: Water Quality Monitoring stations having Faecal Coliform above 500 MPN/100ml (2022)



7.1.13 Sodium Adsorption Ratio (SAR)

The Sodium adsorption ratio (SAR) is an irrigation water quality parameter used in the management of sodium-affected soils. It is an indicator of the suitability of water for use in agricultural irrigation, as determined from the concentrations of the main alkaline and earth alkaline cations present in the water. It is also a standard diagnostic parameter for the sodicity hazard of a soil as determined from analysis of pore water extracted from the soil. SAR is a measure of the amount of sodium (Na^+) relative to calcium (Ca^{2+}) and magnesium (Mg^{2+}) in the water extracted from a saturated soil paste.

Soils that have values for sodium adsorption ratio of 13 or more may have an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity and aeration, and a general degradation of soil structure.

SAR allows assessment of the state of flocculation or of dispersion of clay aggregates in a soil. Sodium and potassium ions facilitate the dispersion of clay particles while calcium and magnesium promote their flocculation. The behaviour of clay aggregates influences the soil structure and affects the permeability of the soil whose directly depends on the water infiltration rate. It is important to accurately know the nature and the concentrations of cations at which the flocculation occurs: critical flocculation concentration (CFC). The SAR parameter is also used to determine the stability of colloids in suspension in water.

Although SAR is only one factor in determining the suitability of water for irrigation, in general, the higher the sodium adsorption ratio, the less suitable the water is for irrigation. Irrigation using water with high sodium adsorption ratio may require soil amendments to prevent long-term damage to the soil.

The pre-monsoon, monsoon, and post-monsoon seasons consistently demonstrated that the average values of SAR (Sodium Adsorption Ratio) at all water quality Monitoring stations remained within the permissible limit of Class E, as designated by the Central Pollution Control Board (CPCB) for the best uses of water. This observation indicates that the levels of sodium relative to other ions in the water were within the acceptable range, suggesting no significant deterioration in water quality with respect to SAR during these periods.

CHAPTER – 8

Comparison Study - Hot Spots in (2011-2020) with (2021-2022)

Comparison has been done among the water quality hotspots observed for the period 2011-2020 with the average values of both monsoon and non-monsoon seasons from June 2021 to May 2022 of 6 parameters (pH, EC, DO, BOD, TC and Ammonia as N). For this purpose specifically, data of 2021 & 2022 was re-arranged before analysis. The summary is as under:

8.1 pH

There were 3 water quality monitoring stations - Elunuthimangalam (Noyyal river), Manakkad (Thodupuzha river), and Kamalpur (Banas River) - that were identified as hotspots during the 2011-2020 monsoon and non-monsoon season. These hotspots were compared with the average value of the monsoon and non-monsoon season of June 2021 to May 2022. The data reveals that the water quality at Elunuthimangalam in monsoon season during the period of 2011-2020 was measured at 8.56, while it slightly increased to 8.64 in the years 2021-2022. This indicates a slight deterioration in water quality at this monitoring station in respect of the pH. During the non-monsoon season of period 2011-2020, at Elunuthimangalam, pH was recorded at 8.6 and identified as a hotspot. There was a slight decrease to 8.48 in the years 2021-2022 during the non-monsoon season, and the pH value observed was within the acceptable limit. So, no hotspot was identified. At the Manakkad WQ monitoring station (Thodupuzha River, Kerala), the pH observed was 6.49 during monsoon season of period 2011-2020, which was below the acceptable limit. But during the 2021-22 period, the pH observed was 6.59, indicating an improvement, and the pH value was within the acceptable limit. During the monsoon season of 2011-2020 period, the water quality monitoring station Kamalpur (Banas River, Gujarat) was not identified as a hotspot and same is observed during the monsoon season of 2021-22. This monitoring station was identified as a hotspot during the non-monsoon season of 2011-2020, but during the 2021-22 period, the river was dry, so no observation was made.

Table 19: Comparison of Hot Spots pH during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Elunuthimangalam	Noyyal	Tamil Nadu	8.56	8.6	8.64	8.48	Deteriorate	No Hotspot
2	Manakkad	Thodupuzha	Kerala	6.49	-	6.59	-	No Hotspot	-
3	Kamalpur	Banas	Gujarat	-	8.53	-	*	-	*

(-) means No Hotspot

(*) means river dry/data not available.

8.2 Electrical Conductivity (EC)

Three (03) water quality monitoring stations—Elunuthimangalam (Noyyal River), Vautha (Sabarmati River), and Luwara (Shetrunji River)—were identified as hotspots during both the monsoon and non-monsoon seasons in the years 2011-2020 and 2021-22. The average electrical conductivity at the Elunuthimangalam monitoring station experienced a significant increase from 3265.04 µmhos/cm (2011-2020) to 3949.4 µmhos/cm (2021-2022), indicating a potential deterioration in water quality during the 2021-22 period. Conversely, during the non-monsoon period, the electrical conductivity decreased from 2840.9 µmhos/cm (2011-2020) to 2237.1 µmhos/cm (2021-2022) at Elunuthimangalam, indicating an improvement in water quality during the non-monsoon season, with the conductivity reaching within acceptable limits. At Vautha water quality monitoring station, there was a slight decrease in conductivity from 2375.64 µmhos/cm (2011-2020) to 2228.95 µmhos/cm (2021-2022), and the monitoring station's conductivity came within the acceptable limit during 2021-22. Meanwhile, Luwara showed substantial improvement in conductivity but is no longer classified as a hotspot during the non-monsoon periods.

Table 20: Comparison of Hot Spots pH during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Elunuthimangalam	Noyyal	Tamil Nadu	3265.04	2840.9	3949.4	2237.1	Deteriorate	No Hotspot
2	Vautha	Sabarmati	Gujarat	-	2375.64	-	2228.95	-	No Hotspot
3	Luwara	Shetrunji	Gujarat	-	7764.88	-	4612.14	-	Improved but Hotspot

(-) means No Hotspot

8.3 Ammonia

8 water quality monitoring stations were identified as hotspots during both the monsoon and non-monsoon seasons in the years 2011-2020 and 2021-22. These Monitoring stations include Agra (P.G), Delhi Rly Bridge, Etawah, Jawahar Bridge (Yamuna River), Galeta (Hindon), Pingalwada (Dhadhar river), Singasadanapalli (Ponnaiyar river), and Vautha (Sabarmati river). During the monsoon season, data reveals that 5 monitoring stations - Agra (P.G), Galeta, Jawahar Bridge, Singasadanapalli and Vautha - show improvement in ammonia levels. However, the ammonia levels at these monitoring stations still exceed the acceptable limit of 1.2 mg/L during the monsoon season. Only 1 water quality monitoring station at Delhi Rly Bridge (Yamuna river) showed an ammonia concentration ranging from 10.6 mg/L to 21.91 mg/L, indicating a deterioration in water quality concerning ammonia levels. Pingalwada (Dhadhar river) in Gujarat was not identified as a hotspot during 2011-2020. Still, in the recent study of 2021-22, the ammonia level exceeded the acceptable limit at 1.42 mg/L. During the non-monsoon

period, the ammonia levels are increasing and deteriorating the water quality at 5 monitoring stations: Agra (P.G), Delhi Rly Bridge, Etawah, Jawahar Bridge, and Singasadanapalli. While the ammonia levels at 3 monitoring stations - Galeta, Pingalwada, and Vautha - are improving, they still surpass the acceptable limit for ammonia.

Table 21: Comparison of Hot Spots Ammonia during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Agra(P.G)	Yamuna	Uttar Pradesh	2.57	7.56	2.09	10.89	Improved but Hotspot	Deteriorate
2	Delhi Rly Bridge	Yamuna	Delhi	10.6	15.56	21.91	20.56	Deteriorate	Deteriorate
3	Etawah	Yamuna	Uttar Pradesh	-	4.28	-	6.82	-	Deteriorate
4	Galeta	Yamuna	Uttar Pradesh	9.67	10.74	7.76	9.16	Improved but Hotspot	Improved but Hotspot
5	Jawahar Bridge	Yamuna	Uttar Pradesh	2.45	10.2	2.22	10.78	Improved but Hotspot	Deteriorate
6	Pingalwada	Dhadhar	Gujarat	-	1.45	1.42	1.43	New Hotspot	Improved but Hotspot
7	Singasadanapalli	Ponnaiyar	Tamil Nadu	15.89	17.47	13.61	28.57	Improved but Hotspot	Deteriorate
8	Vautha	Sabarmati	Gujarat	15.27	23.92	13.87	13.77	Improved but Hotspot	Improved but Hotspot

(-) means No Hotspot

8.4 Dissolved Oxygen (DO)

Comparing water quality data for the dissolved oxygen (DO) parameter, it was observed that during the monsoon season, 3 monitoring stations (Chel river, Bhima river and Brahamani river) and 7 monitoring stations (Burhabalang river, Vamsadhara river, Subarnarekha river, Nagavali river, Musi river and Sina river) emerged as new hotspots for degradation. 18 instances of water quality degradation were found during the monsoon season at various monitoring stations on Sankosh river, Subarnarekha river, Baitarani river, Teesta river, Yamuna river, Ghish river, Burhabalang river, Subarnarekha river, Vamsadhara river, Yamuna river, Ponnaiyar river, Mula-Mutha river, Dhadhar river, Nagavali river, Arkavathy river, and Sabarmati river. These instances indicate a decrease in dissolved oxygen levels at these monitoring stations. During the non-monsoon season, a decline in dissolved oxygen levels was observed at 9 monitoring stations (Subarnarekha River, Yamuna River, Mula-Mutha river, Dhadhar

river, Brahamani river, Sabarmati River, and others).

There are 14 water quality Monitoring stations situated in different locations across India, namely Agra(P.G) (Yamuna river), Ambari(Torsa river), Bendrahalli (Suvarnavathi river), Golokganj (Gadadhar river), Gunupur (Vamsadhara river), Majhitar (Rangeet river), Mathura (Yamuna river), Mohna (Yamuna river), Neora (Neora river), Roorkee D/S & Roorkee U/S (Solani river), Shaladang (Torsa river), , Valigonda (Musi river), Wadakbal (Sina river). During the monsoon period, these monitoring stations are showing improvement in the DO (dissolved oxygen) level. However, they still remain hotspots due to dissolved oxygen levels observed below 5.0 mg/L. On the other hand, during the non-monsoon season, 5 water quality monitoring stations show improvement in DO levels. These monitoring stations are Agra (P.G), Mathura (Yamuna river), Roorkee D/S, Roorkee U/S (Solani river), Singasadanapalli (Ponnaiyar) and T Bekuppe (Arkavathy river). However, they still qualify as hotspots due to dissolved oxygen levels below 5.0 mg/L.

During the monsoon season, 22 water quality monitoring stations were monitored at various locations: Basti U/S (Kuwano river), Bhalwara (Gaur river), Dindori (Narmada river), Gatora(1) (Arpa river), Kakerghati (Kamla river), Kanti (BurhiGandak river), Khairmal (Mahanadi river), Khanitar (Teesta river), Lakhwara (Kachhua river), Mawi (Yamuna river), MBPL (Hasdeo river), Nawapara (Mahanadi river), Nirmali (Kosi river), Paleru Bridge (Paleru river), Palla (Yamuna river), Patan (Hiran river), Poanta (Yamuna river), Rangpo (Rangpochu river), Sakra (BurhiGandak river), Sevoke (Teesta river), T K Halli (Shimsha river) Thottathinkada vu (Iruvazhanjippuzha river). It was observed that no hotspot was identified during this period. These water quality monitoring stations exhibited an improvement in dissolved oxygen levels, and the observed DO levels were within acceptable limits. 11 water quality monitoring stations - Akbarpur (Chhoti Sarju river), Ambari (Torsa river), Baladoba (Sankosh river), Coronation (Teesta river), Chel (Chel river), Dindori (Narmada river), Gazoldoba (Teesta river), Ghish (Ghish river), Khanitar (Teesta river), Majhitar (Rangeet river) and Poanta (Yamuna river) - showed improvement and their status during the non-monsoon season is not identified as a hotspot.

Table 22: Comparison of Hot Spots Dissoved Oxygen (DO) during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Agra(P.G)	Yamuna	Uttar Pradesh	1.61	1.38	2.32	2.42	Improved but Hotspot	Improved but Hotspot
2	Akbarpur	ChhotiSarju	Uttar	-	4.7	-	6.54	-	No Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
			Pradesh						
3	Ambari	Torsa	West Bengal	4.13	4.45	4.43	5.22	Improved but Hotspot	No Hotspot
4	Baladoba	Sankosh	Assam	4.71	4.88	4.34	5.27	Deteriorate	No Hotspot
5	Baridhi Nala	Subarnarekha	Jharkhand	3.1	3.52	3.08	3.47	Deteriorate	Deteriorate
6	Basti U/S	Kuwano	Uttar Pradesh	3.98	-	5.05	-	No Hotspot	-
7	Bendrahalli	Suvarnavathi	Karnataka	3.16	-	4.88	-	Improved but Hotspot	-
8	Bhalwara	Gaur	Madhya Pradesh	4.26	-	6.01	-	No Hotspot	-
9	Champua	Baitarani	Odisha	4.58	-	3.47	-	Deteriorate	-
10	Coronation	Teesta	West Bengal	4.72	4.88	4.53	5.63	Deteriorate	No Hotspot
11	Chel	Chel	West Bengal	-	4.95	4.79	5.43	New Hotspot	No Hotspot
12	Daund	Bhima	Maharashtra	-	4.23	4.28	*	New Hotspot	*
13	Delhi Rly Bridge	Yamuna	Delhi	2	1.3	1.69	0.32	Deteriorate	Deteriorate
14	Dindori	Narmada	Madhya Pradesh	4.71	-	5.92	6.68	No Hotspot	No Hotspot
15	Galeta	Yamuna	Uttar Pradesh	0.98	0.95	0.0	0.0	Deteriorate	Deteriorate
16	Gatora(1)	Arpa	Chhattisgarh	4.28	-	6.08	-	No Hotspot	-
17	Gazoldoba	Teesta	West Bengal	4.88	4.57	4.47	5.59	Deteriorate	No Hotspot
18	Ghish	Ghish	West Bengal	4.76	4.62	4.44	5.56	Deteriorate	No Hotspot
19	Golokganj	Gadadhar	Assam	4.04	-	4.47	-	Improved but Hotspot	-
20	Govindpur	Burhabalang	Odisha	4.88	-	4.00	4.59	Deteriorate	New Hotspot
21	Gunupur	Vamsadhara	Odisha	3.78	-	3.81	4.56	Improved but Hotspot	New Hotspot
22	Jamshedpur	Subarnarekha	Jharkhand	4.76	-	3.34	4.20	Deteriorate	New Hotspot
23	Jawahar Bridge	Yamuna	Uttar Pradesh	3.77	3.42	2.41	2.71	Deteriorate	Deteriorate
24	Kakerghati	Kamla	Bihar	4.21	-	5.91	-	No Hotspot	-
25	Kanti	BurhiGandak	Bihar	4.6	-	6.06	-	No Hotspot	-
26	Kashinagar	Vamsadhara	Odisha	4.37	-	4.22	4.69	Deteriorate	New Hotspot
27	Khairmal	Mahanadi	Odisha	4.38	-	6.17	-	No Hotspot	-
28	Khanitar	Teesta	Sikkim	4.1	4.63	5.26	5.46	No Hotspot	No Hotspot
29	Lakhwara	Kachhua	Bihar	4.37	-	5.99	-	No Hotspot	-
30	Majhitar	Rangeet	Sikkim	4.26	4.72	4.87	5.44	Improved but Hotspot	No Hotspot
31	Mathura	Yamuna	Uttar Pradesh	2.95	2.49	3.66	2.60	Improved but Hotspot	Improved but Hotspot
32	Mawi	Yamuna	Uttar Pradesh	4.73	-	6.38	-	No Hotspot	-
33	MBPL	Hasdeo	Chhattisgarh	4.37	-	6.15	-	No Hotspot	-
34	Mirawadi	Mula-Mutha	Maharashtra	3.71	4.91	3.30	4.22	Deteriorate	Deteriorate
35	Mohna	Yamuna	Haryana	2.31	1.6	2.77	1.15	Improved but Hotspot	Deteriorate
36	Nawapara	Mahanadi	Odisha	4.87	-	5.66	-	No Hotspot	-
37	Neora	Neora	West Bengal	4.44	-	4.58	-	Improved but Hotspot	-

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
38	Nirmali	Kosi	Bihar	3.74	-	5.86	-	No Hotspot	-
39	Paleru Bridge	Paleru	Andhra Pradesh	4.59	-	5.77	-	No Hotspot	-
40	Palla	Yamuna	Delhi	4.91	-	6.94	-	No Hotspot	-
41	Patan	Hiran	Madhya Pradesh	4.59	-	5.63	-	No Hotspot	-
42	Pingalwada	Dhadhar	Gujarat	3.4	2.77	2.35	0.50	Deteriorate	Deteriorate
43	Poanta	Yamuna	Himachal Pradesh	4.12	4.74	8.33	8.24	No Hotspot	No Hotspot
44	Rangpo	Rangpochu	Sikkim	4.54	-	5.39	-	No Hotspot	-
45	Roorkee D/S	SOLANI	Uttarakhand	0	0.75	0.83	1.26	Improved but Hotspot	Improved but Hotspot
46	Roorkee U/S	SOLANI	Uttarakhand	0	0.94	2.22	1.22	Improved but Hotspot	Improved but Hotspot
47	RSP	Brahamani	Odisha	-	4.71	3.07	3.20	New Hotspot	Deteriorate
48	Sakra	BurhiGandak	Bihar	4.77	-	5.94	-	No Hotspot	-
49	Sevoke	Teesta	West Bengal	4.62	-	5.09	-	No Hotspot	-
50	Shaladang	Torsa	West Bengal	4.06	-	4.47	-	Improved but Hotspot	-
51	Singasadanapalli	Ponnaiyar	Tamil Nadu	0.13	0.34	0.0	0.47	Deteriorate	Improved but Hotspot
52	Srikakulam	Nagavali	Andhra Pradesh	4.66	-	3.24	4.63	Deteriorate	New Hotspot
53	T Bekuppe	Arkavathy	Karnataka	2.61	2.81	1.81	3.22	Deteriorate	Improved but Hotspot
54	T K Halli	Shimsha	Karnataka	4.83	-	5.67	-	No Hotspot	-
55	Thottathinkadavu	Iruvazhanjippuzha	Kerala	4.9	-	7.18	-	No Hotspot	-
56	Valigonda	Musi	Telangana	4.18	-	4.46	2.61	Improved but Hotspot	New Hotspot
57	Vautha	Sabarmati	Gujarat	2.36	1.49	0.05	0.00	Deteriorate	Deteriorate
58	Wadakbal	Sina	Maharashtra	3.65	-	3.90	0.00	Improved but Hotspot	New Hotspot

(-) means No Hotspot

(*) means river dry/data not available.

8.5 Biochemical Oxygen Demand (BOD):

6 water quality monitoring stations - AB Road (Parwati river), Gorakhpur D/S (Rapti river), Mirzapur (Ganga river), Mungoli (Penganga river), Pargaon (Bhima river), and Wadakbal (Sina river) - were identified as new hotspots during the monsoon season. Additionally, 7 water quality monitoring stations - Basti (Kuwano river), Baridhi Nala (Subarnarekha river), Kumhari (Wainganga river), Lodhikheda (Jam river), Magardhara (Wainganga river), Nanded (Godavari river), and Parsohan Ghat (Rapti river) - were found to be new hotspots during the non-monsoon season.

25 water quality monitoring stations, including Banda (Ken river), Baridhi Nala (Subarnarekha river), Gandhi Ghat (Ganga river), Ganod (Bhadar river), Garrauli

(Dhasan river), Gorakhpur U/S (Rapti river), Hamirpur (Yamuna river), Jai Nagar (Kamla river), Jaunpur(Gomti river), Kora (Rind river), Kanpur (Ganga river), Maighat(Gomti river), Mirawadi(Mula-Mutha river), Nallamaranpatty (Amaravathi river), Mandala (Ken river), Marol (Varada river), MBPL (Hasdeo river), Nanded (Godavari river), Rajapur (Yamuna river), Rajegaon (Bagh river), Rajghat (Betwa river), RSP (Brahamani river), Sahijana (Betwa river), Shastibridge(Ganga river), Seondha (Sindh river), do not show any hotspots during the monsoon season. The BOD concentration at these monitoring stations was found to be below 3.0 mg/L, indicating better water quality. These monitoring stations show improvement in water quality concerning BOD. 26 water quality monitoring stations, including AB Road (Parwati river), Bhatpalli (Peddavagu river), Banda (Ken river), Ekmighat (AdhwaraSamuh river), Ganod (Bhadar river), Garrauli (Dhasan river), Gopalkheda (Purna river), Jaunpur(Gomti river), Kalna Flow (Bhagirathi (Hooghly), Kanpur (Ganga river), Keolari (Wainganga river), Kora (Rind river), Kulpatang (Kharkai river), Luwara (Shetrunji river), Maighat(Gomti river), Mirawadi(Mula-Mutha river), MBPL (Hasdeo river), Paramakudi (Vaigai river), Pratapgarh (Sai river), Pratappur (Yamuna river), Rajapur (Yamuna river), Rajghat (Betwa river), RSP (Brahamani river), Sahijana (Betwa river), Shahzadpur (Ganga river), Shastibridge(Ganga river) show improvement in water quality during the non-monsoon season concerning BOD. These monitoring stations transition from hot spots to no hot spots.

29 water quality monitoring stations in monsoon season, including Agra (P.G) (Yamuna river), Allahabad (Ganga river), Amgaon (Chulband river), Baluaghat (Ganga river), Basti (Kuwano river), Basti D/S (Kuwano river), Delhi Rly Bridge (Yamuna river), Etawah (Yamuna river), Hivra (Wardha river), Kumhari (Wainganga river), Lodhikheda (Jam river), Mohana (Yamuna river), Nandgaon (Wena river), P.G.Bridge (Penganga river), Palla (Yamuna river), Parsohan Ghat (Rapti river), Pauni (Wainganga river), Pingalwada (Dhadhar river), Ramakona (Kanhan river), Saidpur (Ganga river), Sakmur (Wardha river), Satrapur (Kanhan river), Singasadanapalli (Ponnaiyar river), Sultanpur (Gomti river), Tal (Chambal river), Tekra (Pranhita river), V.S.Bridge (Ganga river), Varanasi (Ganga river), Vautha (Sabarmati river), are observed as deteriorating the water quality. These monitoring stations show an increase in BOD levels above the acceptable limit. Data reveals that the concentration of BOD has increased compared to the periods 2011-2020 and 2021-2022. Additionally, 20 water quality monitoring stations, including Agra (P.G) (Yamuna river), Allahabad (Ganga river), Amgaon (Chulband river), Basti D/S (Kuwano river), Basti U/S (Kuwano river), Gummanur (Ponnaiyar river), Mawi (Yamuna river), Mirzapur (Ganga river), Mohana (Yamuna river), Nandgaon (Wena river), Palla (Yamuna river), Pargaon (Bhima river), Pauni (Wainganga river), Pingalwada (Dhadhar river), Ramakona (Kanhan river), Satrapur (Kanhan river), Singasadanapalli (Ponnaiyar river), Sultanpur (Gomti river), T Bekuppe (Arkavathy river) and Varanasi (Ganga river) are observed as deteriorating the water quality during the non-monsoon season. These monitoring stations show an increase in BOD levels above the acceptable limit.

17 water quality Monitoring stations, including Akbarpur (Chhoti Sarju river), Auraiya (Yamuna river), Bamni (Wardha river), Basti U/S (Kuwano river), Bhatpalli (Peddavagu river), Dholpur (Chambal river), Elunuthimangalam (Noyyal river), Galeta (Yamuna river), Ghazipur (Ganga river), Gummanur (Ponnaiyar river), Keolari (Wainganga river), Magardhara (Wainganga river), Mawi (Yamuna river), Pratapgarh (Sai river), Roorkee D/S (Solani river), Roorkee U/S (Solani river), T Bekuppe (Arkavathy river), show improvement in the BOD level during the monsoon season. However, the water quality at these monitoring stations remains in the hot spot category due to BOD levels exceeding 3.0 mg/L. 20 water quality Monitoring stations, including Akbarpur (Chhoti Sarju), Auraiya (Yamuna river), Baluaghat (Ganga river), Bamni (Wardha river), Delhi Rly Bridge (Yamuna river), Dholpur (Chambal river), Elunuthimangalam (Noyyal river), Etawah (Yamuna river), Galeta (Yamuna river), Ghazipur (Ganga river), Gorakhpur D/S (Rapti river), Hamirpur (Yamuna river), Hivra (Wardha river), Mungoli (Penganga river), Roorkee D/S (Solani river), Roorkee U/S (Solani river), Saidpur (Ganga river), Sakmur (Wardha river), V.S.Bridge (Ganga river) and Vautha (Sabarmati river) during the non-monsoon season, show improvement in the BOD level. However, they still remain hotspots due to BOD levels exceeding 3.0 mg/L.

Table 23: Comparison of Hot Spots Biochemical Oxygen Demand (BOD) during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Ab Road	Parwati	Madhya Pradesh	-	16.90	9.52	1.20	New Hotspot	No Hotspot
2	Agra (P.G)	Yamuna	Uttar Pradesh	19.71	18.27	31.06	32.21	Deteriorate	Deteriorate
3	Akbarpur	ChhotiSarju	Uttar Pradesh	5.37	6.06	3.27	4.04	Improved but Hotspot	Improved but Hotspot
4	Allahabad	Ganga	Uttar Pradesh	3.28	3.23	3.58	3.46	Deteriorate	Deteriorate
5	Amgaon	Chulband	Maharashtra	3.20	3.78	7.52	8.33	Deteriorate	Deteriorate
6	Auraiya	Yamuna	Uttar Pradesh	8.81	12.86	5.99	8.04	Improved but Hotspot	Improved but Hotspot
7	Baluaghat	Ganga	Uttar Pradesh	3.66	3.86	3.80	3.70	Deteriorate	Improved but Hotspot
8	Bamni	Wardha	Maharashtra	15.99	10.67	12.47	6.04	Improved but Hotspot	Improved but Hotspot
9	Banda	Ken	Uttar Pradesh	5.05	5.25	1.55	2.03	No Hotspot	No Hotspot
10	Basti	Kuwano	Uttar Pradesh	3.18	-	6.07	7.00	Deteriorate	New Hotspot
11	Basti D/S	Kuwano	Uttar Pradesh	4.54	3.71	7.50	7.83	Deteriorate	Deteriorate
12	Basti U/S	Kuwano	Uttar Pradesh	9.06	6.05	5.45	6.05	Improved but Hotspot	Deteriorate
13	Baridhi Nala	Subarnarekha	Jharkhand	3.18	-	0.82	9.63	No Hotspot	New Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
14	Bhatpalli	Peddavagu	Telangana	4.94	-	3.99	2.26	Improved but Hotspot	No Hotspot
15	Delhi Rly Bridge	Yamuna	Delhi	28.15	40.87	39.35	33.08	Deteriorate	Improved but Hotspot
16	Dholpur	Chambal	Rajasthan	4.14	3.86	3.56	3.02	Improved but Hotspot	Improved but Hotspot
17	Ekmighat	AdhwaraSamuh	Bihar	-	4.31	-	2.15	-	No Hotspot
18	Elunuthimangalam	Noyyal	Tamil Nadu	9.36	6.29	7.23	5.98	Improved but Hotspot	Improved but Hotspot
19	Etawah	Yamuna	Uttar Pradesh	16.78	33.56	22.14	32.14	Deteriorate	Improved but Hotspot
20	Galeta	Yamuna	Uttar Pradesh	41.35	54.86	30.69	50.50	Improved but Hotspot	Improved but Hotspot
21	Gandhi Ghat	Ganga	Bihar	3.22	-	1.95	-	No Hotspot	-
22	Ganod	Bhadar	Gujarat	3.85	3.78	1.30	1.80	No Hotspot	No Hotspot
23	Garrauli	Dhasan	Madhya Pradesh	4.08	3.91	1.56	1.48	No Hotspot	No Hotspot
24	Ghazipur	Ganga	Uttar Pradesh	3.42	3.40	3.76	3.17	Improved but Hotspot	Improved but Hotspot
25	Gopalkheda	Purna	Maharashtra	-	3.71	-	2.60	-	No Hotspot
26	Gorakhpur D/S	Rapti	Uttar Pradesh	-	3.90	3.27	3.42	New Hotspot	Improved but Hotspot
27	Gorakhpur U/S	Rapti	Uttar Pradesh	5.16	-	2.58	-	No Hotspot	-
28	Gummanur	Ponnaiyar	Tamil Nadu	10.31	8.58	7.46	12.62	Improved but Hotspot	Deteriorate
29	Hamirpur	Yamuna	Uttar Pradesh	5.09	7.36	2.57	4.31	No Hotspot	Improved but Hotspot
30	Hivra	Wardha	Maharashtra	8.33	7.73	15.96	3.22	Deteriorate	Improved but Hotspot
31	Jai Nagar	Kamla	Bihar	3.37	-	2.04	-	No Hotspot	-
32	Jaunpur	Gomti	Uttar Pradesh	3.52	3.65	2.37	2.27	No Hotspot	No Hotspot
33	Kalna Flow	Bhagirathi (Hooghly)	West Bengal	-	3.34	*	0.78	*	No Hotspot
34	Keolari	Wainganga	Madhya Pradesh	9.14	4.65	3.41	2.70	Improved but Hotspot	No Hotspot
35	Kora	Rind	Uttar Pradesh	3.32	3.11	1.42	1.53	No Hotspot	No Hotspot
36	Kulpatanga	Kharkai	Jharkhand	-	5.09	-	1.35	-	No Hotspot
37	Kumhari	Wainganga	Madhya Pradesh	3.55	-	6.33	3.62	Deteriorate	New Hotspot
38	Kanpur	Ganga	Uttar Pradesh	5.58	5.67	2.69	2.22	No Hotspot	No Hotspot
39	Nallamaranpatty	Amaravathi	Tamil Nadu	3.94	-	1.40	-	No Hotspot	-
40	Lodhikheda	Jam	Madhya Pradesh	17.67	-	22.03	19.36	Deteriorate	New Hotspot
41	Luwara	Shetrunji	Gujarat	-	3.43	-	1.01	-	No Hotspot
42	Mandala	Ken	Madhya Pradesh	3.25	-	0.96	-	No Hotspot	-
43	Magardhara	Wainganga	Madhya Pradesh	7.30	-	4.00	12.96	Improved but Hotspot	New Hotspot
44	Maighat	Gomti	Uttar	3.15	3.05	2.24	2.28	No Hotspot	No Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
			Pradesh						
45	Marol	Varada	Karnataka	3.04	-	1.48	-	No Hotspot	-
46	Mawi	Yamuna	Uttar Pradesh	5.20	6.28	4.63	9.01	Improved but Hotspot	Deteriorate
47	MBPL	Hasdeo	Chhattisgarh	26.48	20.87	1.00	0.99	No Hotspot	No Hotspot
48	Mirawadi	Mula-Mutha	Maharashtra	-	3.84	2.30	2.52	No Hotspot	No Hotspot
49	Mirzapur	Ganga	Uttar Pradesh	-	3.07	3.46	3.70	New Hotspot	Deteriorate
50	Mohana	Yamuna	Haryana	17.89	26.14	19.92	33.42	Deteriorate	Deteriorate
51	Mungoli	Penganga	Maharashtra	-	16.18	15.93	6.71	New Hotspot	Improved but Hotspot
52	Nandgaon	Wena	Maharashtra	8.69	4.67	11.27	10.57	Deteriorate	Deteriorate
53	Nanded	Godavari	Maharashtra	3.10	-	2.81	11.02	No Hotspot	New Hotspot
54	P.G.Bridge	Penganga	Maharashtra	3.32	-	15.19	-	Deteriorate	-
55	Palla	Yamuna	Delhi	5.43	5.96	10.97	11.11	Deteriorate	Deteriorate
56	Paramakudi	Vaigai	Tamil Nadu	-	3.85	*	2.63	*	No Hotspot
57	Pargaon	Bhima	Maharashtra	-	3.29	3.60	3.93	New Hotspot	Deteriorate
58	Parsohan Ghat	Rapti	Uttar Pradesh	3.34	-	3.41	3.70	Deteriorate	New Hotspot
59	Pauni	Wainganga	Maharashtra	5.76	6.22	10.25	7.14	Deteriorate	Deteriorate
60	Pingalwada	Dhadhar	Gujarat	8.48	9.54	9.03	13.60	Deteriorate	Deteriorate
61	Pratapgarh	Sai	Uttar Pradesh	4.35	3.51	3.60	2.58	Improved but Hotspot	No Hotspot
62	Pratappur	Yamuna	Uttar Pradesh	-	3.06	-	2.62	-	No Hotspot
63	Rajapur	Yamuna	Uttar Pradesh	3.94	4.30	1.39	2.08	No Hotspot	No Hotspot
64	Rajegaon	Bagh	Madhya Pradesh	4.96	-	2.01	-	No Hotspot	-
65	Rajghat	Betwa	Uttar Pradesh	3.19	3.25	1.14	1.97	No Hotspot	No Hotspot
66	Ramakona	Kanhan	Madhya Pradesh	3.94	3.14	11.95	3.20	Deteriorate	Deteriorate
67	Roorkee D/S	Solani	Uttarakhand	85.52	60.01	35.53	26.83	Improved but Hotspot	Improved but Hotspot
68	Roorkee U/S	Solani	Uttarakhand	82.98	55.88	32.61	25.54	Improved but Hotspot	Improved but Hotspot
69	RSP	Brahamani	Odisha	3.62	4.38	0.90	1.21	No Hotspot	No Hotspot
70	Sahijana	Betwa	Uttar Pradesh	4.51	4.64	2.52	1.81	No Hotspot	No Hotspot
71	Saidpur	Ganga	Uttar Pradesh	3.51	3.73	3.68	3.69	Deteriorate	Improved but Hotspot
72	Sakmur	Wardha	Maharashtra	12.52	9.10	21.53	6.45	Deteriorate	Improved but Hotspot
73	Satrapur	Kanhan	Maharashtra	7.22	7.10	10.20	14.12	Deteriorate	Deteriorate
74	Seondha	Sindh	Madhya Pradesh	3.68	-	1.31	-	No Hotspot	-
75	Shahzadpur	Ganga	Uttar Pradesh	-	3.02	-	2.58	-	No Hotspot
76	Shastri Bridge	Ganga	Uttar Pradesh	3.31	3.88	2.27	2.55	No Hotspot	No Hotspot
77	Singasadanapalli	Ponnaiyar	Tamil Nadu	27.07	34.91	31.55	41.90	Deteriorate	Deteriorate
78	Sultanpur	Gomti	Uttar	3.54	3.49	3.83	4.22	Deteriorate	Deteriorate

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
			Pradesh						
79	T Bekuppe	Arkavathy	Karnataka	13.32	12.94	8.78	15.38	Improved but Hotspot	Deteriorate
80	Tal	Chambal	Madhya Pradesh	4.14	-	8.00	*	Deteriorate	*
81	Tekra	Pranhita	Maharashtra	4.22	-	8.09	-	Deteriorate	-
82	V.S.Bridge	Ganga	Uttar Pradesh	3.36	3.68	3.76	3.49	Deteriorate	Improved but Hotspot
83	Varanasi	Ganga	Uttar Pradesh	3.15	3.16	3.69	3.77	Deteriorate	Deteriorate
84	Vautha	Sabarmati	Gujarat	17.41	28.22	27.90	24.85	Deteriorate	Improved but Hotspot
85	Wadakbal	Sina	Maharashtra	-	4.23	3.32	*	New Hotspot	*

(-) means No Hotspot

(*) means river dry/data not available.

8.6 Total Coliform

On Comparing the water quality hotspots during the period of 2011-2020 with the average values of both monsoon and non-monsoon seasons from June 2021 to May 2022 for 4 water quality monitoring stations: Muthankera (Kabini river) during the monsoon season, Chunchanakatte (Cauvery River), Hariharapura (Tunga river), and Tekra (Pranhita river) during non-monsoon season, no hotspots were observed in 2021-22. The water quality of these monitoring stations improved and reached the MPN value of the total coliform within acceptable limits. There are 118 water quality monitoring stations monitoring on 73 rivers during the monsoon season and 117 water quality monitoring stations on 73 rivers during the non-monsoon season, indicating an improvement in water quality with respect to coliform levels in the rivers during the 2021-22 period. However, despite this improvement, these monitoring stations still fall into the hotspot category. In contrast, 76 water quality monitoring stations monitoring 52 rivers during the monsoon season and 57 monitoring stations monitoring 34 rivers during the non-monsoon season show a deterioration in water quality due to an increase in organic load in the rivers.

Table 24: Comparison of Hot Spots Total Coliform during year 2011-2020 with 2021-2022

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
1	Abu Road	Banas	Rajasthan	3191	5535	3391	7389	Deteriorate	Deteriorate
2	Agra(P.G)	Yamuna	Uttar Pradesh	123537	218129	391667	596500	Deteriorate	Deteriorate
3	Akbarpur	Chhotisarju	Uttar Pradesh	7632	16092	9260	8324	Deteriorate	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
4	Akkihebbal	Hemavati	Karnataka	3688	6851	2237	1203	Improved but Hotspot	Improved but Hotspot
5	Aklera	Parwan	Rajasthan	90200	*	73500	*	Improved but Hotspot	*
6	Alandurai	Noyyal	Tamil Nadu	46425	94750	54800	19780	Deteriorate	Improved but Hotspot
7	Allahabad	Ganga	Uttar Pradesh	8641	15945	10540	9886	Deteriorate	Improved but Hotspot
8	Ambarampalayam	Aliyar	Tamil Nadu	8814	12875	16354	18119	Deteriorate	Deteriorate
9	Ambasamudram	Vaigai	Tamil Nadu	160000	63500	92000	36991	Improved but Hotspot	Improved but Hotspot
10	Arangaly	Chalakudy	Kerala	1078	1425	2167	800	Deteriorate	Improved but Hotspot
11	Arjunwad	Krishna	Maharashtra	27248	44140	9769	*	Improved but Hotspot	*
12	Ashti	Wainganga	Maharashtra	6252	1144	1111	2240	Improved but Hotspot	Deteriorate
13	Auraiya	Yamuna	Uttar Pradesh	44629	47689	61840	74025	Deteriorate	Deteriorate
14	Ayodhya	Ghaghra	Uttar Pradesh	3272	2908	3627	3790	Deteriorate	Deteriorate
15	Badlapur	Ulhas	Maharashtra	39181	80159	88857	33095	Deteriorate	Improved but Hotspot
16	Balrampur	Rapti	Uttar Pradesh	2111	1285	3620	3800	Deteriorate	Deteriorate
17	Baluaghat	Ganga	Uttar Pradesh	59800	71290	15047	11248	Improved but Hotspot	Improved but Hotspot
18	Banda	Ken	Uttar Pradesh	15025	24006	10500	13546	Improved but Hotspot	Improved but Hotspot
19	Bansi	Rapti	Uttar Pradesh	2183	2042	4387	4276	Deteriorate	Deteriorate
20	Barod	Kalisindh	Rajasthan	56583	719000	90111	44133	Deteriorate	Improved but Hotspot
21	Basti	Kuwano	Uttar Pradesh	3383	2538	6353	6625	Deteriorate	Deteriorate
22	Basti D/S	Kuwano	Uttar Pradesh	1520	1230	6293	6745	Deteriorate	Deteriorate
23	Basti U/S	Kuwano	Uttar Pradesh	1100	990	5407	5857	Deteriorate	Deteriorate
24	Bawapuram	Tungabhadra	Andhra Pradesh	7223	5778	906	1740	Improved but Hotspot	Improved but Hotspot
25	Belne Bridge	Gad	Maharashtra	8775	11000	1749	622	Improved but Hotspot	Improved but Hotspot
26	Bendrahalli	Suvarnavathi	Karnataka	64000	34736	1048	1700	Improved but Hotspot	Improved but Hotspot
27	Bhadrachalam	Godavari	Telangana	8004	6078	752	2613	Improved but Hotspot	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
28	Bhatpalli	Peddavagu	Telangana	9281	3089	3055	1929	Improved but Hotspot	Improved but Hotspot
29	Biligundulu	Cauvery	Tamil Nadu	1565	4622	10769	7876	Deteriorate	Deteriorate
30	Birdghat	Rapti	Uttar Pradesh	4006	2677	6420	6110	Deteriorate	Deteriorate
31	Chitrasani	Balaram	Gujarat	3681	4289	1495	*	Improved but Hotspot	*
32	Cholachuguddа	Malaprabha	Karnataka	41817	128586	10515	*	Improved but Hotspot	*
33	Chunchanakatte	Cauvery	Karnataka	8706	3200	1538	260	Improved but Hotspot	No Hotspot
34	Dameracherla	Musi	Telangana	6058	5546	1082	1280	Improved but Hotspot	Improved but Hotspot
35	Daund	Bhima	Maharashtra	9738	45600	6573	*	Improved but Hotspot	*
36	Delhi Rly Bridge	Yamuna	Delhi	13039333	30052381	12026667	12090476	Improved but Hotspot	Improved but Hotspot
37	Derol Bridge	Sabarmati	Gujarat	7559	7371	3438	*	Improved but Hotspot	*
38	Dhalegaon	Godavari	Maharashtra	7607	16000	796	1714	Improved but Hotspot	Improved but Hotspot
39	Dholpur	Chambal	Rajasthan	7678	6536	4700	7890	Improved but Hotspot	Deteriorate
40	Duddhi	Kanhar	Uttar Pradesh	2343	4000	6400	5690	Deteriorate	Deteriorate
41	Elginbridge	Ghaghra	Uttar Pradesh	2517	1777	3193	3510	Deteriorate	Deteriorate
42	Elunuthimangalam	Noyyal	Tamil Nadu	206200	137565	34580	14838	Improved but Hotspot	Improved but Hotspot
43	Etawah	Yamuna	Uttar Pradesh	87400	126678	361429	550000	Deteriorate	Deteriorate
44	Galeta	Hindon	Uttar Pradesh	14741333	48429444	16429333	39761905	Deteriorate	Improved but Hotspot
45	Gandhavayal	Gandhayar	Tamil Nadu	100333	46444	83408	28324	Improved but Hotspot	Improved but Hotspot
46	Ganod	Bhadar	Gujarat	6577	4542	5299	5420	Improved but Hotspot	Deteriorate
47	Garrauli	Dhasan	MP	1850	9970	2075	1408	Deteriorate	Improved but Hotspot
48	Ghazipur	Ganga	Uttar Pradesh	43400	90240	11320	9700	Improved but Hotspot	Improved but Hotspot
49	Gorakhpur D/S	Rapti	Uttar Pradesh	5020	2000	6313	6176	Deteriorate	Deteriorate
50	Gorakhpur U/S	Rapti	Uttar Pradesh	3860	2580	4827	4810	Deteriorate	Deteriorate

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
51	Gummanur	Ponnaiyar	Tamil Nadu	250130	83878	11228	25329	Improved but Hotspot	Improved but Hotspot
52	Halia	Halia	Telangana	7207	5354	897	1233	Improved but Hotspot	Improved but Hotspot
53	Hamirpur	Yamuna	Uttar Pradesh	50930	28468	30214	28650	Improved but Hotspot	Deteriorate
54	Hariharapura	Tunga (Thunga)	Karnataka	7984	3500	2323	416	Improved but Hotspot	No Hotspot
55	Haralahalli	Tungabhadra	Karnataka	9398	1652	5354	1488	Improved but Hotspot	Improved but Hotspot
56	Hivra	Wardha	Maharashtra	10776	1192	2891	1421	Improved but Hotspot	Deteriorate
57	Holehonnur	Tunga (Thunga)	Karnataka	14178	6584	1623	2696	Improved but Hotspot	Improved but Hotspot
58	Honnali	Tungabhadra	Karnataka	32471	8409	2584	1279	Improved but Hotspot	Improved but Hotspot
59	Huvinhedigi	Krishna	Karnataka	5497	4703	739	1670	Improved but Hotspot	Improved but Hotspot
60	Jagdalpur	Indravati	Chhattisgarh	9008	6518	567	2369	Improved but Hotspot	Improved but Hotspot
61	Jaunpur	Gomti	Uttar Pradesh	30867	49860	9460	8929	Improved but Hotspot	Improved but Hotspot
62	Jawahar Bridge	Yamuna	Uttar Pradesh	315909	252867	501333	681500	Deteriorate	Deteriorate
63	K.M.Vadi	Lakshmanthirtha	Karnataka	34550	13183	4448	2200	Improved but Hotspot	Improved but Hotspot
64	Kabirganj	Sarda	Uttar Pradesh	880	692	3593	3729	Deteriorate	Deteriorate
65	Kalampur	Kaliyar	Kerala	1170	1367	1500	1700	Deteriorate	Deteriorate
66	Kallooppara	Manimala	Kerala	1094	1425	1325	1300	Deteriorate	Improved but Hotspot
67	Karathodu	Kadalundi	Kerala	1536	950	1867	1300	Deteriorate	Deteriorate
68	Keesara	Krishna/Munneru	Andhra Pradesh	9685	5341	784	1869	Improved but Hotspot	Improved but Hotspot
69	Kellodu	Vedavathi	Karnataka	11700	6567	2978	*	Improved but Hotspot	*
70	Keolari	Wainganga	Madhya Pradesh	4518	1867	3620	1323	Improved but Hotspot	Improved but Hotspot
71	Kanpur	Ganga	Uttar Pradesh	7565	4054	18343	17424	Deteriorate	Deteriorate
72	Khanpur	Mahi	Gujarat	11981	5551	2666	14052	Improved but Hotspot	Deteriorate
73	Khatoli	Parwati	Rajasthan	238667	315167	137700	19882	Improved but Hotspot	Improved but Hotspot
74	Kidangoor	Meenachil	Kerala	1421	1500	1700	1300	Deteriorate	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
75	Kodumudi	Cauvery	Tamil Nadu	8916	25625	14777	12333	Deteriorate	Improved but Hotspot
76	Kollegal	Cauvery	Karnataka	9646	6070	1386	1683	Improved but Hotspot	Improved but Hotspot
77	Konta	Sabari	Chhattisgarh	7056	4893	753	1986	Improved but Hotspot	Improved but Hotspot
78	Kopergaon	Godavari	Maharashtra	10079	4563	1105	3891	Improved but Hotspot	Improved but Hotspot
79	Kora	Rind	Uttar Pradesh	4163	2433	2690	3581	Improved but Hotspot	Deteriorate
80	Kudige	Cauvery	Karnataka	4400	6271	2365	1491	Improved but Hotspot	Improved but Hotspot
81	kudlur	Palar	Karnataka	190000	24133	30800	14222	Improved but Hotspot	Improved but Hotspot
82	Kuldah Bridge	Sone	Madhya Pradesh	3696	5926	5927	4738	Deteriorate	Improved but Hotspot
83	Kumbidi	Bharathapuzha	Kerala	1206	1299	1225	1700	Deteriorate	Deteriorate
84	Kumhari	Wainganga	Madhya Pradesh	4020	1113	3037	552	Improved but Hotspot	Improved but Hotspot
85	Kuniyil	Chaliyar	Kerala	1306	1475	1833	1300	Deteriorate	Improved but Hotspot
86	Kuppellur	Kumudavathi	Karnataka	17817	2260	2850	1700	Improved but Hotspot	Improved but Hotspot
87	Kurundwad	Krishna	Maharashtra	93755	2160	19377	*	Improved but Hotspot	*
88	Kuttyadi	Kuttyadi	Kerala	1233	1250	1325	800	Deteriorate	Improved but Hotspot
89	Lakkavalli	Bhadra	Karnataka	2804	2844	1620	668	Improved but Hotspot	Improved but Hotspot
90	Lakshmananpatti	Kodaganar	Tamil Nadu	65667	8050	*	18867	*	Deteriorate
91	Luwara	Shetrunji	Gujarat	3562	6600	6593	13092	Deteriorate	Deteriorate
92	M.H.Halli	Hemavati	Karnataka	21066	7076	754	1279	Improved but Hotspot	Improved but Hotspot
93	Madla	Ken	Madhya Pradesh	1336	4640	1462	940	Deteriorate	Improved but Hotspot
94	Madhira	Wyra	Telangana	9990	4734	549	2239	Improved but Hotspot	Improved but Hotspot
95	Maighat	Gomti	Uttar Pradesh	6890	11630	9187	8143	Deteriorate	Improved but Hotspot
96	Malakkara	Pampa	Kerala	1151	1400	2267	1100	Deteriorate	Improved but Hotspot
97	Malkhed	Kagna	Karnataka	8094	5962	690	2151	Improved but Hotspot	Improved but Hotspot
98	Mancherial	Godavari	Telangana	7609	5577	1713	1366	Improved but Hotspot	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
99	Mangaon	Kal	Maharashtra	39003	15578	11286	*	Improved but Hotspot	*
100	Mankara	Bharathapuzha	Kerala	1104	1187	2267	1300	Deteriorate	Deteriorate
101	Mantralayam	Tungabhadra	Andhra Pradesh	6589	3727	533	1611	Improved but Hotspot	Improved but Hotspot
102	Marol	Varada	Karnataka	25602	3500	6537	5400	Improved but Hotspot	Deteriorate
103	Mataji	Mahi	Madhya Pradesh	9423	3716	5970	13183	Improved but Hotspot	Deteriorate
104	Mawi	Yamuna	Uttar Pradesh	171562	328100	562133	114524	Deteriorate	Improved but Hotspot
105	Meja Road	Tons	Uttar Pradesh	3406	5837	8447	6605	Deteriorate	Deteriorate
106	Mirawadi	Mula-Mutha	Maharashtra	24514	38080	32923	2700	Deteriorate	Improved but Hotspot
107	Mirzapur	Ganga	Uttar Pradesh	8202	13857	9413	8176	Deteriorate	Improved but Hotspot
108	Mohana	Betwa	Uttar Pradesh	1982867	5994211	4107	6935	Improved but Hotspot	Improved but Hotspot
109	Munugodu	Edduvagu	Andhra Pradesh	7094	3920	615	1254	Deteriorate	Deteriorate
110	Muradpur	Vashishti	Maharashtra	44675	11000	29182	2175	Improved but Hotspot	Improved but Hotspot
111	Murappanadu	Tambraparni	Tamil Nadu	9020	8058	21350	6890	Deteriorate	Improved but Hotspot
112	Musiri	Cauvery	Tamil Nadu	14400	9562	16323	18410	Deteriorate	Deteriorate
113	Muthankera	Kabini	Kerala	7510	2702	280	2090	No Hotspot	Improved but Hotspot
114	Nagothane	Amba	Maharashtra	9156	53080	24000	*	Deteriorate	*
115	Nandgaon	Wunna	Maharashtra	13864	6115	5979	3101	Improved but Hotspot	Improved but Hotspot
116	Nanded	Godavari	Maharashtra	6630	7011	2107	1679	Improved but Hotspot	Improved but Hotspot
117	Neeleswaram	Periyar	Kerala	1229	1065	2333	1300	Deteriorate	Deteriorate
118	Nellithurai	Bhavani	Tamil Nadu	13000	160000	92000	*	Deteriorate	*
119	Nowrangpur	Indravati	Odisha	6984	3798	1129	1930	Improved but Hotspot	Improved but Hotspot
120	Odanthurai	Cauvery/Kallar	Tamil Nadu	63667	90600	85583	25762	Deteriorate	Improved but Hotspot
121	P.G.Bridge	Penganga	Maharashtra	8504	1483	5410	841	Improved but Hotspot	Improved but Hotspot
122	Pachegaon	Pravara	Maharashtra	5157	7983	1810	2034	Improved but Hotspot	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
123	Paderdibadi	Mahi	Rajasthan	9495	5291	5177	12610	Improved but Hotspot	Deteriorate
124	Paleru Bridge	Paleru	Andhra Pradesh	7390	5636	621	1094	Improved but Hotspot	Improved but Hotspot
125	Paliakalan	Sarda	Uttar Pradesh	3411	2373	3500	3629	Deteriorate	Deteriorate
126	Palla	Yamuna	Delhi	227600	452105	779286	142952	Deteriorate	Improved but Hotspot
127	Paramakudi	Vaigai	Tamil Nadu	*	17000	*	26200	*	Deteriorate
128	Pargaon	Bhima	Maharashtra	26725	7400	18769	3300	Improved but Hotspot	Improved but Hotspot
129	Parsohan Ghat	Rapti	Uttar Pradesh	1040	809	3900	4171	Deteriorate	Deteriorate
130	Pathagudem	Indravati	Chhattisgarh	5077	3812	569	1441	Improved but Hotspot	Improved but Hotspot
131	Pattazhy	Kallada	Kerala	1180	1280	1933	700	Deteriorate	Improved but Hotspot
132	Pauni	Wainganga	Maharashtra	14218	5951	6625	3957	Improved but Hotspot	Improved but Hotspot
133	Perumannu	Valapatnam	Kerala	998	1087	2333	1300	Deteriorate	Deteriorate
134	Perur	Godavari	Telangana	6480	4951	823	1139	Improved but Hotspot	Improved but Hotspot
135	Phulgaon	Bhima	Maharashtra	31333	900	26600	*	Improved but Hotspot	*
136	Poanta	Yamuna	Himachal Pradesh	58556	75275	3813	29905	Improved but Hotspot	Improved but Hotspot
137	Polavaram	Godavari	Andhra Pradesh	7538	6293	651	2841	Improved but Hotspot	Improved but Hotspot
138	Pratapgarh	Sai	Uttar Pradesh	8746	16730	9147	8071	Deteriorate	Improved but Hotspot
139	Pratappur	Pravara	Maharashtra	4641	6187	20207	14205	Deteriorate	Deteriorate
140	Pudur	Kannadipuzha	Kerala	1088	1600	2400	1700	Deteriorate	Deteriorate
141	Pulamanthole	Pulanthodu	Kerala	1433	1243	2033	1700	Deteriorate	Deteriorate
142	Rajapur	Yamuna	Uttar Pradesh	12600	13836	17873	15095	Deteriorate	Deteriorate
143	Rajegaon	Bagh	Madhya Pradesh	10296	2412	3921	1861	Improved but Hotspot	Improved but Hotspot
144	Ramakona	Kanhan	Madhya Pradesh	3606	955	8164	2192	Deteriorate	Deteriorate
145	Ramamangalam	Muvattupuzha	Kerala	1600	1367	1467	1100	Improved but Hotspot	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
146	Rangeli	Som	Rajasthan	7180	2845	2332	15110	Improved but Hotspot	Deteriorate
147	Shahjina	Betwa	Uttar Pradesh	27044	19242	15207	9952	Improved but Hotspot	Improved but Hotspot
148	Saidpur	Ganga	Uttar Pradesh	21875	19800	10893	8152	Improved but Hotspot	Improved but Hotspot
149	Saigaon	Manjira	Karnataka	7801	8171	1737	1409	Improved but Hotspot	Improved but Hotspot
150	Sakleshpur	Hemavati	Karnataka	6377	7773	3798	800	Improved but Hotspot	Improved but Hotspot
151	Sakmur	Wardha	Maharashtra	2700	682	3216	1686	Deteriorate	Deteriorate
152	Saloora	Manjira	Telangana	2100	11333	1065	2156	Improved but Hotspot	Improved but Hotspot
153	Samdoli	Varna	Maharashtra	10371	18000	12000	*	Deteriorate	*
154	Sangod	Parwan	Rajasthan	85083	*	112875	*	Deteriorate	*
155	Saradaput	Sabari	Odisha	2700	7980	861	1497	Improved but Hotspot	Improved but Hotspot
156	Sarati	Nira	Maharashtra	14575	5240	8856	*	Improved but Hotspot	*
157	Satna	Tons	Madhya Pradesh	29000	42000	8580	6852	Improved but Hotspot	Improved but Hotspot
158	Satrapur	Kanhan	Maharashtra	24546	10042	7169	3649	Improved but Hotspot	Improved but Hotspot
159	Savandapur	Bhavani	Tamil Nadu	39516	12508	17477	21633	Improved but Hotspot	Deteriorate
160	Seondha	Sindh	Madhya Pradesh	8366	9542	2294	1564	Improved but Hotspot	Improved but Hotspot
161	Sevanur	Chittar	Tamil Nadu	39367	33878	13750	17940	Improved but Hotspot	Improved but Hotspot
162	Shahzadpur	Ganga	Uttar Pradesh	6186	11226	10580	8124	Deteriorate	Improved but Hotspot
163	Shastri Bridge	Ganga	Uttar Pradesh	26333	85423	10960	8833	Improved but Hotspot	Improved but Hotspot
164	Shimoga	Tunga (Thunga)	Karnataka	15967	12017	3747	*	Improved but Hotspot	*
165	Singasadanapalli	Ponnaiyar	Tamil Nadu	2861933	4999564	10675000	4256381	Deteriorate	Improved but Hotspot
166	Sultanpur	Gomti	Uttar Pradesh	7535	12232	10467	8429	Deteriorate	Improved but Hotspot
167	T. Bekuppe	Arkavathy	Karnataka	321567	143865	7786	9913	Improved but Hotspot	Improved but Hotspot
168	T.K.Halli	Shimsha	Karnataka	24407	15693	2140	3375	Improved but Hotspot	Improved but Hotspot

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
169	T Narasipura	Kabini	Karnataka	13113	6858	4341	2286	Improved but Hotspot	Improved but Hotspot
170	T.Ramapuram	Hagari	Karnataka	7513	7566	795	1153	Improved but Hotspot	Improved but Hotspot
171	Tal	Chambal	Madhya Pradesh	235167	*	201800	*	Improved but Hotspot	*
172	Tanda D/S	Ghaghra	Uttar Pradesh	4240	1450	4060	3800	Improved but Hotspot	Deteriorate
173	Tanda U/S	Ghaghra	Uttar Pradesh	3640	1160	3453	3219	Improved but Hotspot	Deteriorate
174	Tekra	Pranhita	Maharashtra	4774	*	629	401	Improved but Hotspot	No Hotspot
175	Terwad	Panchganga	Maharashtra	20538	9675	17246	*	Improved but Hotspot	*
176	Thengumarahada	Moyar	Tamil Nadu	24840	22405	26608	7605	Deteriorate	Improved but Hotspot
177	Theni	Suruliar	Tamil Nadu	16180	46250	34075	17419	Deteriorate	Improved but Hotspot
178	Thevur	Sarabenga	Tamil Nadu	48050	55983	9760	21663	Improved but Hotspot	Improved but Hotspot
179	Thimmanahalli	Yagachi	Karnataka	7489	6865	5806	899	Improved but Hotspot	Improved but Hotspot
180	Thumpamon	Achankovil	Kerala	1377	1240	2100	800	Deteriorate	Improved but Hotspot
181	Tuini	Tons	Uttarakhand	90667	57388	2480	1771	Improved but Hotspot	Improved but Hotspot
182	Turtipar	Ghaghra	Uttar Pradesh	3756	1977	3453	3219	Improved but Hotspot	Deteriorate
183	Udi	Chambal	Uttar Pradesh	11820	10129	4007	7050	Improved but Hotspot	Improved but Hotspot
184	Urachikottai	Cauvery	Tamil Nadu	16808	96643	41700	16533	Deteriorate	Improved but Hotspot
185	V.S. Bridge	Ganga	Uttar Pradesh	26267	60683	10047	8043	Improved but Hotspot	Improved but Hotspot
186	Valigonda	Musi	Telangana	6875	5948	1573	1203	Improved but Hotspot	Improved but Hotspot
187	Vandiperiyar	Periyar	Kerala	1600	1500	1550	1700	Improved but Hotspot	Deteriorate
188	Varanasi	Ganga	Uttar Pradesh	9914	16156	12433	9876	Deteriorate	Improved but Hotspot
189	Vautha	Sabarmati	Gujarat	58444	144316	356667	1012857	Deteriorate	Deteriorate
190	Vijayawada	Krishna	Andhra Pradesh	10333	7326	1204	1797	Improved but Hotspot	Improved but Hotspot
191	Wadakbal	Sina	Maharashtra	31340	46000	8000	*	Improved but Hotspot	*

S. No.	Water Quality Monitoring station	River	State	M (2011-2020)	NM (2011-2020)	M (2021-2022)	NM (2021-2022)	Comparison of Hot Spots during year 2011-2020 with 2021-2022	
								M	NM
192	Wadenapally	Krishna	Telangana	6372	6489	743	1547	Improved but Hotspot	Improved but Hotspot
193	Wairagarh	Khobragarhi	Maharashtra	4501	1829	4470	603	Improved but Hotspot	Improved but Hotspot
194	Warunji	Koyna	Maharashtra	47638	47800	15167	*	Improved but Hotspot	*
195	Yadgir	Bhima	Karnataka	10576	8850	952	1517	Improved but Hotspot	Improved but Hotspot
196	Yashwant Nagar	Giri	Himachal Pradesh	100111	403038	2700	11048	Improved but Hotspot	Improved but Hotspot
197	Yelli	Godavari	Maharashtra	3086	5166	1459	1613	Improved but Hotspot	Improved but Hotspot

(*) means river dry/data not available.

CHAPTER – 9

Conclusion

The study conducted in the years 2022 covered a total of 776 water quality monitoring stations respectively, situated in important rivers across the country to identify water quality hotspots. The study report is based on the average values recorded during pre-monsoon, monsoon, and post-monsoon seasons at these monitoring stations for the two years. The report provides a detailed analysis of 13 water quality parameters, highlighting the water quality status at various locations in India. The report also sheds light on the variations observed in the parameters essential for both the Central Pollution Control Board (CPCB) and Bureau of Indian Standards (BIS) classifications, along with parameters specific to the primary water quality criteria for bathing water as per the Ministry of Environment, Forest and Climate Change (MoEFCC). Based on the water quality data analysis, the following observations have been found:

pH

The pH levels analysis of the water quality at various monitored monitoring stations in 2022 showed dynamic variations. Water quality station Kharkhana again exhibited the lowest pH of 4.12 among all monitored monitoring stations, while Maharo located in Jharkhand and situated on the Mayurakshi River had the highest pH of 8.82. The pre-monsoon season recorded the highest number of water quality monitoring stations exceeding the acceptable pH limit. The pre-monsoon season had the highest number again, with 13 monitoring stations surpassing the acceptable pH limit, followed by 5 monitoring stations during the monsoon season and 9 monitoring stations during the post-monsoon period.

Electrical Conductivity

Seven (07) water quality Monitoring stations - Elunuthi Mangalam (Noyyal River), Luwara (Shetrunji River), A.P. Puram (Chittar), B.P.M. (Bamni) (Wardha), Dhansa (Sahibi), Kopergaon (Godavari), and Varanavasi (Maruthaiyar River) showed conductivity > 2250 µS/cm during the pre-monsoon, monsoon, and post-monsoon seasons. Among these, Elunuthi Mangalam (Noyyal River), Luwara (Shetrunji River), and Varanavasi (Maruthaiyar River) are common in both 2021 and 2022 where the conductivity observed is above the acceptable limit. The highest conductivity recorded was at Kopergaon on the Godavari River in the state of Maharashtra, which was 7983 µS/cm.

Ammonia as N (NH_3-N)

During the study period water quality station R.S.P. in Odisha recorded the highest concentration of ammonia at 38.71 mg/L during the monsoon season.

Twenty three(23) water quality monitoring stations during the pre-monsoon season, 26 monitoring stations during the monsoon season, and 25 water quality monitoring

stations during the post-monsoon season were found to exceed the acceptable limit of ammonia as N. Twenty one (21) water quality monitoring stations were common across all seasons (pre-monsoon, monsoon, and post-monsoon) in 2021. During the study period, 28 water quality monitoring stations along 11 rivers, exhibited ammonia concentrations above 1.2 mg/L.

Fluoride

Seven (07) water quality monitoring stations, namely Avarankuppam (Palar), Kamalapuram (Papagani), Lingdem (HS) (Talangchu), R.S.P (Brahmani), R.S.P-1 (Brahmani), Singavaram (Chitravathi), and Thoppur (Thoppaiyar), recorded fluoride concentrations exceeding the acceptable limits. Lingdem (HS) and R.S.P (Brahmani) were the only two water quality monitoring stations that recorded elevated fluoride levels in both 2021 and 2022. The maximum fluoride concentration recorded during the post-monsoon season at Lingdem (HS) water quality monitoring station was 7.91 mg/L.

Total Hardness

The total hardness parameter results exceeded at 3 different monitoring stations: B.P.M. (Bamni) in Wardha, Maharashtra, Kopergaon in Godavari, Maharashtra, and Luwara in Shetrunji, Gujarat. The highest total hardness value was recorded at Kopergaon in the Godavari River, Maharashtra, with a value of 1454 mg/L.

Chloride

The levels of chloride were measured at 1507.43 mg/L before the monsoon season (pre-monsoon) and 1204.59 mg/L after the monsoon season (post-monsoon), indicating a significant decrease in chloride concentration. At Luwara (Shetrunji) monitoring station in Gujarat, the chloride concentration slightly increased from 1349 to 1507.43 mg/L during the pre-monsoon seasons of both 2021 and 2022.

Boron

The Central Pollution Control Board (CPCB) sets a limit of 2 mg/l for boron in specific classes, including irrigation and industrial cooling. The limit prescribed by CPCB for Boron (B) in Class-E (Irrigation, Industrial Cooling, Controlled Waste disposals) is not greater than 2 mg/l. Monitoring stations consistently show average boron values within the acceptable permissible limit during pre-monsoon, monsoon, and post-monsoon seasons.

Nitrate

The concentration of nitrate was found to be the highest in Gatora-2 (Arpa, Chhattisgarh) during the pre-monsoon period of both years, with a concentration of 26.83 mg/L in 2021 and 29.87 mg/L in 2022. The number of water quality monitoring stations exceeding the acceptable limit increased significantly. 25 monitoring stations exceeded the limit during the pre-monsoon season, 79 during the monsoon season, and 17 during the post-monsoon period. This indicates a worsening of water quality and raises serious concerns about nitrate contamination in rivers. The comparison between

the pre-monsoon and monsoon seasons of 2021 and 2022 shows a significant escalation in the number of water quality monitoring stations exceeding acceptable limits. The number of monitoring stations exceeding the acceptable limit in the pre-monsoon season was 25, while in it increased to 79 during monsoon season.

Dissolved Oxygen

During the study period, 5 monitoring stations, Manderial and Pali in the Chambal River, Baleni in Yamuna River, Vautha in Sabarmati river, Galeta in Hindon river located in the state of Rajasthan, Uttar Pradesh and Gujarat recorded extremely low Dissolved Oxygen (DO) levels of 0.00 mg/L during the pre-monsoon period. Additionally, 3 water quality monitoring stations at Galeta (Hindon), Noida (Yamuna), and Singasadanapalli (Ponnaiyar) and 5 water quality monitoring stations located at Noida and Baleni (Yamuna river) and Galeta (Hindon river) in Uttar Pradesh, K.T. (Satrapur) (Kanhan river) in Maharashtra, and Singasadanapalli (Ponnaiyar river) in Tamil Nadu at different rivers reported extremely low Dissolved Oxygen (DO) levels of 0.00 mg/L during the monsoon and post-monsoon period respectively. The pre-monsoon season recorded 79 water quality monitoring stations with DO values below 5.0 mg/l, while the monsoon season recorded 96 monitoring stations with the same issue. In the post-monsoon season, 41 water quality monitoring stations reported average DO values below 5.0 mg/L.

Biochemical Oxygen Demand

During the post-monsoon season the highest BOD level observed at Singasadanapalli at Ponnaiyar River was 95.33 mg/L. The pre-monsoon season witnessed 93 water quality monitoring stations with average BOD values exceeding 3.0 mg/l, while the monsoon season recorded 123 monitoring stations with the same. In the post-monsoon season, 85 water quality monitoring stations recorded average BOD values exceeding 3.0 mg/l.

Total Coliform

During the study period, the pre-monsoon season, 235 water quality monitoring stations, and during the monsoon season, 247 water quality monitoring stations reported average TC values exceeding 500 MPN/100 ml. In the post-monsoon season of 2022, 171 water quality monitoring stations recorded elevated TC values. The water quality data collected during the pre-monsoon, monsoon, and post-monsoon seasons of 2022 indicate a positive trend in terms of Total Coliforms (TC) levels in Indian rivers. There was a slight increase in the number of water quality monitoring stations with elevated TC levels during the pre-monsoon season of 2022, a reduction in the number of monitoring stations during the monsoon season, and a decrease in the number of monitoring stations with elevated TC levels during the post-monsoon season of 2022.

Faecal coliform

During the pre-monsoon season, 199 water quality monitoring stations recorded average FC values exceeding 500 MPN/100 ml. In the monsoon season, this number decreased to 241 and during the post-monsoon season of 2022, 158 monitoring stations showed elevated FC levels. The comparison between 2021 and 2022 suggests that there are some variations in the trends of Faecal Coliforms across different seasons. While the pre-monsoon season of 2022 showed a slight increase in the number of monitoring stations with elevated FC levels, both the monsoon and post-monsoon seasons displayed some improvement compared to the corresponding seasons in 2021.

Sodium Adsorption Ratio (SAR)

All the samples have been found within the acceptable limit of the SAR.

ABBREVIATION

Ammonia	= NH_3
Andhra Pradesh	= AP
Alpha Benzenehexachloride	= BHC
Biochemical Oxygen Demand	= BOD
Bureau of Indian Standards	= BIS
Boron	= B
Calcium	= Ca^{+2}
Cauvery Division	= CD
Central Pollution Control Board	= CPCB
Central Water Commission	= CWC
Chambal Division	= CD
Chenab Division	= CD
Chloride	= Cl^-
Dissolved Oxygen Dichlorodiphenyltrichloroethane	= DO = DDT
Eastern Rivers Division	= ERD
Electrical Conductance	= EC
Godavari Division	= GD
Himachal Pradesh	= HP
Himalayan Ganga Division	= HGD
Hydrology Division Hot Spring	= HD = HS
Iron	= Fe
Lower Krishna Division	= LKD
Lower Yamuna Division	= LYD
Madhya Pradesh	= MP
Magnesium	= Mg^{+2}
Mahanadi Division	= MD
Mahi Division	= MD
Middle Brahmaputra Division	= MBD
Middle Ganga Division	= MGD
Monsoon Season	=M
Narmada Division	= ND
Nitrate	= NO_3^-
Non-Monsoon Season	=NM
Sodium Absorption Ratio	= SAR
South West Khasi Hills	= SW Khasi Hills
South Western Rivers Division	= SWR
Southern Rivers Division	= SRD
Sulphate	= SO_4^{-2}
Tapi Division	= TD
Total Dissolved Solids	= TDS
Total Coliforms	= TC
Total Hardness	= TH
Upper Yamuna Division	= UYD
Uttar Pradesh	= UP
Wainganga Division	= WGD
Rourkela Steel Plant	= RSP
Madhya Bharat Paper Ltd	=MBPL

Annexure-I

Water Quality Laboratories of CWC & NABL accreditation Status

Out of 23 Water Quality Laboratories in CWC, 22 laboratories received accreditation from NABL as on August, 2024.

List of Water Quality Labs in CWC			
S. No.	**Location of laboratory**	**Level of Laboratory**	**Organisation**
1	National River Water Quality Laboratory, New Delhi	III	YBO, New Delhi
2	Lower Cauvery Water Quality Laboratory, Coimbatore	III	C&SRO, Coimbatore
3	Upper and Middle Ganga Water Quality Laboratory, Varanasi	III	LGBO, Patna
4	Krishna and Godavari River Water Quality Laboratory, Hyderabad	III	K&GBO, Hyderabad
5	Upper Cauvery Water Quality Laboratory, Bangalore	II	MSO, Bangalore
6	South Western Flowing Rivers Water Quality Laboratory, Kochi	II	C&SRO, Coimbatore
7	Upper Krishna Division Water Quality Laboratory, Pune	II	K&GBO, Hyderabad
8	Mahi Division Water Quality Laboratory, Gandhinagar	II	MTBO, Gandhinagar
9	Lower Yamuna Water Quality Laboratory, Agra	II	YBO, New Delhi
10	Eastern Rivers Water Quality Laboratory, Bhubaneswar	II	M&ERO, Bhubaneswar
11	Hydrology Division, Chennai	II	C&SRO, Coimbatore
12	Wainganga Division, Nagpur	II	MCO, Nagpur
13	Chenab Division, Jammu	II	IBO, Chandigarh
14	Middle Ganga Division -I, Lucknow	II	UGBO, Lucknow
15	Mahanadi Division, Raipur	II	M&ERO, Bhubaneswar
16	Middle Brahmaputra Division, Guwahati	III	BBO, Guwahati
17	Lower Brahmaputra Division, Jalpaiguri	II	T&BDBO, Kolkata
18	U.B. Division, Dibrugarh	II	BBO, Guwahati
19	Lower Ganga Division-3, Berhampore	II	T&BDBO, Kolkata
20	Lower Ganga Division-2, Patna	II	LGBO, Patna
21	Narmada Division, Bhopal	II	NBO, Bhopal
22	Tapi Division, Surat	II	MTBO, Gandhinagar
23	Himalayan Ganga Division, Haridwar	II	UGBO, Lucknow

Annexure-II

List of Parameters analyzed in different levels of Water Quality Labs of CWC

S. No.	Level-I	Level-II	Level-III
1	Temperature	Temperature	Temperature
2	Colour	Ph	pH
3	Odour	Electrical Conductivity	Electrical Conductivity
4	pH	Total Dissolved Solids	Total Dissolved Solids
5	Electrical Conductivity	Turbidity	Turbidity
6	Dissolved Oxygen	Dissolved Oxygen	Dissolved Oxygen
7		Biochemical Oxygen Demand	Biochemical Oxygen Demand
8		Chemical Oxygen Demand	Chemical Oxygen Demand
9		Sodium	Sodium
10		Calcium	Calcium
11		Magnesium	Magnesium
12		Potassium	Potassium
13		Carbonate	Carbonate
14		Bicarbonate	Bicarbonate
15		Chloride	Chloride
16		Sulphate	Sulphate
17		Fluoride	Fluoride
18		Boron	Boron
19		Ammonia (Nitrogen)	Ammonia (Nitrogen)
20		Nitrate	Nitrate
21		Nitrite	Nitrite
22		Silicate	Silicate
23		Phosphate	Phosphate
24		Total Coliform	Total Coliform
25		F. Coliform	F. Coliform
26			Arsenic
27			Cadmium
28			Chromium
29			Copper
30			Iron
31			Lead
32			Nickel
33			Mercury
34			Zinc
35			Alpha Benzenehexachloride (BHC), Beta BHC, Gama BHC (Lindane)
36			OP-Dichlorodiphenyltrichloroethane (OP DDT), PP-DDT
37			AlphaEndosulphan, Beta Endosulphan,
38			Aldrin, Dieldrin,
39			Carbaryl (Carbamate),
40			Malathian, Methyl parathion
41			Anilophos, Chloropyriphos

References

1. Langland, M., & Cronin, T. (Eds.). (2003). A Summary Report of Sediment Processes in Chesapeake Bay and Watershed. In Water-Resources Investigations Report 03-4123. New Cumberland, PA: U S Geological Survey.
2. EPA. (2012, March). Channel Processes: Bedload Transport. In Water: Science & Technology.
3. Hickin, E. J. (Ed.). (1995). River Geomorphology. Chichester: Wiley.
4. Fink, J. C. (2005, August). CHAPTER 4 – ESTABLISHING A RELATIONSHIP BETWEEN SEDIMENT CONCENTRATIONS AND TURBIDITY In The Effects of Urbanization on Baird Creek, Green Bay, WI (Thesis).
5. McManus, M., Woodson, B. (2012). Plankton distribution and ocean dispersal. In the Journal of Experimental Biology.
6. Beskenis, J. (2006). Chlorophyll *a* and Periphyton Technical Memorandum. In The Connecticut River Watershed.
7. Guiry, M. (2014). What are algae? In The Seaweed Monitoring station: information on marine algae.
8. Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems (3rd ed.). San Diego, CA: Academic Press.
9. Langland, M., & Cronin, T. (Eds.). (2003). A Summary Report of Sediment Processes in Chesapeake Bay and Watershed. In Water-Resources Investigations Report 03-4123. New Cumberland, PA: U S Geological Survey.
10. Palermo, M. R., Schroeder, P. R., Estes, T. J., & Francingues, N. R. (2008, September). Technical Guidelines for Environmental Dredging of Contaminated Sediments. US Army Corps of Engineers: Engineer Research and Development Center, ERDC/EL TR-08-29.
11. Department of Wildlife & Fisheries Sciences. (2014). Plant Identification. In AquaPlant: A Pond Manager Diagnostics Tools.
12. NSIDC. (2014). Wildlife: Phytoplankton. In National Snow & Ice Data Center.
13. Sallenave, R. (2011, October). Managing Filamentous Algae in Ponds. In New Mexico State University.
14. Earth Science Communications Team. (2013, July). Graphic: The relentless rise of carbon dioxide. In NASA Global Climate Change.
15. Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems (3rd ed.). San Diego, CA: Academic Press.
16. EPA. (2014, February). Sediments. In Water: Pollution Prevention & Control.
17. Kaiser, K.L.E., 1998. Review of biodegradability tests for the purpose of developing regulations. Water Qual. Res. J. Can. 33, 185–211.
18. Armiento, M., 2016. The Sustainable Welfare Index for Italy, 1960–2013. (Working Papers).
19. Grover, A.S., Wats, M., 2013. Decaying water bodies—victims of human neglect or urbanization. IPCBEE 54, 48–52.
20. Sawyer, C.N. and McCarty, P.L. Chemistry for sanitary engineers. 2nd edition. McGraw-Hill Series in Sanitary Science and Water Resources Engineering, McGraw-Hill, Toronto (1967).
21. Biesecker, J.E. and George, J.R. Stream quality in Appalachia as related to coal-mine drainage, 1965. In: Water quality in a stressed environment: readings in environmental hydrology. W.A. Pettyjohn (ed.). Burgess Publishing Company, Minneapolis, MN (1972).
22. P.Ramya et al, A Study On The Estimation Of Hardness In Ground Water Samples By Edta Tritrimetric Method. International Journal of Recent Scientific Research Vol. 6, Issue, 6, pp.4505-4507, June, 2015
23. Sana Akram, Hardness in drinking water, its sources, its effects on humans and its Household Treatment, June 2018, https://www.researchgate.net/publication/325781174, Last seen 15th Jan and-soft-water#hard-water-risks (log on 05th Jan 2022
24. Pallav Sengupta, Potential Health Impacts of Hard Water, Int J Prev Med. 2013

25. Hamzaraj, E., Lazo, P., Paparisto, A., et al., 2014. An overview of water quality of Vjosa river in Albania based on biological and chemical parameters. Int. J. Adv. Eng. Technol. 7 (5), 1359–1374.
26. Cotton, F.A. and Wilkinson, G. Advanced inorganic chemistry. John Wiley & Sons, New York, NY. p. 546 (1988).
27. Mackay, K.M. and Mackay, R.A. Introduction to modern inorganic chemistry. 4th edition. Prentice Hall, Englewood Cliffs, NJ. p. 339 (1989).
28. Canadian Public Health Association. Fluoride in the environment. Chapter 3 in: Criteria document in support of a drinking water standard for fluoride. Final report. Ottawa (1979).
29. Hussain, J., K.C. Sharma, and I. Hussain. 2010. "Fluoride and Health Hazards: Community Perception in a Fluorotic Area of Central Rajasthan (India): An Arid Environment." Environmental Monitoring and Assessment 162: 1–14.
30. National Research Council of Canada. The effects of alkali halides in the Canadian environment. NRCC No. 15019, Associate Committee on Scientific Criteria for Environmental Quality, Ottawa (1977).
31. National Academy of Sciences. Nutrient and toxic substances in water for livestock and poultry. National Academy Press, Washington, DC (1974).
32. World Health Organization. Sodium, chlorides and conductivity in drinking-water. Report on a WHO Working Group. EURO Reports and Studies 2, Regional Office for Europe, Copenhagen (1979).
33. Department of National Health and Welfare. Recommended nutrient intake for Canadians. Ottawa (1983).
34. CEPA, Canadian Environmental Protection Act 1999. Priority Substances List Assesment Report–Priority substances assessment report: ammonia in the aquatic environment. Minister of Public Works and Government Services, Canada. 2001; 40-215/55E.
35. Camargo JA, Alonso A. Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: a global assessment. Environ Int. 2006; 32: 831–849.
36. Baker LA, Herlihy AT, Kaufmann PR, Eilers JM. Acidic lakes and streams in the role of acidic deposition. Science. 1991; 252: 1151–1154.
37. Francis-Floyd R, Watson C, Petty D, Pounder DB. Ammonia in aquatic systems. UF/IFAS University of Florida (UF)/ Institute of Food and Agricultural Sciences (IFAS), FA 16. 2009; 1–4.
38. Benli ACK, Köksal G, Özkul A. Sublethal ammonia exposure of Nile tilapia (*Oreochromis niloticus* L.): Effects on gill, liver and kidney histology. Chemosphere. 2008; 72: 1355–1358.
39. Schram E, Roques JAC, Abbink W, Spanings T, de Vries P, et al. The impact of elevated water ammonia concentration on physiology, growth and feed intake of African catfish (*Clarias gariepinus*). Aquaculture. 2010; 306: 108–115.
40. EPA (U.S. Environmental Protection Agency). Aquatic life Ambient Water Quality Criteria for Ammonia (Freshwater). Office of Water EPA 822-R-18-002. 2013. Washington, D. C.
41. Sinha AK, AbdElgawad H, Giblen T, Zinta G, De Rop M., Asard H., et al. Anti-oxidative defences are modulated differentially in three freshwater teleosts in response to ammonia-induced oxidative stress. PLoS ONE. 2014; 9: e95319.
42. Wicks BJ, Joensen R, Tang Q, Randall DJ. Swimming and ammonia toxicity in salmonids: the effect of sub lethal ammonia exposure on the swimming performance of coho salmon and the acute toxicity of ammonia in swimming and resting rainbow trout. Aquat Toxicol. 2002; 59: 55–69.
43. Tudorache C, Blust R, Boeck G De. Social interactions, predation behaviour and fast start performance are affected by ammonia exposure in brown trout (*Salmo trutta* L.). Aquat Toxicol. 2008; 90: 145–153.
44. McKenzie DJ, Shingles A, Claireaux G, Domenic P. Sublethal concentrations of ammonia impair performance of the teleost fast-start escape response. Physiol Biochem Zool. 2009; 82: 353–362.
45. Laxmi, V., Hussain, J., Husain, I. & Gambhir, G. (2022). Assessment of Groundwater Quality for Drinking and Irrigation Use in Gurugram Block of Gurugram District, Haryana, India. Asian Journal of Chemistry. 34. 1555-1564. 10.14233/ajchem.2022.23779.

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