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Water Quality Monitoring of Rivers

The Nationwide Lockdown

(25.03.2020 – 17.05.2020)

Central Water Commission
RDC-II Directorate

WATER QUALITY MONITORING OF RIVERS: THE NATIONWIDE LOCKDOWN

RIVER DATA COMPILATION-II DIRECTORATE

CENTRAL WATER COMMISSION

DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVNATION

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FOREWORD

Water is the most essential element for life existence on earth. The quantity and quality of the world's water has been deteriorating with exponential growth in human population and its needs for industrial and agricultural activities. Central Water Commission (CWC) has been playing a vital role in water quality monitoring of river water over the past years and at present, is observing water quality at 658 key locations covering all major river basins of India.

On March 11, 2020, the World Health Organization (WHO) declared that an outbreak of the viral disease COVID-19, had reached the level of a global pandemic and instructed the governments to take urgent and aggressive action to stop the spread of the virus. The nationwide lockdown to contain the spread of the COVID-19 in India was announced on March 25. The important and exemplary aspect of all this was that while humans all over the world were in a lockdown, Nature appeared to have recuperated and was in the process of healing. The lockdown following the outbreak was a time to take a journey within and introspect. CWC has monitored Water Quality (WQ) of rivers at WQ sites across India. The present report attempts to provide the water quality scenario of Indian rivers during the lockdown period.

I appreciate the hard work done and efforts put in by Shri. Reading Shimray, Chief Engineer, P&DO, Shri. Pankaj Kumar Sharma, Director, Sh. Rakesh Kumar Gupta, Dy. Director, Dr. Sakshi Sharma and Dr. Prabhakar Rao, SRA, RDC-II Directorate, CWC in bringing out this publication titled "Water Quality Monitoring of Rivers: The Nationwide Lockdown". I also appreciate the work done by all field Chief Engineers of CWC and by large number of officials and staff posted at sampling sites & divisional water quality laboratories for collecting and analysing the samples.

I hope this publication would prove to be useful to all the stakeholders and agencies that are responsible for taking necessary remedial measures for conservation of river water quality.

(S. K. Haldar)

Date:

New Delhi.

Shri. R. K. Sinha,
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PREFACE

Globally, severe acute respiratory syndrome coronavirus (SARS-CoV-2) has affected several countries and territories. The swift and stern actions were taken around the world to keep people stay at their homes by shutting down schools, industries, businesses, suspended travels, and by closing the international and state boundaries.

Relatively, the nationwide lockdown to control the spread of the novel corona virus (COVID-19) in India was announced on March 25th 2020 for 21 days which was further extended till 17th May 2020 in three phases. Due to the forced restrictions, pollution loads to the environment drastically slowed down since people's movements and industrial activities were closed during lockdown. Several studies stated that anthropogenic activities are one of the key drivers of pollution in surface waters.

The above situation provided a lifetime opportunity to measure the near-baseline water quality parameter of a river-system in absence of industrial activity. CWC field offices have availed this lockdown window and collected the samples from 128 sites for testing most of the water quality parameters. Based on the obtained analysis results, this report titled as "Water Quality Monitoring of Rivers: the nationwide lockdown" has been prepared. This report explains parameter wise status of water quality in Indian rivers and basin wise status of water quality during lockdown period.

I would like to place on record my appreciation of Shri Reading Shimray, Chief Engineer (P&DO), CWC; Shri Pankaj Kumar Sharma, Director, RDC-II, CWC, Sh. Rakesh Kumar Gupta, Dy. Director, RDC-II, CWC, Dr. Sakshi Sharma and Dr. Prabhakar Rao, SRA, RDC-II, CWC for excellently bringing out this book. I also express sincere thanks to all field Chief Engineers of CWC for making arrangements for collection, transportation and analysis of river water samples during the nationwide lockdown. Efforts put in by Scientific officials in divisional water quality laboratories of CWC for collecting and analysing river water samples during the lockdown are also appreciated.

I hope this publication will be helpful in understanding the impact of lockdown on water quality of Indian Rivers.

Date:
New Delhi.

(R. K. Sinha)

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ANALYSIS AND SAMPLING

ALL FIELD ORGANISATIONS

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EXECUTIVE SUMMARY

Central Water Commission (CWC) is monitoring river water quality at 658 key stations covering all the important river basins of India. A total number of 128 water quality stations and 57 Gauge & Discharge (GD) stations covering all the major river basins of country were studied for lockdown effect on Indian rivers. There were no significant changes in water level and discharge. The river water quality was assessed on parameters Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform, Chemical Oxygen Demand (COD), pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Alkalinity, Fluoride, Chloride, Total Hardness and Turbidity.

River water samples from 96 WQ stations were analysed for DO and 80% of them showed the considerable increase in DO values during the lockdown period as compared to the pre lockdown values. 34 WQ stations were analysed for BOD and water quality has considerably improved at 82% stations in terms of Biochemical Oxygen Demand (BOD). The values of Total Coliform at 24 stations out of 26 stations have a significant decrease. Chemical Oxygen Demand (COD) values have decreased in lockdown period at 23 WQ sites out of 37. Further, out of 47 locations the values of pH were improved at 41 locations. Electrical Conductivity have a significant decrease at 59 locations out of 80 in lockdown period and a considerable decrease in the value of Total Dissolved Solids (TDS) at 9 WQ sites out of 12 sites during the lockdown period. There is a significant decrease in turbidity value at 5 locations out of 9 which indicates that the water is clearer. The values of Fluoride have improved at 8 locations out of 9 and the values of Chloride have a significant decrease at 23 locations out of 33 in lockdown period. At 7 locations value of Total hardness were improved while alkalinity values improved at 9 locations out of 13 during the lockdown.

Hence, the nationwide lockdown has engendered an improvement in water quality of most of Indian Rivers due to shut down of industries and people staying indoors.

1. Introduction

The water quality of the Indian rivers has a considerable importance as these waters are used for various purposes such as: drinking domestic and residential water supplies, agriculture (irrigation), hydroelectric power plants, transportation and infrastructure, tourism, recreation, and other human or economic ways to use water.

Unlike water quantity, monitoring water quality is not a straightforward and simple process. Managing water quality is a rather complex task. All the indications are that it is likely to become increasingly more complex in the future. One of the main reasons is that the number of new chemicals that are being introduced globally each year is very large and mostly unknown. It is impossible to reliably assess the health and environmental consequences of all the new chemicals that have been introduced in recent decades and the new ones that are likely to be introduced in the coming years.

The nationwide lockdown to contain the spread of the novel coronavirus (COVID-19) in India was announced on March 25 till April 14, 2020 (Lockdown 1.0). It was further extended by 19 days till May 3, 2020 (Lockdown 2.0). The lockdown was again extended until May 17, 2020 (Lockdown 3.0). The lockdown has led to closure of all the industrial sectors and restricted the movement of population. A significant drop in industrial wastewater discharges and agricultural run-offs amid the lockdown, has breathed fresh life into the otherwise polluted rivers as reported in various news reports. The nationwide lockdown that brought 1.3 billion people to a stop has apparently caused rejuvenation of nature; at least temporarily. People living in the towns situated near the river have shared videos of how rivers have been flowing cleaner, with more aquatic life visible near the banks. Many of local people have claimed that rivers had clear flows, aquatic species were reclaiming their legitimate place with no foul smell anymore during the lockdown. All of this had happened without any technological intervention, the rivers have become cleaner on their own using biological capacity.

This may primarily be attributed to absence of industrial wastewater discharge, agricultural runoff and increased fresh-water flow in the river. A decline in general human activities at ghats and entrainment of solid organic waste into the river may have also contributed. Even if the industrial effluents contribute very less to the wastewater discharge, their impact is greater than sewage water.

The coronavirus pandemic, and India's subsequent lockdown, offer several lessons in river hydrology, ecological flow, pollution and the role of the community. The increased snow melt combined with lack of industrial production, lower irrigation and commercial use have also contributed to the change. With people staying indoors and industries shut during the lockdown period, it is crucial to assess if the water quality in the Indian Rivers has indeed seen a significant improvement. During this lockdown period, CWC has monitored Water Quality (WQ) of rivers at WQ sites of CWC across India. The report analyses the impact of lockdown on water quality of Indian Rivers.

2. Importance of water quality parameters

There is a great range of water quality parameters that can be used to characterise waters. Largely the water quality measurement objectives and the previous history of the water body will determine selection of parameters. It is true, however, that some parameters are of special importance and deserve frequent attention.

2.1 TURBIDITY

The turbidity of sample is the reduction of transparency due to the presence of particulate matter such as clay or silt, finely divided organic matter, plankton or other microscopic organisms. These cause light to be scattered and absorbed rather than transmitted through the sample. The values are expressed in Nephelometric Turbidity Units (NTU). In general, the range of turbidity for drinking, surface, and saline waters is the 0-40 NTU.

2.2 TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) refer to the residue left after evaporation of a known volume of water at 105 °C, which has been filtered through a standard filter. It is approximately equal to the total content of dissolved substances in a water sample since approximately half of the bicarbonate ion, which is one of the dominant ions in waters, is lost as CO_2 during evaporation process. The TDS value for river waters depends largely on the ratio of the contribution of the overland flow to the subsoil flow. It may vary from less than 50 mg/L to a few thousand mg/L. Surface evaporation in arid climates and agricultural return waters increase the TDS considerably.

2.3 ELECTRICAL CONDUCTIVITY

Electrical Conductivity (EC) of natural water is due to the presence of salts, which dissociate into cations and anions. It is the ability of a solution to conduct current. The units of EC are μmhos/cm or μS/cm (microSiemens/cm) and is expressed at 25^{o}C. Even in cases where the

chemical composition of water is represented almost exclusively by inorganic ions, the correlation between their content and EC may change considerably since different ions conduct electricity to different extents. The value of EC may serve as an approximate index of the total content of dissolved substances in water samples. TDS, mg/L may be obtained by multiplying EC, μmhos/cm, by a factor ranging between 0.55 and 0.9. A commonly used value is 0.67. The conductivity of most fresh waters ranges from 10 to 1000 μmhos/cm. It is, at times, used as an indication of ingress of sea water in estuarine region of a river.

2.4 pH

The hydrogen ion concentration in water is expressed in terms of pH. It is defined as the logarithm of inverse of hydrogen ion concentration in moles/L. The pH value of natural waters mostly depends on free carbon dioxide, bicarbonates, and carbonate ions. The equilibrium condition may be changed by the intensity of photosynthetic process (which consumes carbon dioxide) and the biochemical oxidation of organic substances (which produces carbon dioxide), as well as chemical conversions of some mineral substances, such as reduction-oxidation reactions of ammonia, sulphur containing minerals, iron, etc. The pH value is also affected by the presence of naturally present humic substances and various acids and alkalis, which may be discharged into the body of water through wastes.

2.5 TOTAL HARDNESS

The Hardness of water is the property of water which prevents the lather formation with soap and increases the boiling point of water. The hardness of water is due to the presence of dissolved metal ions in it. In river water, the hardness is mainly due to the presence of Calcium and Magnesium ions. Hardness is measured by the reaction of polyvalent metallic ions in water with a chelating agent like EDTA and expressed as an equivalent concentration of Calcium Carbonate. Although the hardness is caused by cations, it may also be expressed in terms of carbonate (temporary) and noncarbonates (permanent) hardness. Carbonate hardness (temporary) refers to the amount of carbonate and bicarbonate in the sample that can be

removed by boiling. This type of hardness is responsible for the deposition of scales in hot water pipes and boilers. Non carbonate hardness (permanent) is due to the association of hardness causing cations with anions like sulfates, chloride or nitrates and is named as "permanent hardness" as it cannot be removed by boiling.

2.6 ALKALINITY

Alkalinity of water is its acid neutralising capacity. It is a measure of an aggregate property of water and is interpreted in terms of specific ions of a sample with known chemical composition. It is expressed in terms of an equivalent amount of calcium carbonates. Alkalinity of river water is generally interpreted as the quantity and kinds of salts like carbonates bicarbonates, phosphates, borates, silicates etc. together with hydroxyl ions, which collectively shift the pH to the alkaline side of neutrality Organic ligands, especially acetate, propionate and rare species such as NH_4OH or HS^- may contribute to alkalinity of water. Generally, the river water is rich in carbonates and bicarbonates with little concentration of other alkalinity imparting ions. These constituents result from dissolution of mineral substances in the soil and atmosphere. In most natural water the alkalinity is produced by the dissolved carbon dioxide species, bicarbonate and carbonate.

2.7 CHLORIDE

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. Some waters containing 250 mg/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 mg/L when predominant cations are calcium and magnesium. Chloride ions are present in all-natural waters, but mostly the concentrations are low. In most surface streams, chloride ion concentrations are lower than those of sulphate or bicarbonate ions. The possible sources of chloride ions in river water are municipal waste water, industrial sources and organic wastes.

2.8 FLUORIDE

Fluorides appear in unpolluted natural water as the result of the interaction of the water with fluorine containing minerals. Fluorides may also be contributed to surface waters through industrial wastes, such as, from glass industry and some ore enriching plants. Fluoride, in concentration range between 1.5 and 2 mg/L in drinking water, results in mottling of teeth. Higher concentrations may cause bone diseases.

2.9 DISSOLVED OXYGEN

The dissolved oxygen (DO) saturation concentration of water varies with temperature, salinity, and atmospheric pressure. In fresh waters, at sea level, it ranges from 15 mg/L at 0 ^{o}C to 7.5 mg/L at 30 ^{o}C. In water samples, it may be expressed in absolute terms as mg/L or as percent of saturation value.

Deviation in the concentration of DO from the saturation equilibrium value in a surface water body may exist due to aerobic biochemical oxidation of organic matter and photosynthetic activity of plants in water. These reactions, combined with atmospheric reaeration may result in establishing a different equilibrium concentration at a location, which may be below or above the saturation value. Oxygen content of fresh, unpolluted water bodies, having normal biological activity, ranges from 80% to 100% of saturation DO level. Lower levels indicate presence of organic pollution. DO in grossly polluted waters may be less than 25% of the saturation value. At this level, a drastic shift from the biological community of fresh waters may be expected. The water also becomes turbid and foul smelling.

In the main current of a stream the DO is usually the same at all depths because of mixing. However, in still water areas there may be stratification. This is particularly true for lakes. In eutrophic waters, the variation in DO with depth is very pronounced. Further, it is important to record the time of sampling since wide variation in DO at a location may occur over a 24-hour period.

2.10 BIOCHEMICAL OXYGEN DEMAND

Micro-organisms utilise waste organic matter as food. In aerobic environment, the organic matter is biochemically converted to carbon dioxide and water. The biochemical oxygen demand (BOD) test measures the oxygen consumed in the reaction. The standard test is carried out by incubating the sample at 20 ℃ for 5 days. Since not all organic matter is biochemically decomposable, the test measures the oxygen equivalence of the degradable matter only. Compounds such as cellulose, lignin and many synthetic petrochemicals are very resistant to biological breakdown. Nitrification is the term applied to the biological oxidation of ammonia to nitrate. The oxygen consumed during this process is differentiated from that required for the oxidation of organic matter. It is called the nitrogenous BOD. The BOD of unpolluted waters is usually less than 2 mg/L. Higher values indicate organic pollution from municipal or industrial wastes. In slow moving streams, values greater than 8 mg/L indicate the possibility of onset of anaerobic conditions in the stream since the oxygen demand may exceed the supply of oxygen through atmospheric reaeration. The BOD test is used extensively in the modelling of oxygen concentration in rivers and streams subjected to pollution.

2.11 CHEMICAL OXYGEN DEMAND

The chemical oxygen demand (COD) test measures the oxygen equivalent of the organic matter using potassium dichromate ($K_2Cr_2O_7$), which is a strong oxidant. The oxidation is carried out at a high temperature in an acidic medium, in the presence of a catalyst, to ensure complete oxidation of all organic matter. Only aromatic hydrocarbons and pyridines are not oxidised. One of the chief limitations of the COD test is its inability to differentiate between biologically oxidisable and biologically inert organic matter. In addition, it does not provide any information regarding the rate at which the oxidation of biodegradable matter would proceed in nature. The COD test is used extensively in surveys where industrial wastes are discharged in streams. In conjunction with the BOD test, the COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic matter. Compared to the BOD test,

it has better precision and can be completed in a shorter period. The COD of unpolluted surface waters is typically lower than 20 mg/L, which is mainly due to the presence of humic substances and the normal biota of the water body. The COD value of domestic and municipal wastes ranges between 400 and 800 mg/L.

2.12 COLIFORMS

Microorganisms are a valuable parameter of water quality in relation to drinking water quality. Although tests are available for specific pathogenic organism, there is no way of knowing which pathogenic organism is present in a sample. Also, the cost of testing for all the pathogenic organisms is prohibitive. The sanitary quality of drinking water is therefore routinely measured on the basis of the presence or absence of indicator bacteria.

Since most of the common disease, such as typhoid, cholera, dysentery, infectious hepatitis, etc., affect the gastrointestinal tract, faeces of the affected persons contain large number of the causative agents of the diseases. Non-pathogenic bacteria are also excreted in even higher numbers in faeces of all persons. Some of these bacteria have been shown to be present exclusively in faecal matter. Presence of these indicator bacteria in water therefore can be taken to indicate the presence of faecal matter and the possible presence of pathogenic bacteria. Escherichia coli and some related bacteria, together called ‘faecal coliforms’, which originate only from faeces are used as an indicator bacteria. The faecal coliforms are a part of a larger group known as ‘total coliforms”.

Other members of the total coliform group originate from soil and decaying plant matter. Generally, the faecal coliforms are about 20% of the total coliform concentration, although a widespread exists depending on the general sanitary conditions in the area of monitoring. In polluted waters, the die-away rate of faecal coliforms usually parallels that of most of the pathogenic organisms. However, it is possible, that some pathogens may survive for longer periods of time compared to faecal coliforms. Therefore, often the drinking water quality is judged on the basis of the presence or absence of total coliforms. This provides an additional

factor of safety. The count of coliform bacteria is determined statistically on the basis of analysis of different volumes of the same sample. The result is expressed in terms of most probable number (MPN) per 100 mL.

3. Water Quality Standards in India

The physico-chemical parameters like pH, Electrical Conductance (EC), Chloride, Fluoride, Nitrate, Sulphate, Boron, Total hardness, Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD) are main constituents defining the quality of river water in surface water. Presence of these parameters in river water beyond the permissible limit is considered as polluted river water quality.

Central Pollution Control Board (CPCB) has identified water quality requirements in terms of a few chemical characteristics, known as primary water quality criteria (Table 1). On this basis of classification, the 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 its document BIS 10500:2012 has recommended water quality standards for drinking water (Table 2).

Table 1: 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 2: 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	0.3	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	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	Total Chromium (as Cr), mg/L, Max	0.05	No relaxation
27	Total Alkalinity mg/L, Max	200	600
28	Aluminum (as Al) mg/L, Max	0.03	0.2
29	Boron mg/L, Max	0.5	1.0
30	Mineral oil, mg/L, Max	0.5	
31	Poly Nuclear Aromatic Hydrocarbons, PAH's, mg/L, Max	0.0001	No relaxation
32	Anionic detergents (as MBAS), mg/L, Max	0.2	1
33	Total Coliform	Shall not be detected in any 100 of sample	
36	Phenolic Compounds, mg/L, Max	0.001	0.002

**** Limits have been given for specific parameters only as per Drinking Water Quality Standards, BIS: 10500, 2012.***

4. River Water Monitoring by CWC

Presently, Central Water Commission (CWC) is monitoring river water quality at its 625 key hydrological observation stations covering all the important river basins of India. Also, water quality samples are being collected from 33 water quality sampling stations (Figure 1a and Table 3).

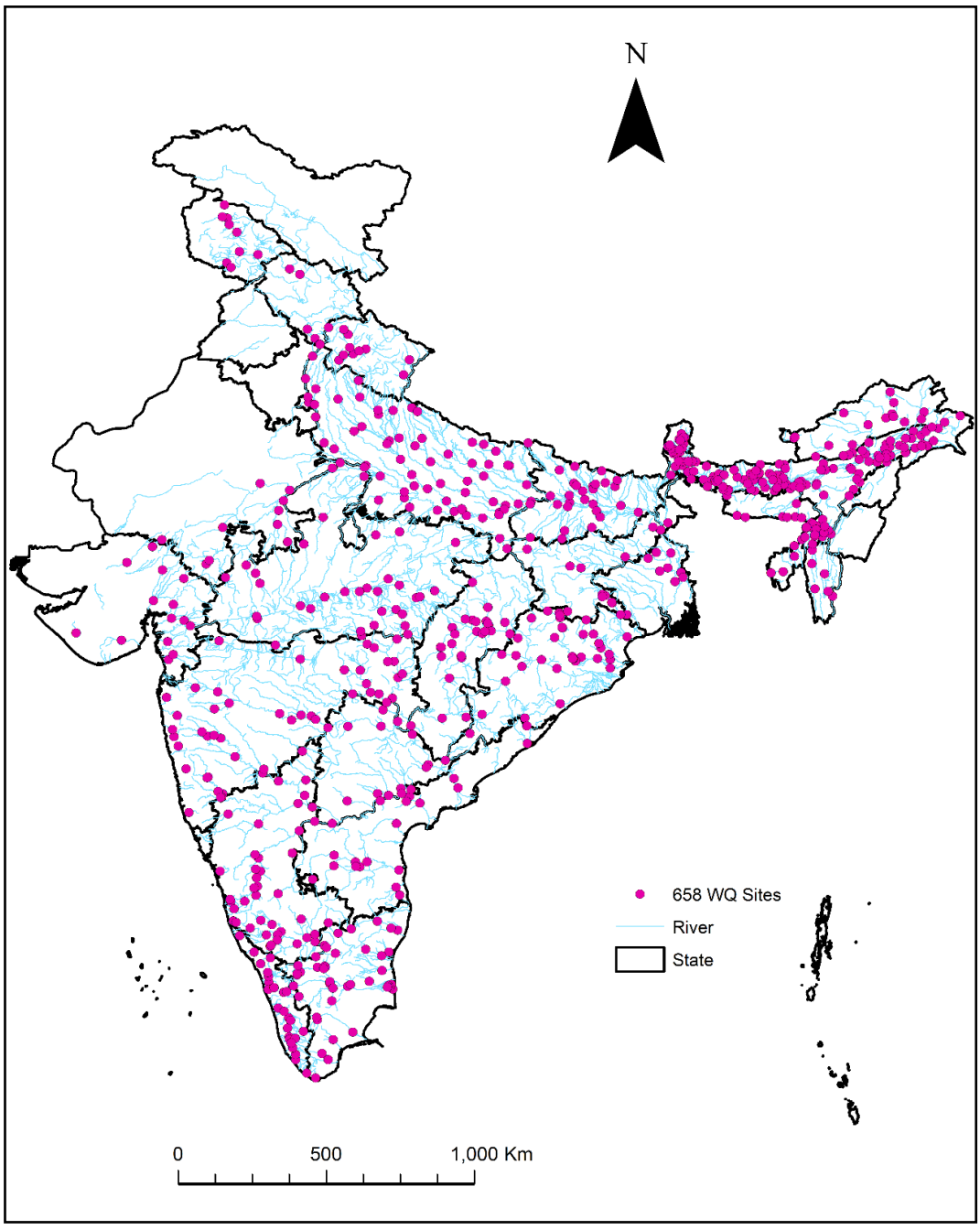

Figure 1a: Water quality network of CWC

Further, CWC is planning to increase the water quality network on Indian rivers by considering future objectives and necessities, to cover all rivers in the country. The basin-wise and state-wise water quality stations monitored by Central Water Commission as on Sep 2020 are depicted in Figure 1b and Figure 1c. Details are given in Table 4 and Table 5 respectively.

Table 3: Organisation–wise distribution of Water Quality Sites of CWC

S.No.	Organisation	GDQ	GDSQ	GQ	WQSS	Total
1	B&BBO Shillong	35	45	67		147
2	C&SRO Coimbatore	35	53			88
3	IBO Chandigarh	3	8			11
4	KGBO Hyderabad	21	34	6		61
5	LGBO Patna	8	33	2		43
6	MERO Bhubaneswar	2	43	1	27	73
7	NTBO Gandhinagar	6	15		1	22
8	MCO Nagpur	4	20	1		25
9	MSO Bengaluru	9	19			28
10	NBO Bhopal	5	8	1		14
11	T&BDBO Kolkata	21	22	19		62
12	UGBO, Lucknow	6	31	1	4	42
13	YBO, New Delhi	2	37	2	1	42
Grand Total		**157**	**368**	**100**	**33**	**658**

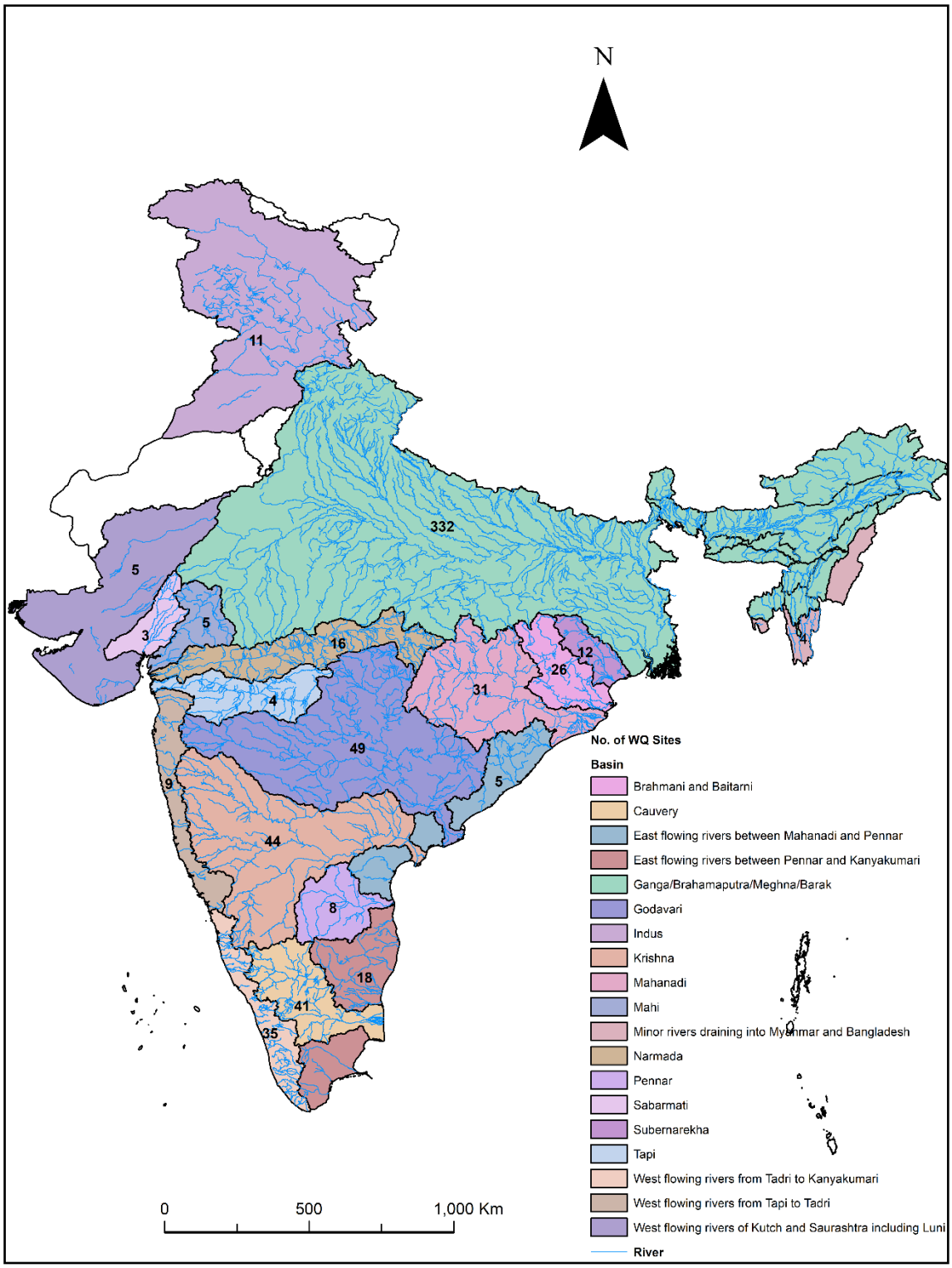

Figure 1b: Map showing the basin-wise no. of water quality sites monitored by CWC.

Table 4: Basin-wise water-quality stations monitored by CWC

S.No.	Basin	GDQ	GDSQ	GQ	WQSS	Total
1	Brahmani-Baitarni Basin		11	1	14	26
2	Cauvery Basin	17	24			41
3	East Flowing rivers between Mahanadi and Pennar		5			5
4	East Flowing rivers between Pennar and Kanyakumari	10	8			18
5	Ganga/Brahmaputra/Meghna/Barak	72	164	91	5	332
6	Godavari Basin	13	32	4		49
7	Indus Basin	3	8			11
8	Krishna Basin	12	29	3		44
9	Mahanadi Basin	1	22		8	31
10	Mahi Basin	2	3			5
11	Minor Rivers Draining into Myanmar and Bangladesh		4			4
12	Narmada Basin	5	10	1		16
13	Pennar Basin	4	4			8
14	Sabarmati Basin	1	1		1	3
15	Subarnarekha Basin	1	6		5	12
16	Tapi Basin	1	3			4
17	West Flowing rivers from Tadri to Kanyakumari	9	26			35
18	West flowing rivers from Tapi to Tadri	4	5			9
19	West flowing rivers of Kutchh and Saurashtra including Luni	2	3			5
Total		**157**	**368**	**100**	**33**	**658**

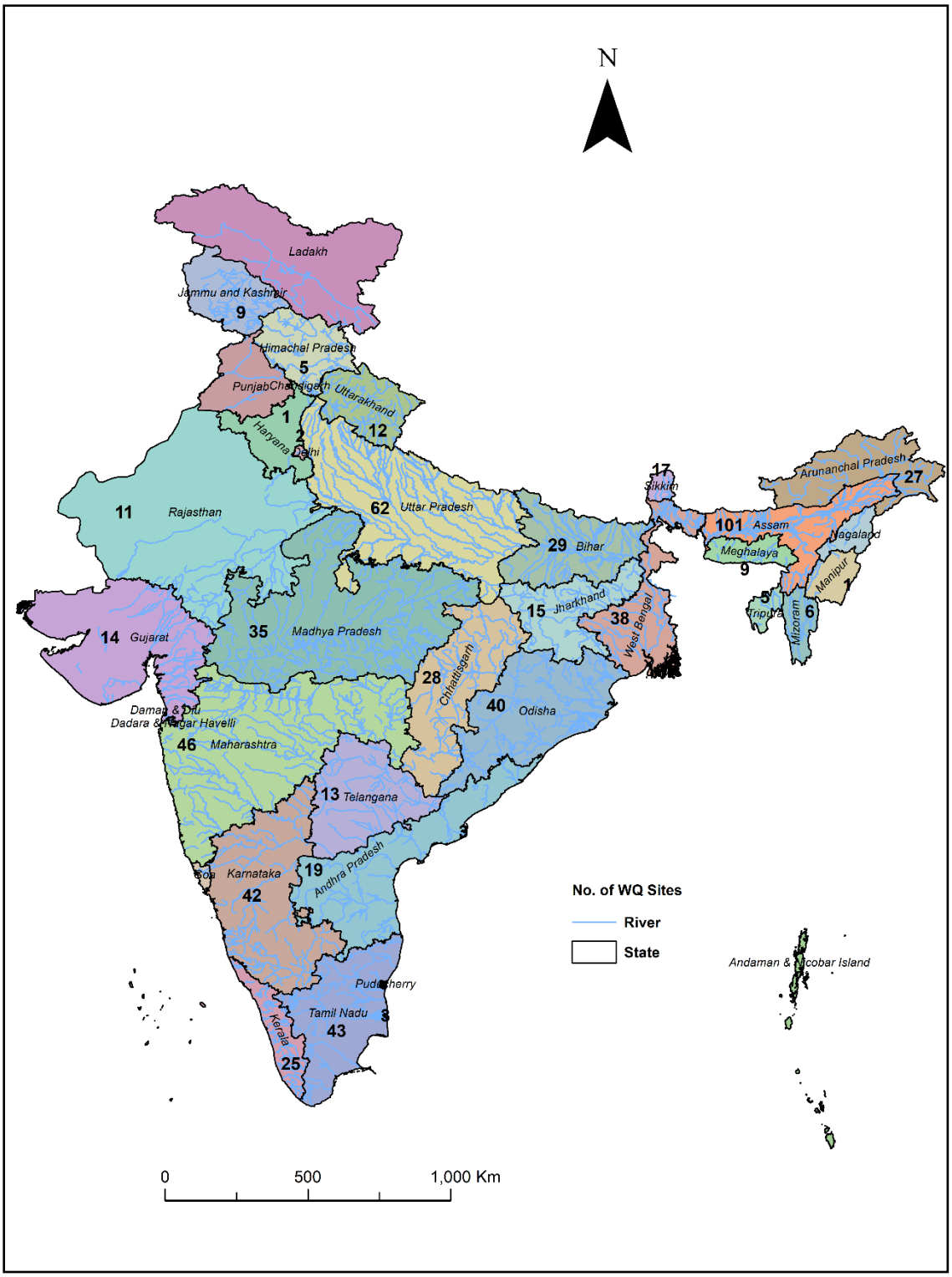

Figure 1c: Map showing the state-wise no. of water quality sites monitored by CWC.

Table 5: State–wise distribution of Water Quality Sites of CWC

S.No.	State	GDQ	GDSQ	GQ	WQSS	Total
1	Andhra Pradesh	4	14	1		19
2	Arunachal Pradesh	10	8	9		27
3	Assam	21	26	54		101
4	Bihar	5	22	2		29
5	Chhattisgarh	2	18		8	28
6	Delhi		2			2
7	Gujarat	4	9		1	14
8	Haryana		1			1
9	Himachal Pradesh		5			5
10	Jammu & Kashmir	3	6			9
11	Jharkhand	4	6	1	4	15
12	Karnataka	15	25	2		42
13	Kerala	3	22			25
14	Madhya Pradesh	8	26	1		35
15	Maharashtra	15	28	3		46
16	Manipur			1		1
17	Meghalaya	5	3	1		9
18	Mizoram		6			6
19	Odisha	2	22	1	15	40
20	Pondicherry	3				3
21	Rajasthan	3	8			11
22	Sikkim	9	1	7		17
23	Tamil Nadu	20	23			43
24	Telangana	4	8	1		13
25	Tripura		2	3		5
26	Uttar Pradesh	9	46	3	4	62
27	Uttarakhand	1	10		1	12
28	West Bengal	7	21	10		38
	Total	**157**	**368**	**100**	**33**	**658**

CWC is maintaining a three-tier laboratory system for analysis of the physio-chemical parameters of the water. The Level-I laboratories are located at 295 field water quality monitoring stations on major rivers of India where physical parameters such as temperature, colour, odour, specific conductivity, pH and dissolved oxygen of river water are observed. There are 18 Level–II laboratories located at selected division offices throughout India to analyses 25 nos. of physio-chemical and bacteriological parameters of water. 5 Level-III laboratories are functioning at Varanasi, Delhi, Hyderabad, Coimbatore, and Guwahati where 41 parameters including heavy metals / toxic parameters and pesticides are analysed. The list of 23 Level-II and Level-III laboratories and parameters analysed in the laboratories are given in Annexure-I and Annexure-II respectively. Out of 23, 14 laboratories of CWC have got accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL) in accordance with Standard ISO/IEC 17025:2017 and 9 laboratories are under process, details of which are given in Figure 2.

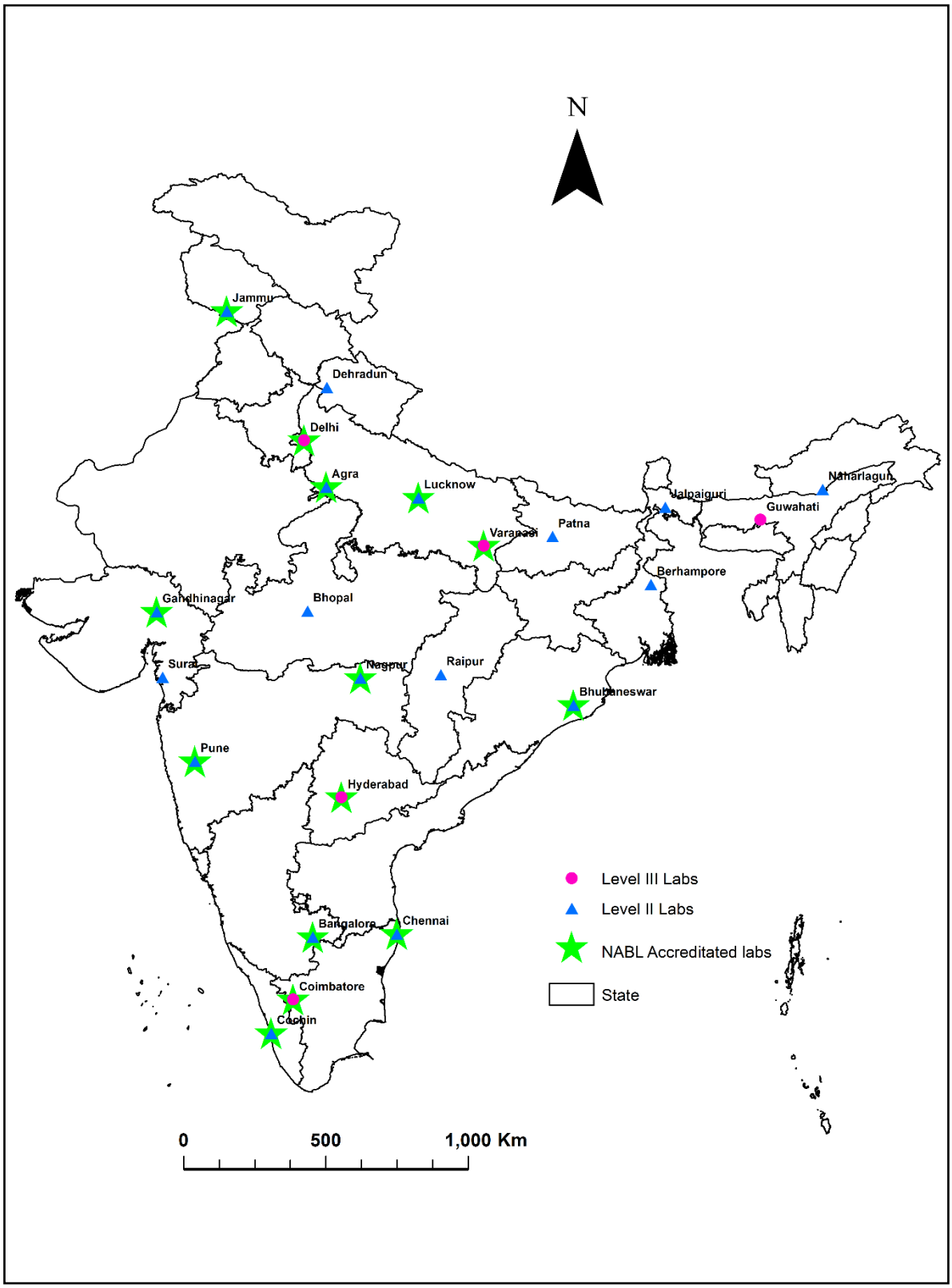

Figure 2: Water quality laboratories of CWC

5. Study Area

A total number of 128 water quality stations covering all the major river basins of country were studied for lockdown effect on Indian rivers. The details of these stations are shown in map in Figure 3. Basin wise summary of these stations is given in Table 6.

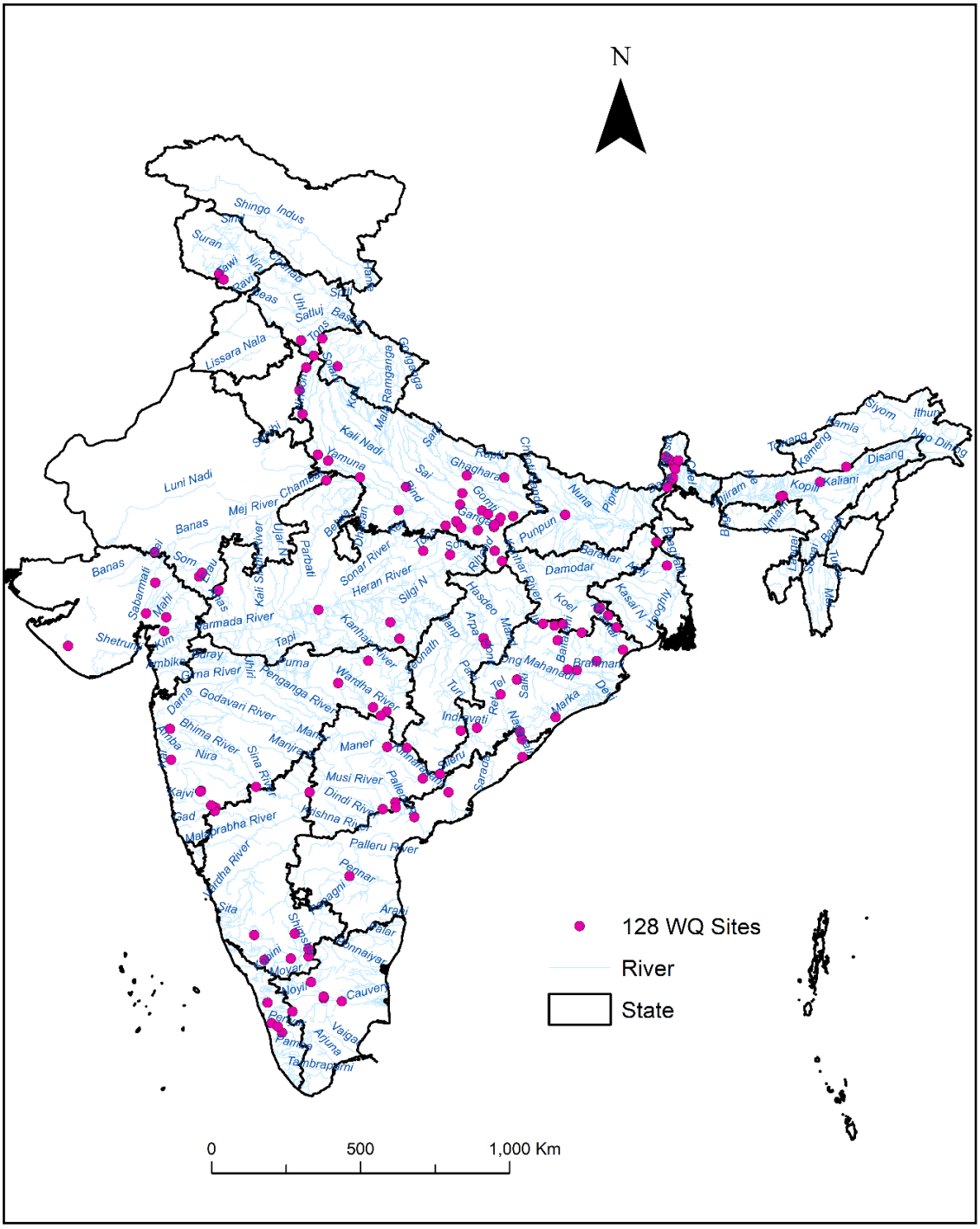

Figure 3: Water Quality (WQ) stations monitored during the lockdown on important rivers covering all the major river basin of India.

Table 6: Basin wise stations for Water Quality (WQ) monitored during the lockdown

S.No.	Basin	WQ Sites
1	Brahamaputra Basin	4
2	Brahmani and Baitarni	9
3	Cauvery	10
4	East flowing rivers between Mahanadi and Pennar	4
5	Ganga	40
6	Godavari	14
7	Indus	2
8	Krishna	10
9	Mahanadi	4
10	Mahi	5
11	Narmada	1
12	Pennar	1
13	Sabarmati	2
14	Subernarekha	6
15	Teesta Basin	7
16	West flowing rivers from Tadri to Kanyakumari	5
17	West flowing rivers from Tapi to Tadri	2
18	West flowing rivers of Kutch and Saurashtra including Luni	2
Total		**128**

6. Status of Water Quality

6.1 Status of Water Quality in Indian Rivers in terms of Biochemical Oxygen Demand (BOD)

The prescribed limits for BOD as per CPCB Criteria for Designated Best use of fresh water is < 2 mg/L for Class-A and < 3 mg/L for Class-B & C. 44 no. of pre-lockdown period samples of BOD were taken for comparison, 18 no. of samples were within limits for Class A, 27 were within limits for Class B & C while 17 no. of samples were beyond the limits for all the classes i.e., Class A, B & C. The obtained range of BOD for all samples was "0.3 to 22.0 mg/L". 34 no. of lockdown period samples of BOD were taken for comparison, 14 no. of samples were within limits for Class A, 19 were within limits for Class B & C while 15 no. of samples were beyond the limits for all the classes i.e., Class A, B & C. The obtained range of BOD for all samples was "0.20 to 11.5 mg/L".

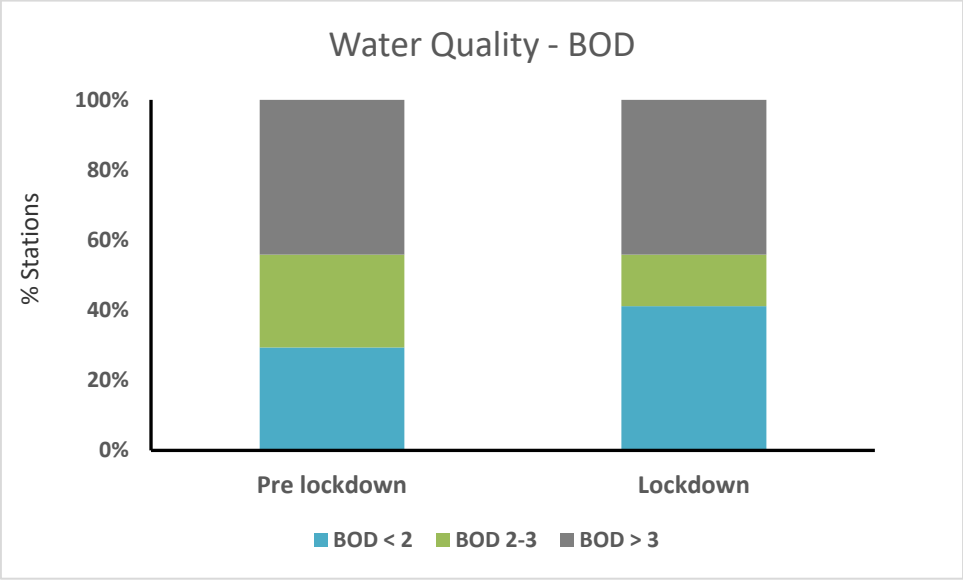

Figure 4a: Graph showing the Status of Water Quality in Indian Rivers in terms of Biochemical Oxygen Demand (BOD).

On perusal, it was seen that 34 no. of samples of same location were comparable. Water quality has considerably improved at 28 stations out of 34 stations in terms of Biochemical Oxygen Demand (BOD) by considering the numerical value (Figure 4a and 4b). While at 4 locations,

BOD values have increased. Jammu Tawi station of River Tawi and Ramamangalam station of River Muvattupuzha shows minimal increase and the value is within tolerance limit. At Site Farakka of River Ganga, BOD value increased marginally. In general, the range of the BOD value improved during the lockdown period. The details thereof given in Table 7.

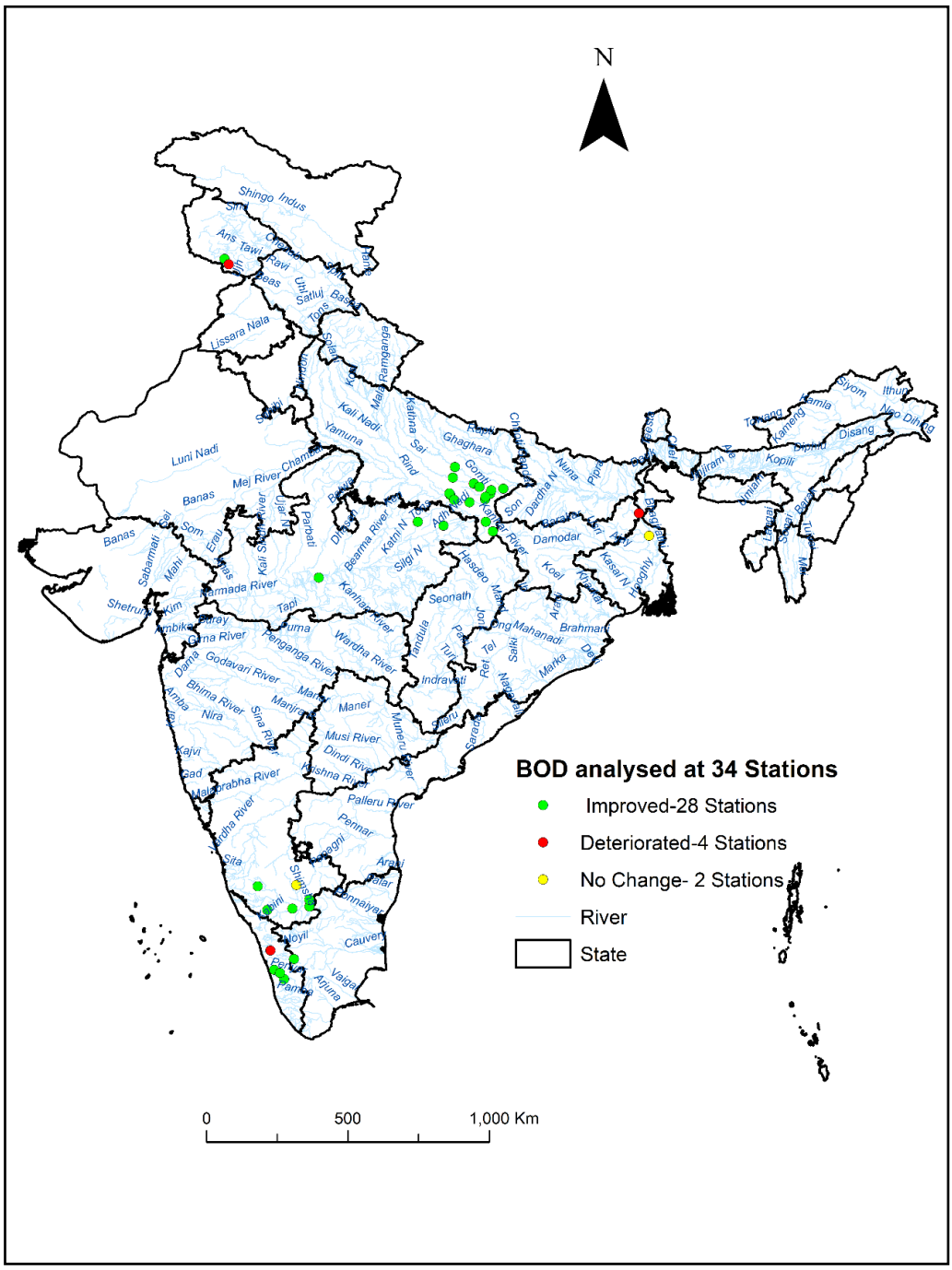

Figure 4b: Map showing the Status of Water Quality in Indian Rivers in terms of Biochemical Oxygen Demand (BOD).

Table 7: Status of Water Quality in Indian Rivers in terms of Biochemical Oxygen Demand (BOD).

S.No.	Site	River	BOD pre lockdown	BOD during lockdown	WQ Status
			(mg/L)		
1	Akhnoor	Chenab	0.80	0.40	Improved
2	Ambarampalayam	Bharathapuzha	1.30	1.00	Improved
3	Arangaly	Chalakudy	1.60	1.10	Improved
4	Baluaghat	Ganga	4.05	3.39	Improved
5	Berhampore	Bhagirathi	2.20	2.20	No Change
6	C.S-97 A, Farakka	Ganga	2.10	4.20	Deteriorated
7	Chhatnag Allahabad	Ganga	3.85	3.36	Improved
8	Farakka (HR)	Ganga	2.70	3.60	Deteriorated
9	Ghazipur	Ganga	3.10	3.02	Improved
10	Hoshangabad	Narmada	1.09	1.00	Improved
11	Jammu Tawi	Tawi	0.70	0.90	Deteriorated
12	Kalampur	Kaliyar	0.80	0.50	Improved
13	Kokkedoddy	Arkavathy	3.00	0.60	Improved
14	Kollegal	Cauvery	5.90	0.60	Improved
15	Mirzapur	Ganga	3.66	3.32	Improved
16	Neeleswaram	Periyar	0.80	0.50	Improved
17	Ramamangalam	Muvattupuzha	0.60	0.90	Deteriorated
18	Saidpur	Ganga	3.90	3.37	Improved
19	Sakleshpur	Hemavati	1.40	0.80	Improved
20	Shastri Bridge	Ganga	3.65	3.27	Improved
21	T. Bekuppe	Arkavathi	22.00	11.50	Improved
22	T.Narasipur	Kabini	3.70	0.20	Improved
23	Thimmanahalli	Yagachi	1.20	1.20	No Change
24	V.S. Bridge	Ganga	4.05	3.28	Improved
25	Varanasi	Ganga	4.15	3.34	Improved
26	Chopan	Sone	2.48	2.24	Improved
27	Duddhi	Ganga	2.27	2.02	Improved
28	Jaunpur	Sai	3.51	3.39	Improved
29	Kuldah Bridge	Sone	2.27	2.01	Improved
30	Maighat	Gomti	3.72	3.50	Improved
31	Meja Road	Tons	2.68	2.48	Improved
32	Pratapgarh	Sai	3.10	3.08	Improved
33	Satna	Tons	2.07	1.98	Improved
34	Sultanpur	Gomti	4.13	3.95	Improved

6.2 Status of Water Quality in Indian Rivers in terms of Dissolved Oxygen (DO)

The prescribed limits for DO as per CPCB Criteria for Designated Best use of fresh water is > 6 mg/L for Class-A, > 5 mg/L for Class-B and > 4 mg/L for Class-C and D. 96 no. of pre-lockdown samples of DO were taken for comparison, 64 were within limits for Class A, 84 were within limits of Class B, 88 were within limits for Class C & D and 8 values were beyond the limits for all the classes i.e. Class A, B, C & D. The obtained range of DO for all samples was "0 to 9.1 mg/L". 97 no. of lockdown period samples of DO were taken for comparison, 85 no. of samples were within limits for Class A, 93 were within limits for Class B, 94 were within limits for Class C & D while 3 no. of samples were beyond the limits for all the classes i.e. Class A, B, C & D. The obtained range of DO for all samples was "1.58 to 12.21 mg/L". On perusal, it was seen that 96 no. of samples of same location were comparable. Water quality has considerably improved at 77 stations in terms of Dissolved Oxygen (DO) by considering the numerical value (Figure 5a and 5b). While 17 stations showed the minimal decrease in comparison to preceding year data but the values come under Class B except for Dameracherla station of Musi River. There was no change in DO values at 2 locations. In general, the range of the DO value improved during lockdown period. The details thereof given in Table 8.

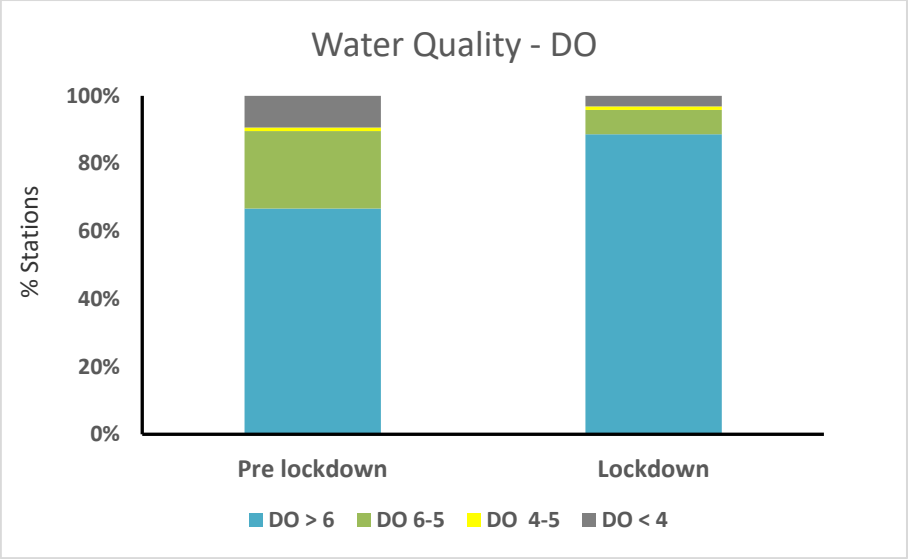

Figure 5a: Graph showing the status of Water Quality in Indian Rivers in terms of Dissolved Oxygen (DO).

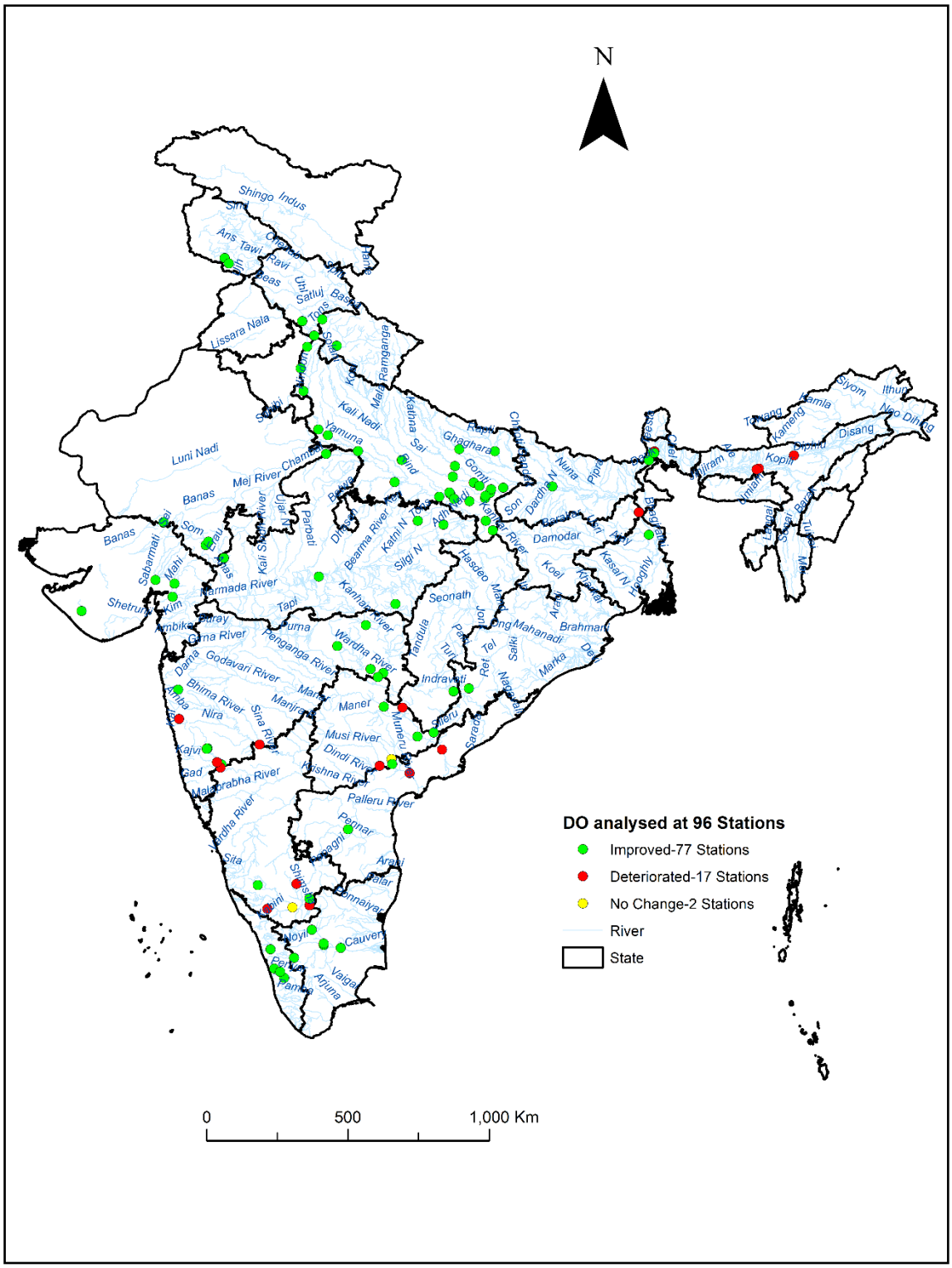

Figure 5b: Map showing the status of Water Quality in Indian Rivers in terms of Dissolved Oxygen (DO).

Table 8: Status of Water Quality in Indian Rivers in terms of Dissolved Oxygen (DO).

S.No.	Site	River	DO pre lockdown	DO during lockdown	WQ Status
			(mg/L)		
1	Abu Road	Banas	6.80	7.29	Improved
2	Agra (P.G.)	Yamuna	2.47	2.80	Improved
3	Akhnoor	Chenab	7.60	8.80	Improved
4	Alladupalli	Kunderu	5.20	5.47	Improved
5	Ambarampalayam	Bharathapuzha	7.30	8.10	Improved
6	Arangaly	Chalakudy	7.80	7.90	Improved
7	Arjunwad (Seasonal)	Krishna	7.00	9.50	Improved
8	Ashti	Wainganga	6.20	7.30	Improved
9	Ayodhya	Ghaghra	7.80	8.28	Improved
10	Badlapur	Ulhas	4.60	7.20	Improved
11	Baluaghat	Ganga	8.02	8.11	Improved
12	Bamni	Wardha	2.40	7.20	Improved
13	Berhampore	Bhagirathi	6.07	7.80	Improved
14	Bhadrachalam	Godavari	6.00	6.80	Improved
15	Bhomoraguri	Brahmaputra	8.68	5.80	Deteriorated
16	Birdghat	Rapti	5.00	8.85	Improved
17	C.S-97 A, Farakka	Ganga	6.70	6.60	Deteriorated
18	Chhatnag Allahabad	Ganga	7.71	8.26	Improved
19	Dameracherla	Musi	5.90	4.05	Deteriorated
20	Delhi Rly Bridge	Yamuna	1.89	5.20	Improved
21	Dhaulpur	Chambal	7.14	9.50	Improved
22	Elunuthimangalam	Noyyal	6.00	7.60	Improved
23	Etawah	Yamuna	3.47	5.60	Improved
24	Farakka/(HR)	Feeder Canal	7.60	6.03	Deteriorated
25	Gandhighat	Ganga	5.49	7.88	Improved
26	Ganod	Bhadar	6.43	10.15	Improved
27	Ghazipur	Ganga	6.61	8.05	Improved
28	Gokul Barrage (Mathura)	Yamuna	3.15	6.40	Improved
29	Guwahati DC court	Brahamaputra	7.40	7.10	Deteriorated
30	Hamirpur	Yamuna	6.56	7.80	Improved
31	Hivra	Wardha	6.40	7.30	Improved
32	Hoshangabad	Narmada	5.38	7.60	Improved
33	Jagdalpur	Indravati	8.00	8.20	Improved
34	Jammu Tawi	Tawi	8.10	8.80	Improved
35	Kalampur	Kaliyar	6.40	7.00	Improved
36	Kalanaur	Yamuna	6.54	8.00	Improved
37	Kanpur	Ganga	8.10	8.65	Improved
38	Karad	Krishna	7.90	8.80	Improved
39	Khanpur	Mahi	8.83	12.21	Improved
40	Kodumudi	Cauvery	6.10	6.50	Improved
41	Kokkedoddy	Arkavathy	8.80	8.60	Deteriorated
42	Kollegal	Cauvery	7.90	6.80	Deteriorated
43	Konta	Sabari	6.80	8.90	Improved
44	Kumhari	Wainganga	8.40	8.80	Improved
45	Kurundwad	Krishna	7.55	6.35	Deteriorated
46	Mataji	Mahi	5.95	9.55	Improved
47	Matigara	Balason	5.20	7.60	Improved
48	Mawi	Yamuna	5.62	7.70	Improved

S.No.	Site	River	DO pre lockdown	DO during lockdown	WQ Status
			(mg/L)		
49	Mirzapur	Ganga	7.81	8.17	Improved
50	Musiri	Cauvery	6.70	6.80	Improved
51	Neeleswaram	Periyar	8.20	8.30	Improved
52	Noukaghat	Mahananda	4.90	7.60	Improved
53	Nowrangpur	Godavari	6.60	6.80	Improved
54	Paderdibadi	Mahi	5.57	7.49	Improved
55	Paleru Bridge	Paleru	6.70	6.70	No Change
56	Pandu	Brahmaputra	8.30	7.50	Deteriorated
57	Paonta	Yamuna	6.24	8.80	Improved
58	Perur	Godavari	7.10	6.80	Deteriorated
59	Pingalwada	Dhadher	0.64	6.80	Improved
60	Polavaram	Godavari	9.00	7.90	Deteriorated
61	Pratappur	Yamuna	6.14	8.50	Improved
62	Ramamangalam	Muvattupuzha	7.20	7.40	Improved
63	Rangeli	som	5.09	8.27	Improved
64	Rishikesh	Ganga	8.14	10.70	Improved
65	Saidpur	Ganga	7.52	7.68	Improved
66	Sakleshpur	Hemavati	6.80	6.90	Improved
67	Sakmur	Wardha	5.40	7.40	Improved
68	Sangam	Murredu	5.70	8.70	Improved
69	Satrapur	Kanhan	5.00	9.80	Improved
70	Savandapur	Bhavani	6.40	10.30	Improved
71	Shastri Bridge	Ganga	7.62	8.35	Improved
72	Sonapurhat	Mahananda	5.50	6.40	Improved
73	T. Bekuppe	Arkavathi	3.00	3.80	Improved
74	T.Narasipur	Kabini	5.80	5.80	No Change
75	Thimmanahalli	Yagachi	6.80	6.00	Deteriorated
76	Tuini (Tons)	Tons	5.89	6.99	Improved
77	V.S. Bridge	Ganga	7.32	8.14	Improved
78	Varanasi	Ganga	7.92	8.13	Improved
79	Vautha	Sabarmati	0.00	1.58	Improved
80	Vijayawada	Krishna	7.90	5.60	Deteriorated
81	Wadenapally	Krishna	5.00	7.20	Improved
82	Warunjli	Koyna	9.10	9.12	Improved
83	Yashwant nagar	Giri	6.47	9.50	Improved
84	Champasari	Mahananda	8.70	5.00	Deteriorated
85	Chopan	Sone	5.58	7.67	Improved
86	Duddhi	Ganga	6.20	7.39	Improved
87	Jaunpur	Sai	5.58	6.25	Improved
88	Kuldah Bridge	Sone	6.40	7.55	Improved
89	Maighat	Gomti	6.20	6.35	Improved
90	Mangaon (Seasonal)	Kal	7.40	7.20	Deteriorated
91	Meja Road	Tons	5.99	7.10	Improved
92	Pratapgarh	Sai	5.78	7.57	Improved
93	Samdoli (Seasonal)	Varna	8.90	6.50	Deteriorated
94	Satna	Tons	6.40	7.71	Improved
95	Sultanpur	Gomti	5.99	6.52	Improved
96	Takli	Bhima	8.20	7.40	Deteriorated

6.3 Status of Water Quality in Indian Rivers in terms of Total Coliform

The prescribed limits for Total Coliform as per CPCB Criteria for Designated Best use of fresh water is < 50 MPN/100 mL for Class-A, < 500 MPN/100 mL for Class-B & < 5000 MPN/100 mL for Class-C. 26 no. of pre-lockdown period samples of Total Coliform were taken for comparison, 2 no. of samples were within limits for Class C while remaining 24 no. of samples were beyond the limits for all the classes i.e. Class A, B & C. The obtained range of Total Coliform for all samples was "1700 to 63000 MPN/100 mL". 28 no. of lockdown period samples of Total Coliform were taken for comparison, 3 no. of samples were within limits for Class B, 7 no. of samples were within limits for Class C while 21 no. of samples were beyond the limits for all the classes i.e. Class A, B & C. The obtained range of Total Coliform for all samples was "330 to 22000 MPN/100 mL".

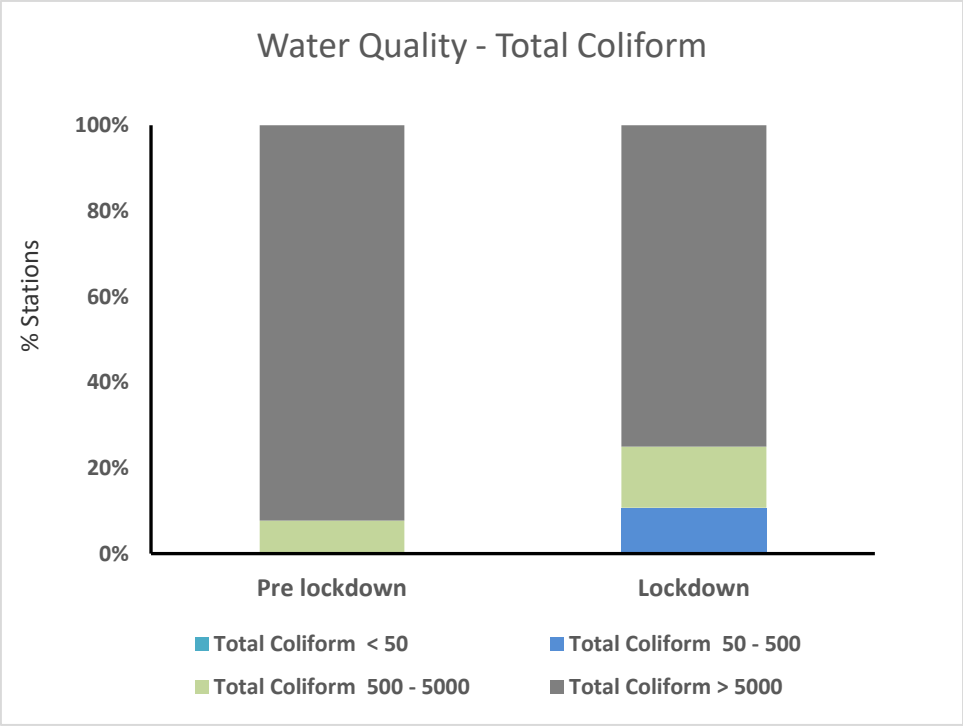

Figure 6a: Graph showing the status of Water Quality in Indian Rivers in terms of Total Coliform.

On perusal, it was seen that only 26 no. of samples of same location were comparable out of which at 24 stations water quality has considerably improved out as the values of Total Coliform have a significant decrease during lockdown period. While at 2 sites; Savandapur of

River Bhawani and T. Bekuppe of River Arkavathi, the value of Total coliform has increased (Figure 6a and 6b). In general, the range of the Total Coliform value improved during lockdown period. The details thereof given in Table 9.

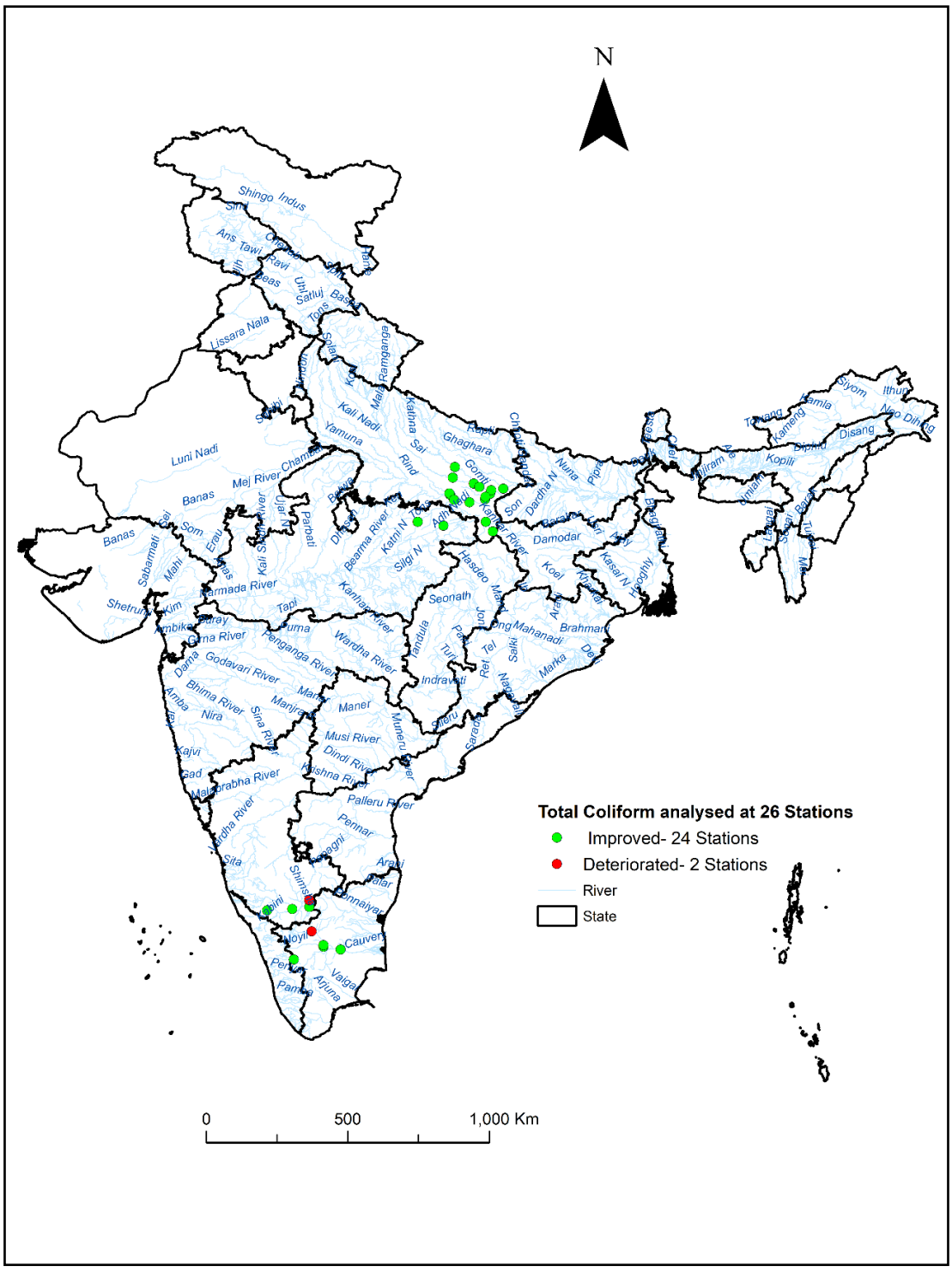

Figure 6b: Map showing the status of Water Quality in Indian Rivers in terms of Total Coliform.

Table 9: Status of Water Quality in Indian Rivers in terms of Total Coliform

S.No.	Site	River	TC pre lockdown	TC during lockdown	WQ Status
			MPN/100 mL		
1	Ambarampalayam	Bharathapuzha	14833	7900	Improved
2	Baluaghat	Ganga	37500	20000	Improved
3	Chhatnag Allahabad	Ganga	30000	11900	Improved
4	Elunuthimangalam	Noyyal	28214	11000	Improved
5	Ghazipur	Ganga	58000	17000	Improved
6	Kodumudi	Cauvery	8300	3100	Improved
7	Kokkedoddy	Arkavathy	5400	3500	Improved
8	Kollegal	Cauvery	1700	330	Improved
9	Mirzapur	Ganga	26000	10900	Improved
10	Musiri	Cauvery	2153	1700	Improved
11	Saidpur	Ganga	23000	12000	Improved
12	Savandapur	Bhavani	5700	22000	Deteriorated
13	Shastri Bridge	Ganga	21000	14000	Improved
14	T. Bekuppe	Arkavathi	11000	13000	Deteriorated
15	T.Narasipur	Kabini	5400	490	Improved
16	V.S. Bridge	Ganga	15500	12000	Improved
17	Varanasi	Ganga	28500	17000	Improved
18	Chopan	Sone	13000	6800	Improved
19	Duddhi	Ganga	20000	7800	Improved
20	Jaunpur	Sai	39000	17000	Improved
21	Kuldah Bridge	Sone	39000	8300	Improved
22	Maighat	Gomti	41000	15000	Improved
23	Meja Road	Tons	35000	8200	Improved
24	Pratapgarh	Sai	58000	13000	Improved
25	Satna	Tons	49000	12000	Improved
26	Sultanpur	Gomti	63000	20000	Improved

6.4 Status of Water Quality in Indian Rivers in terms of Total Dissolved Solids (TDS)

The prescribed limits for TDS as per Drinking Water Quality standards BIS: 10500:2012 is 500 mg/L. 12 no. of pre-lockdown period samples of TDS were taken for comparison, 9 no. of samples were within acceptable limit and 3 no. of samples were beyond the acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of TDS for all samples was "69.70 to 1772 mg/L". 12 no. of lockdown period samples of TDS were taken for comparison, 9 no. of samples were within acceptable limit and 3 no. of samples were beyond the acceptable limit which is same as pre-lockdown period (Figure 7a). The obtained range of TDS for all samples was "68.55 to 1432 mg/L". However, there is a considerable decrease in the value of TDS at 9 out of 12 sites during the lockdown period. But TDS value has increasing trend in case of Abu Road site of Banas river. At site Guwahati DC Court of river Brahmputra and at site Khanpur of river Mahi, there is only marginal increase and TDS values are still within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The details thereof given in Figure 7b and Table 10.

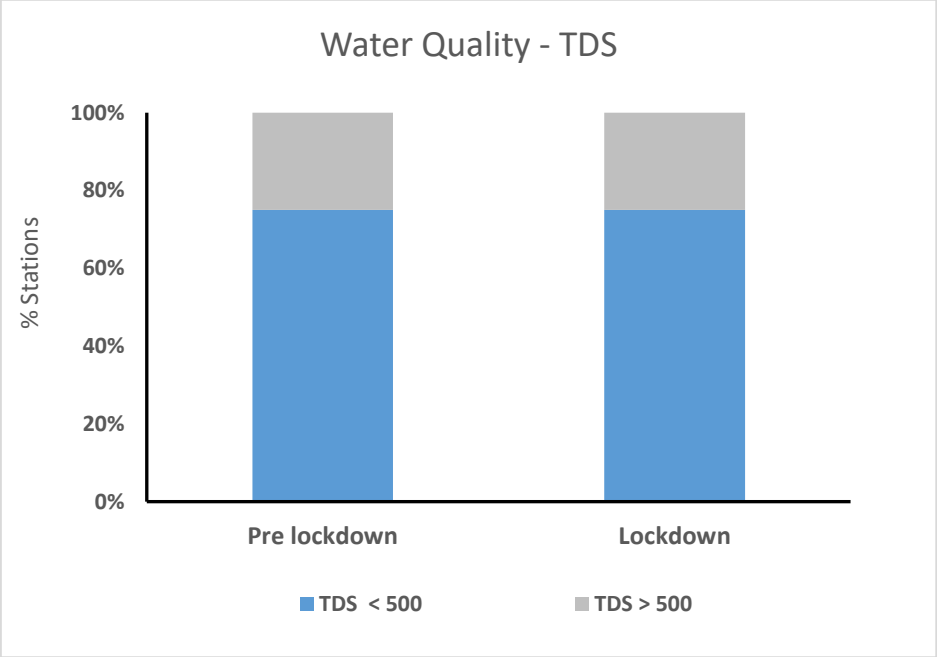

Figure 7a: Graph showing the status of Water Quality in Indian Rivers in terms of Total Dissolved Solids (TDS).

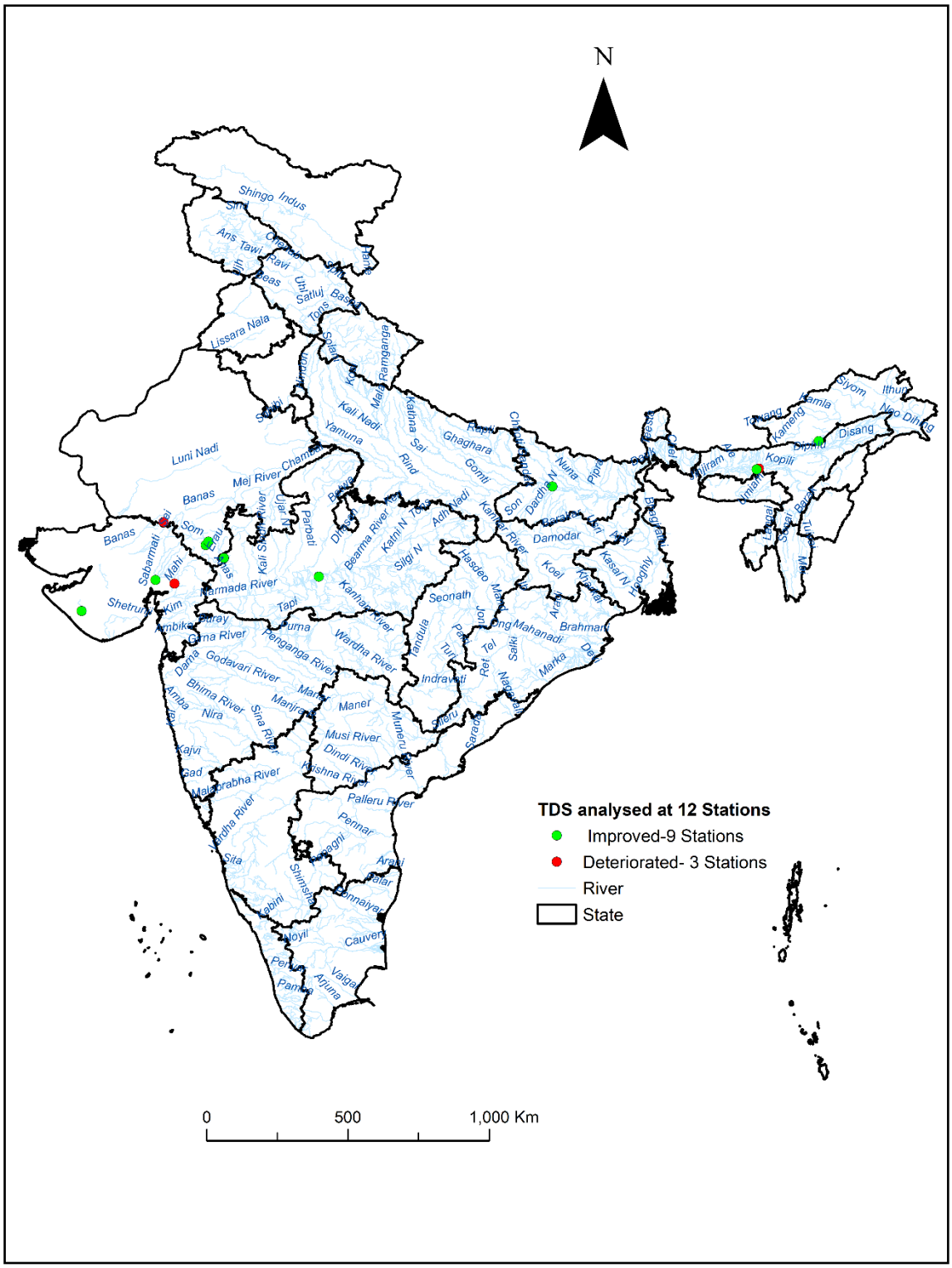

Figure 7b: Map showing the status of Water Quality in Indian Rivers in terms of Total Dissolved Solids (TDS).

Table 10: Status of Water Quality in Indian Rivers in terms of Total Dissolved Solids (TDS).

S.No.	Site	River	TDS pre lockdown	TDS during lockdown	WQ Status
			(mg/L)		
1	Abu Road	Banas	1102	1432	Deteriorated
2	Gandhighat	Ganga	225	207.06	Improved
3	Ganod	Bhadar	1274	961	Improved
4	Guwahati DC court	Brahamaputra	86.5	90.3	Deteriorated
5	Hoshangabad	Narmada	153.8	125	Improved
6	Khanpur	Mahi	240	245	Deteriorated
7	Mataji	Mahi	202	180	Improved
8	Paderdibadi	Mahi	291	238	Improved
9	Pandu	Brahmaputra	101.4	90	Improved
10	Rangeli	som	317	298	Improved
11	Vautha	Sabarmati	1772	1054	Improved
12	Jollang	Dikrong(Sinki)	69.7	68.55	Improved

6.5 Status of Water Quality in Indian Rivers in terms of pH

The prescribed limits for pH as per CPCB Criteria for Designated Best use of fresh water is 6.5 – 8.5 for Class-A, B & D, 6.0 – 9.0 for Class C and 6.0 – 8.5 for Class E. 97 number of pre-lockdown period samples of pH were taken for comparison, 87 number of samples were within limits for Class A, B & D; while 96 no. of samples were within limits of Class C and 88 no. of samples were within limits of Class E. The obtained range of pH for all samples was "6.10 to 9.10". 101 number of lockdown period samples of pH were taken for comparison, 88 number of samples were within limits for Class A, B, D & E, while all the 101 no. of samples were within limits of Class C. The obtained range of pH for all samples was "6.75 to 8.95". On perusal, it was seen that 94 samples of same location were comparable. By considering the numerical value, and assuming pH value "7" as ideal value, it can be seen that at 47 locations, pH values improved during lockdown period. While at 41 locations, it has decreased and at 6 locations, there was no change (Figure 8a and 8b). The details thereof given in Table 11.

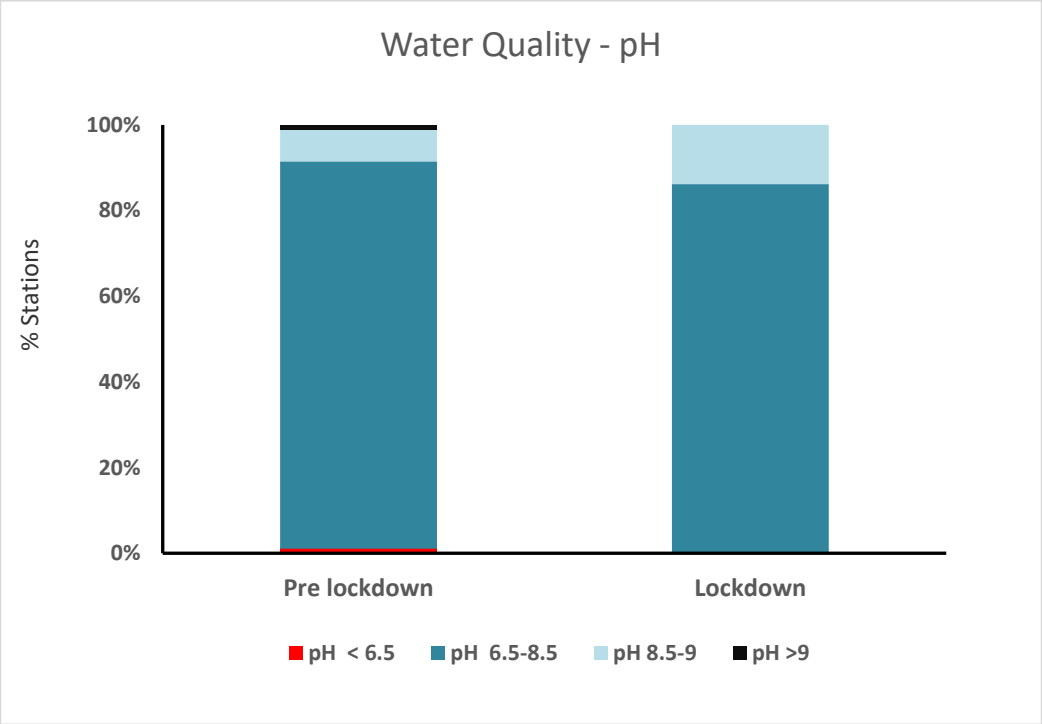

Figure 8a: Graph showing the status of Water Quality in Indian Rivers in terms of pH.

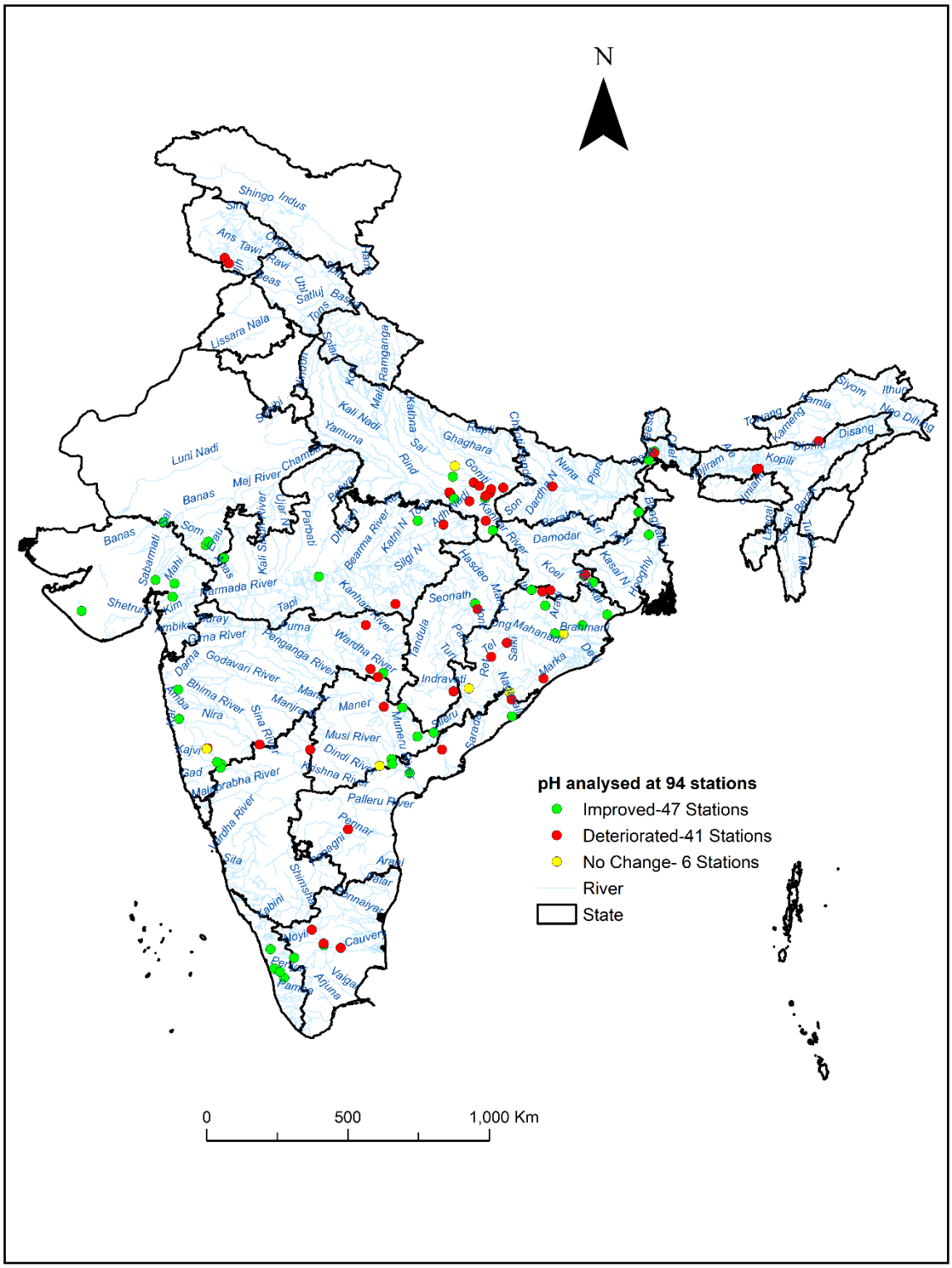

Figure 8b: Map showing the status of Water Quality in Indian Rivers in terms of pH.

Table 11: Status of Water Quality in Indian Rivers in terms of pH

S.No.	Site	River	pH pre lockdown	pH during lockdown	WQ Status
1	Abu Road	Banas	7.90	7.73	Improved
2	Adityapur	Kharkai	7.40	7.20	Improved
3	Akhnoor	Chenab	7.82	7.92	Deteriorated
4	Alladupalli	Kunderu	7.98	8.00	Deteriorated
5	Altuma	Ramyala	7.50	7.50	No Change
6	Ambarampalayam	Bharathapuzha	7.60	7.40	Improved
7	Anandpur	Baitarni	7.80	7.30	Improved
8	Arangaly	Chalakudy	6.50	6.80	Improved
9	Arjunwad (Seasonal)	Krishna	8.74	8.65	Improved
10	Ashti	Wainganga	8.20	8.00	Improved
11	Badlapur	Ulhas	7.80	7.10	Improved
12	Baluaghat	Ganga	8.16	8.37	Deteriorated
13	Bamni	Wardha	7.40	8.20	Deteriorated
14	Bamnidhi	Hasdeo	8.20	7.70	Improved
15	Basantpur	Mahanadi	7.30	7.50	Deteriorated
16	Berhampore	Bhagirathi	8.40	7.20	Improved
17	Bhadrachalam	Godavari	8.10	7.80	Improved
18	C.S-97 A, Farakka	Ganga	8.40	7.30	Improved
19	Chhatnag Allahabad	Ganga	8.25	8.30	Deteriorated
20	Dameracherla	Musi	7.90	7.90	No Change
21	Elunuthimangalam	Noyyal	9.00	8.90	Improved
22	Farakka/(HR)	Feeder Canal	8.40	7.80	Improved
23	Gandhighat	Ganga	8.00	8.52	Deteriorated
24	Ganod	Bhadar	8.50	8.21	Improved
25	Ghatsila	Subarnarekha	7.60	7.20	Improved
26	Ghazipur	Ganga	8.13	8.21	Deteriorated
27	Gomlai	Brahmani	7.70	7.60	Improved
28	Govindapur	Burhabalang	7.70	7.30	Improved
29	Gunupur	Vamsadhara	8.10	8.10	No Change
30	Guwahati DCcourt	Brahamaputra	7.11	7.76	Deteriorated
31	Hoshangabad	Narmada	8.00	7.60	Improved
32	Jagdalpur	Indravati	7.80	8.40	Deteriorated
33	Jammu Tawi	Tawi	8.01	8.42	Deteriorated
34	Jamshedpur	Subarnarekha	7.20	8.60	Deteriorated
35	Jenapur	Brahmni	7.30	7.60	Deteriorated
36	Kalampur	Kaliyar	6.10	7.06	Improved
37	Karad	Krishna	7.50	7.80	Deteriorated
38	Kashinagar	Vamsadhara	8.00	8.20	Deteriorated
39	Khanpur	Mahi	9.10	8.05	Improved
40	Kodumudi	Cauvery	8.10	8.60	Deteriorated
41	Konta	Sabari	7.40	6.85	Improved
42	Kumhari	Wainganga	7.70	7.80	Deteriorated
43	Kurundwad	Krishna	8.51	6.75	Improved
44	Mataji	Mahi	8.40	8.13	Improved
45	Matigara	Balason	7.60	7.20	Improved
46	Mirzapur	Ganga	8.28	8.47	Deteriorated
47	Muri	Subarnarekha	7.70	8.30	Deteriorated
48	Musiri	Cauvery	8.30	8.90	Deteriorated
49	Neeleswaram	Periyar	6.70	7.05	Improved

S.No.	Site	River	pH pre lockdown	pH during lockdown	WQ Status
50	Noukaghat	Mahananda	7.00	7.30	Deteriorated
51	Nowrangpur	Godavari	7.20	7.20	No Change
52	Paderdibadi	Mahi	8.20	8.03	Improved
53	Paleru Bridge	Paleru	7.40	6.85	Improved
54	Pandu	Brahmaputra	6.82	7.85	Deteriorated
55	Panposh	Brahmani	7.40	8.30	Deteriorated
56	Perur	Godavari	8.10	7.80	Improved
57	Pingalwada	Dhadher	8.02	7.91	Improved
58	Polavaram	Godavari	8.10	8.90	Deteriorated
59	Purushottampur	Rushikulya	7.50	8.90	Deteriorated
60	Ramamangalam	Muvattupuzha	6.80	6.97	Improved
61	Rangeli	som	8.10	7.90	Improved
62	Saidpur	Ganga	8.30	8.41	Deteriorated
63	Sakmur	Wardha	8.00	8.30	Deteriorated
64	Sangam	Murredu	7.90	8.40	Deteriorated
65	Satrapur	Kanhan	7.50	8.00	Deteriorated
66	Savandapur	Bhavani	7.60	8.40	Deteriorated
67	Shastri Bridge	Ganga	8.22	8.25	Deteriorated
68	Sonapurhat	Mahananda	7.40	7.20	Improved
69	Srikakulam	Nagavali	7.40	7.10	Improved
70	V.S. Bridge	Ganga	8.47	8.42	Improved
71	Varanasi	Ganga	8.41	8.53	Deteriorated
72	Vautha	Sabarmati	8.20	7.83	Improved
73	Vijayawada	Krishna	8.10	7.95	Improved
74	Wadenapally	Krishna	7.70	7.40	Improved
75	Warunjli	Koyna	6.90	6.90	No Change
76	Champasari	Mahananda	7.50	6.80	Improved
77	Jollang	Dikrong(Sinki)	7.37	8.28	Deteriorated
78	Chopan	Sone	8.05	8.09	Deteriorated
79	Duddhi	Ganga	8.76	8.07	Improved
80	Jaraikela	Koel	7.20	7.90	Deteriorated
81	Jaunpur	Sai	8.22	8.95	Deteriorated
82	Kantamal	Tel	7.80	8.20	Deteriorated
83	Kesinga	Tel	7.60	7.80	Deteriorated
84	Kuldah Bridge	Sone	8.40	8.50	Deteriorated
85	Maighat	Gomti	8.48	8.76	Deteriorated
86	Mangaon (Seasonal)	Kal	7.20	7.10	Improved
87	Meja Road	Tons	8.10	8.04	Improved
88	Pratapgarh	Sai	8.58	8.49	Improved
89	Samdoli (Seasonal)	Varna	8.56	7.25	Improved
90	Satna	Tons	8.20	7.94	Improved
91	Sultanpur	Gomti	8.66	8.66	No Change
92	Takli	Bhima	6.70	8.72	Deteriorated
93	Talcher	Brahmani	7.70	7.60	Improved
94	Tilga	Sankh	8.00	7.70	Improved

6.6 Status of Water Quality in Indian Rivers in terms of Electrical Conductivity (EC)

The prescribed limits for EC as per CPCB Criteria for Designated Best use of fresh water is 2250 µmhos/cm for Class- E. 82 number of lockdown period samples of EC were taken for comparison, 80 no. of samples were within limits of Class E. The obtained range of EC for all samples was "0 to 4153 µmhos/cm". 90 number of lockdown period samples of EC taken for comparison, all the 100 no. of samples were within limits of Class E. The obtained range of EC for all samples was "30 to 2167 µmhos/cm". On perusal, it was seen that 80 samples of same location were comparable. By considering the numerical value, water quality has improved at 59 locations in terms of EC while at 20 locations value of EC has increased and at 1 location, there was no change in EC value (Figure 9a and 9b). In general, the range of EC value improved during lockdown period. The details thereof given in Table 12.

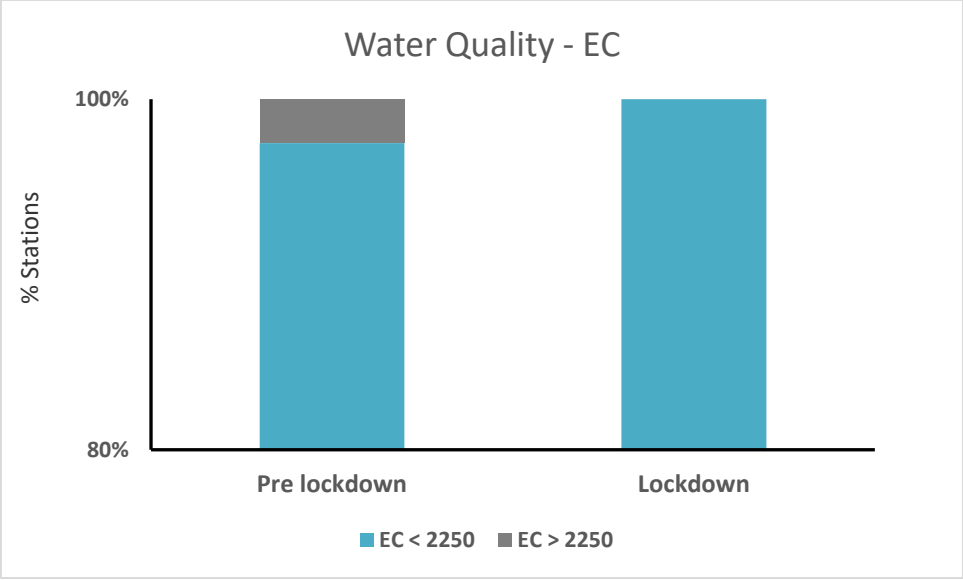

Figure 9a: Graph showing the status of Water Quality in Indian Rivers in terms of Electrical Conductivity (EC).

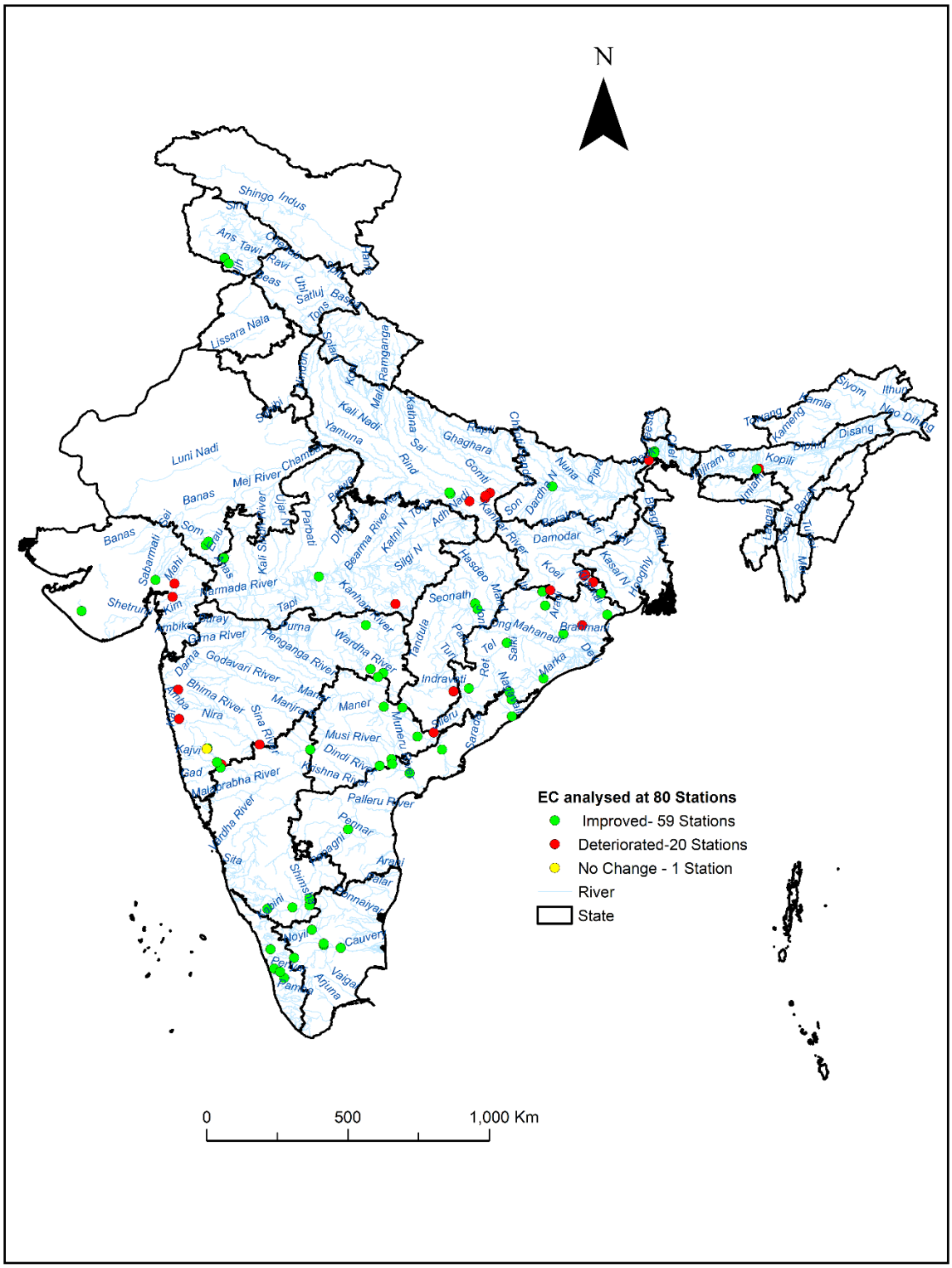

Figure 9b: Map showing the status of Water Quality in Indian Rivers in terms of Electrical Conductivity (EC).

Table 12: Status of Water Quality in Indian Rivers in terms of Electrical Conductivity (EC).

S.NO.	Site	River	EC pre lockdown (µmhos/cm)	EC during lockdown (µmhos/cm)	WQ Status
1	Adityapur	Kharkai	351	361	Deteriorated
2	Akhnoor	Chenab	211	148	Improved
3	Alladupalli	Kunderu	1199	1089	Improved
4	Altuma	Ramyala	658	93	Improved
5	Ambarampalayam	Bharathapuzha	154	123	Improved
6	Anandpur	Baitarni	125	266	Deteriorated
7	Arangaly	Chalakudy	55	47	Improved
8	Arjunwad (Seasonal)	Krishna	17.27	304.9	Deteriorated
9	Ashti	Wainganga	270	208	Improved
10	Badlapur	Ulhas	135	153	Deteriorated
11	Baluaghat	Ganga	523	563	Deteriorated
12	Bamni	Wardha	1769	1108	Improved
13	Bamnidhi	Hasdeo	208	176	Improved
14	Basantpur	Mahanadi	330	180	Improved
15	Bhadrachalam	Godavari	307	212	Improved
16	Chhatnag Allahabad	Ganga	388	364	Improved
17	Dameracherla	Musi	925	436	Improved
18	Elunuthimangalam	Noyyal	4153	2103	Improved
19	Gandhighat	Ganga	349	329.6	Improved
20	Ganod	Bhadar	2081	1535	Improved
21	Ghatsila	Subarnarekha	320	408	Deteriorated
22	Gomlai	Brahmani	172	109	Improved
23	Govindapur	Burhabalang	200	129	Improved
24	Gunupur	Vamsadhara	300	250	Improved
25	Guwahati DC court	Brahamaputra	133.2	139.1	Deteriorated
26	Hoshangabad	Narmada	246	179	Improved
27	Jagdalpur	Indravati	0	145	Deteriorated
28	Jammu Tawi	Tawi	387	193	Improved
29	Jamshedpur	Subarnarekha	167	165	Improved
30	Jamsholaghat	Subarnarekha	427	252	Improved
31	Jenapur	Brahmni	120	110	Improved
32	Kalampur	Kaliyar	67	51	Improved
33	Karad	Krishna	306	178	Improved
34	Kashinagar	Vamsadhara	364	131	Improved
35	Khanpur	Mahi	416	433	Deteriorated
36	Kodumudi	Cauvery	571	503	Improved
37	Kokkedoddy	Arkavathy	1467	1394	Improved
38	Kollegal	Cauvery	374	369	Improved
39	Konta	Sabari	92	130	Deteriorated
40	Kumhari	Wainganga	371	510	Deteriorated
41	Kurundwad	Krishna	637.8	486.4	Improved
42	Mataji	Mahi	341	320	Improved
43	Matigara	Balason	85	80	Improved
44	Mirzapur	Ganga	459	542	Deteriorated
45	Muri	Subarnarekha	269	359	Deteriorated
46	Musiri	Cauvery	627	605	Improved
47	Neeleswaram	Periyar	32	30	Improved
48	Noukaghat	Mahananda	218	213	Improved

S.NO.	Site	River	EC pre lockdown	EC during lockdown	WQ Status
			(µmhos/cm)		
49	Nowrangpur	Godavari	158	138	Improved
50	Paderdibadi	Mahi	501	414	Improved
51	Paleru Bridge	Paleru	760	695	Improved
52	Pandu	Brahmaputra	156.2	138.5	Improved
53	Panposh	Brahmani	160	142	Improved
54	Perur	Godavari	221	212	Improved
55	Pingalwada	Dhadher	1504	1518	Deteriorated
56	Polavaram	Godavari	136	100	Improved
57	Purushottampur	Rushikulya	258	160	Improved
58	Ramamangalam	Muvattupuzha	56	49	Improved
59	Rangeli	som	530	518	Improved
60	Sakmur	Wardha	727	623	Improved
61	Sangam	Murredu	549	534	Improved
62	Satrapur	Kanhan	663	540	Improved
63	Savandapur	Bhavani	364	352	Improved
64	Shastri Bridge	Ganga	373	322	Improved
65	Sonapurhat	Mahananda	72	97	Deteriorated
66	Srikakulam	Nagavali	254	195	Improved
67	T. Bekuppe	Arkavathi	1583	1273	Improved
68	T.Narasipur	Kabini	398	372	Improved
69	V.S. Bridge	Ganga	495	553	Deteriorated
70	Varanasi	Ganga	485	542	Deteriorated
71	Vautha	Sabarmati	2743	1658	Improved
72	Vijayawada	Krishna	634	574	Improved
73	Wadenapally	Krishna	269	252	Improved
74	Warunjli	Koyna	234	234	No Change
75	Champasari	Mahananda	194	91	Improved
76	Jaraikela	Koel	124	127	Deteriorated
77	Kantamal	Tel	287	224	Improved
78	Mangaon (Seasonal)	Kal	141.2	153.2	Deteriorated
79	Samdoli (Seasonal)	Varna	839.5	108.1	Improved
80	Takli	Bhima	207	1475	Deteriorated

6.7 Status of Water Quality in Indian Rivers in terms of Chemical Oxygen Demand (COD)

The concentrations of COD observed in surface waters range from 20 mg/L or less in unpolluted waters to greater than 200 mg/L in waters receiving effluents. 37 number of pre-lockdown period samples of COD were taken for comparison. The concentrations of COD for 12 number of samples were within 20mg/L, while 25 no. of samples were within 200 mg/L. Obtained range of Chemical Oxygen Demand (COD) for all samples was "3.41 to 162 mg/L. 37 number of lockdown period samples of COD were taken for comparison. The concentrations of COD for 18 number of samples were within 20 mg/L, while 19 no. of samples were within 200 mg/L. Obtained range of Chemical Oxygen Demand (COD) for all samples was "3 to 93 mg/L". By considering the numerical value, water quality has improved at 23 locations in terms of concentrations of COD while at 12 locations, there is only marginal increase in COD value and at 2 locations, there was no change in COD values (Figure 10a and 10b). The details thereof given in Table 13.

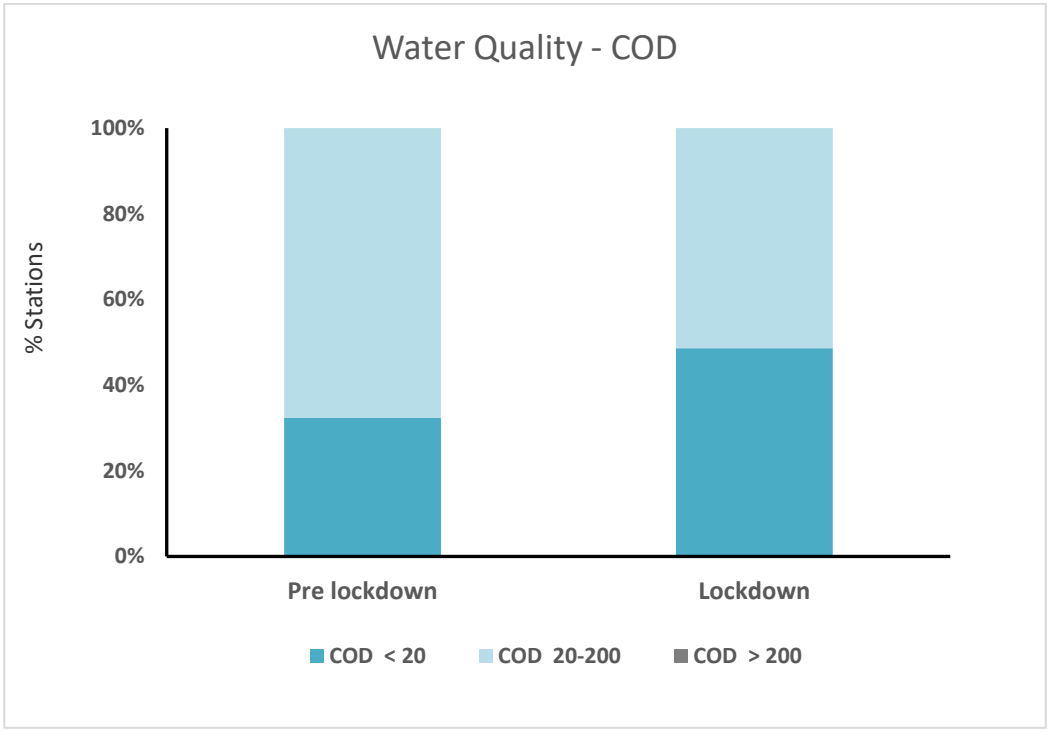

Figure 10a: Graph showing the status of Water Quality in Indian Rivers in terms of Chemical Oxygen Demand (COD).

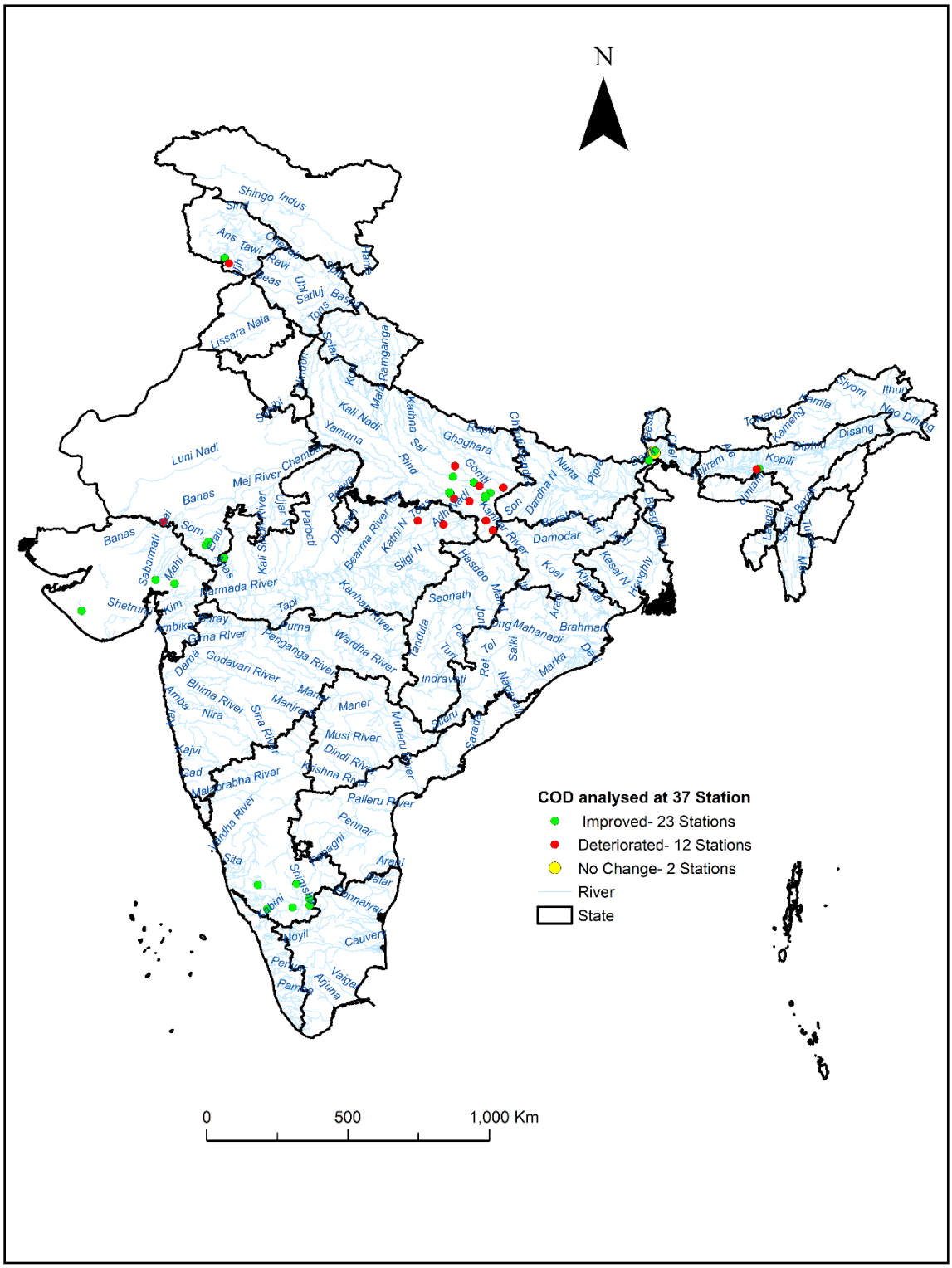

Figure 10b: Map showing the status of Water Quality in Indian Rivers in terms of Chemical Oxygen Demand (COD).

Table 13: Status of Water Quality in Indian Rivers in terms of Chemical Oxygen Demand (COD).

S.No.	Site	River	COD pre lockdown	COD during lockdown	WQ Status
			(mg/L)		
1	Abu Road	Banas	7	48	Deteriorated
2	Akhnoor	Chenab	19	16	Improved
3	Baluaghat	Ganga	37	32	Improved
4	Chhatnag Allahabad	Ganga	37	25	Improved
5	Ganod	Bhadar	75	31	Improved
6	Ghazipur	Ganga	27	29	Deteriorated
7	Guwahati DC court	Brahamaputra	31	8	Improved
8	Jammu Tawi	Tawi	3	12	Deteriorated
9	Khanpur	Mahi	15	9	Improved
10	Kokkedoddy	Arkavathy	32	10	Improved
11	Kollegal	Cauvery	22	3	Improved
12	Mataji	Mahi	25	7	Improved
13	Matigara	Balason	12	12	No Change
14	Mirzapur	Ganga	32	32	Deteriorated
15	Noukaghat	Mahananda	8	8	No Change
16	Paderdibadi	Mahi	23	11	Improved
17	Pandu	Brahmaputra	5	6	Deteriorated
18	Rangeli	som	26	16	Improved
19	Sakleshpur	Hemavati	11	7	Improved
20	Shastri Bridge	Ganga	31	30	Improved
21	Sonapurhat	Mahananda	12	8	Improved
22	T. Bekuppe	Arkavathi	37	20	Improved
23	T.Narasipur	Kabini	39	3	Improved
24	Thimmanahalli	Yagachi	22	16	Improved
25	V.S. Bridge	Ganga	40	31	Improved
26	Varanasi	Ganga	33	31	Improved
27	Vautha	Sabarmati	162	93	Improved
28	Champasari	Mahananda	16	12	Improved
29	Chopan	Sone	19	27	Deteriorated
30	Duddhi	Ganga	20	28	Deteriorated
31	Jaunpur	Sai	32	32	Improved
32	Kuldah Bridge	Sone	23	25	Deteriorated
33	Maighat	Gomti	31	34	Deteriorated
34	Meja Road	Tons	20	29	Deteriorated
35	Pratapgarh	Sai	37	29	Improved
36	Satna	Tons	24	25	Deteriorated
37	Sultanpur	Gomti	34	38	Deteriorated

6.8 Status of Water Quality in Indian Rivers in terms of Total Hardness (TH)

The prescribed limits for Total Hardness as per Drinking Water Quality standards BIS: 10500:2012 is 200 mg/L. 7 no. of pre-lockdown period samples of Total Hardness were taken for comparison. All samples except one were within acceptable limit. The obtained range of Total Hardness for all samples was "18.00 to 202.48 mg/L". 7 no. of lockdown period samples of Total Hardness were taken for comparison. All samples were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Total Hardness for all samples was "14.00 to 184.12 mg/L". In general, the range of the Total Hardness value improved during lockdown period (Figure 11a and 11b). The details thereof given in Table 14.

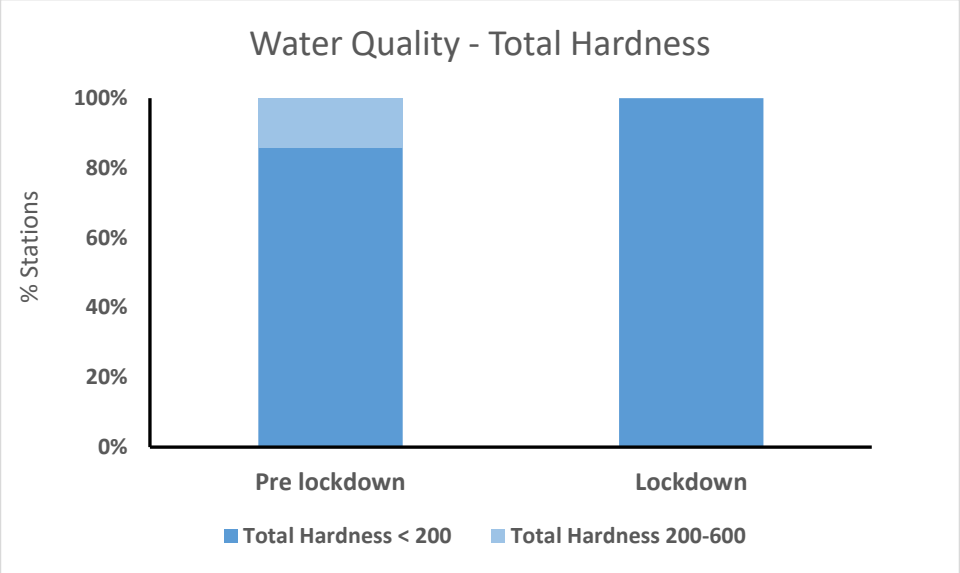

Figure 11a: Graph showing the status of Water Quality in Indian Rivers in terms of Total Hardness.

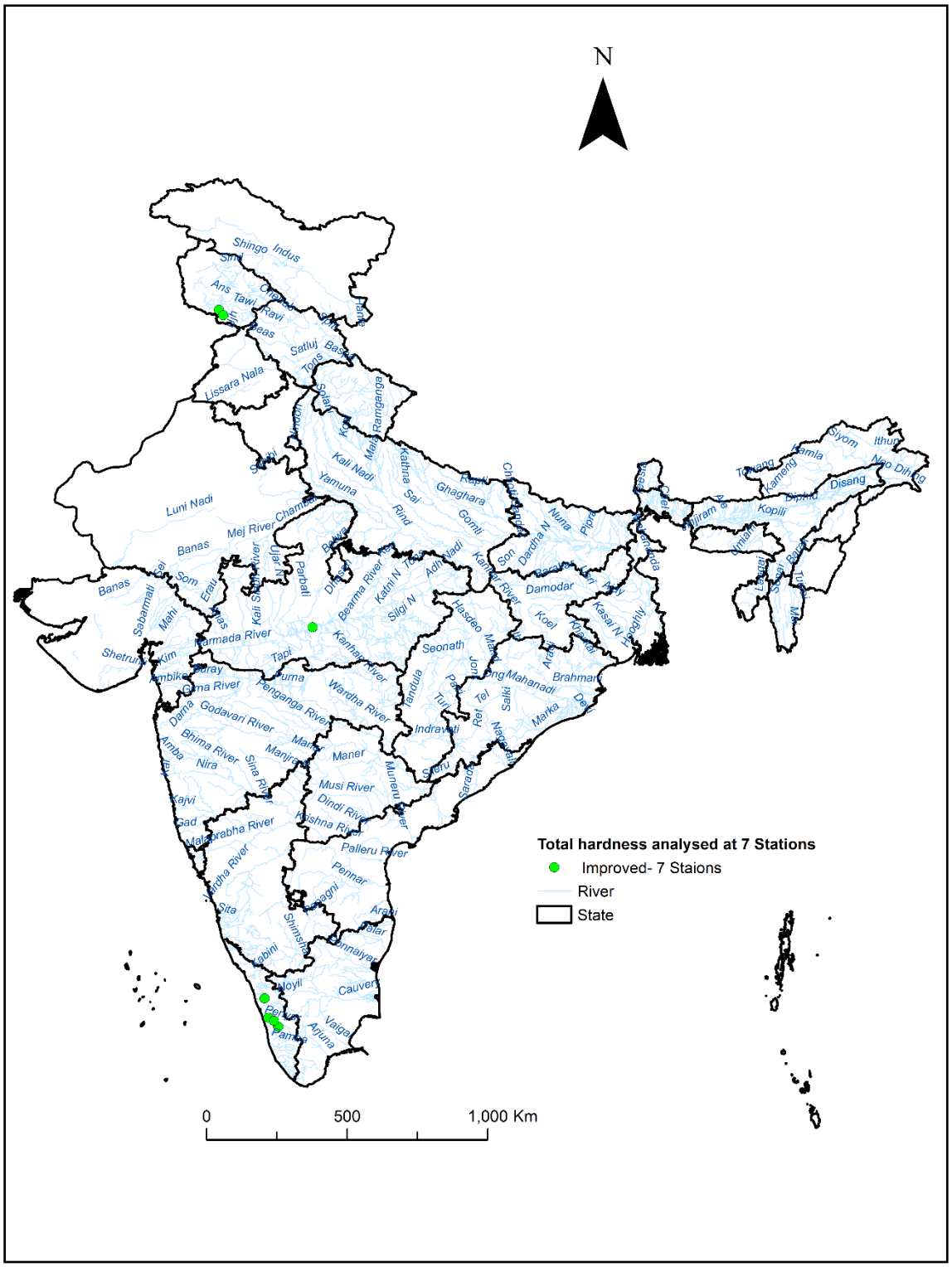

Figure 11b: Map showing the status of Water Quality in Indian Rivers in terms of Total Hardness.

Table 14: Status of Water Quality in Indian Rivers in terms of Total Hardness.

S.No.	Site	River	TH pre lockdown	TH during lockdown	WQ Status
			(mg/L)		
1	Akhnoor	Chenab	136.64	104.92	Improved
2	Arangaly	Chalakudy	35	18	Improved
3	Hoshangabad	Narmada	114.3	104	Improved
4	Jammu Tawi	Tawi	202.48	184.12	Improved
5	Kalampur	Kaliyar	28	19	Improved
6	Neeleswaram	Periyar	18	14	Improved
7	Ramamangalam	Muvattupuzha	19	18	Improved

6.9 Status of Water Quality in Indian Rivers in terms of Turbidity

The prescribed limits for Turbidity as per Drinking Water Quality standards BIS: 10500:2012 is 1 NTU. 9 number of pre-lockdown period samples of Turbidity were taken for comparison. 3 samples were within acceptable limit while 6 samples were beyond acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Turbidity for all samples was "1 to 97 NTU". 10 number of lockdown period samples of Turbidity were taken for comparison. All samples were beyond within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Turbidity for all samples was "0 to 26.76 NTU". On perusal, it was seen that 9 samples of same location were comparable. by considering the numerical value, water quality has significantly improved at 5 locations in terms of Turbidity value while at 4 locations Water Quality has deteriorated but there is only marginal increase in Turbidity values. However, the range of the Turbidity values improved during lockdown period (Figure 12a and 12b). The details thereof given in Table 15.

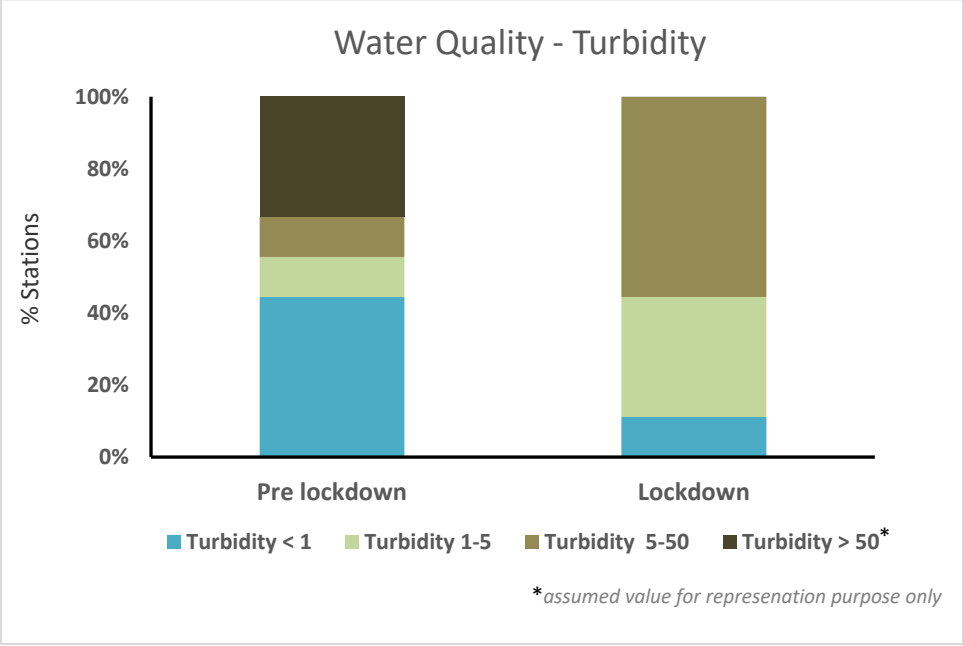

Figure 12a: Graph showing the status of Water Quality in Indian Rivers in terms of Turbidity.

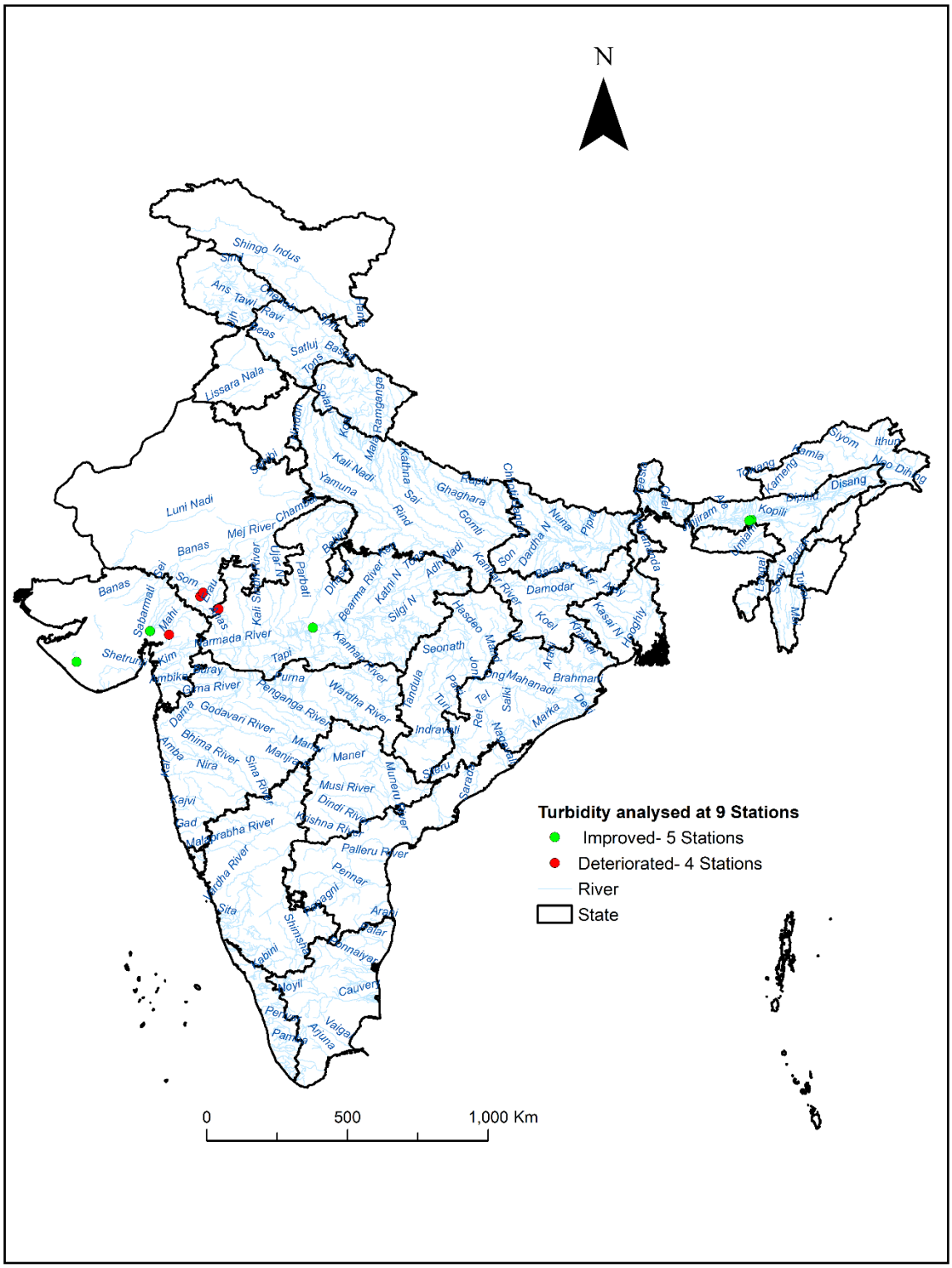

Figure 12b: Map showing the status of Water Quality in Indian Rivers in terms of Turbidity.

Table 15: Status of Water Quality in Indian Rivers in terms of Turbidity.

S.No.	Site	River	Turbidity pre lockdown	Turbidity during lockdown	WQ Status
			(NTU)		
1	Ganod	Bhadar	35	8	Improved
2	Khanpur	Mahi	2	4	Deteriorated
3	Mataji	Mahi	1	8	Deteriorated
4	Paderdibadi	Mahi	1	3	Deteriorated
5	Rangeli	som	1	3	Deteriorated
6	Vautha	Sabarmati	61	17	Improved
7	Guwahati DC Court	Brahamaputra	97	26	Improved
8	Pandu	Brahamaputra	85	18	Improved
9	Hoshangabad	Narmada	0.02	0	Improved

6.10 Status of Water Quality in Indian Rivers in terms of Fluoride

The acceptable limits for Fluoride as per Drinking Water Quality standards BIS: 10500:2012 is 1 mg/L. 9 number of pre-lockdown period samples of Fluoride were taken for comparison. 7 samples were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Fluoride for all samples was "0.2 to 1.1 mg/L". 11 number of lockdown period samples of Fluoride were taken for comparison. All samples were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Fluoride for all samples was "0.046 to 0.95 mg/L". On perusal, it was seen that 9 samples of same location were comparable. By considering the numerical value, water quality has improved at 8 locations in terms of fluoride while at 1 location namely Musiri site of River Cauvery there was no change. In general, the range of the Fluoride value improved during lockdown period (Figure 13a and 13b). The details thereof given in and Table 16.

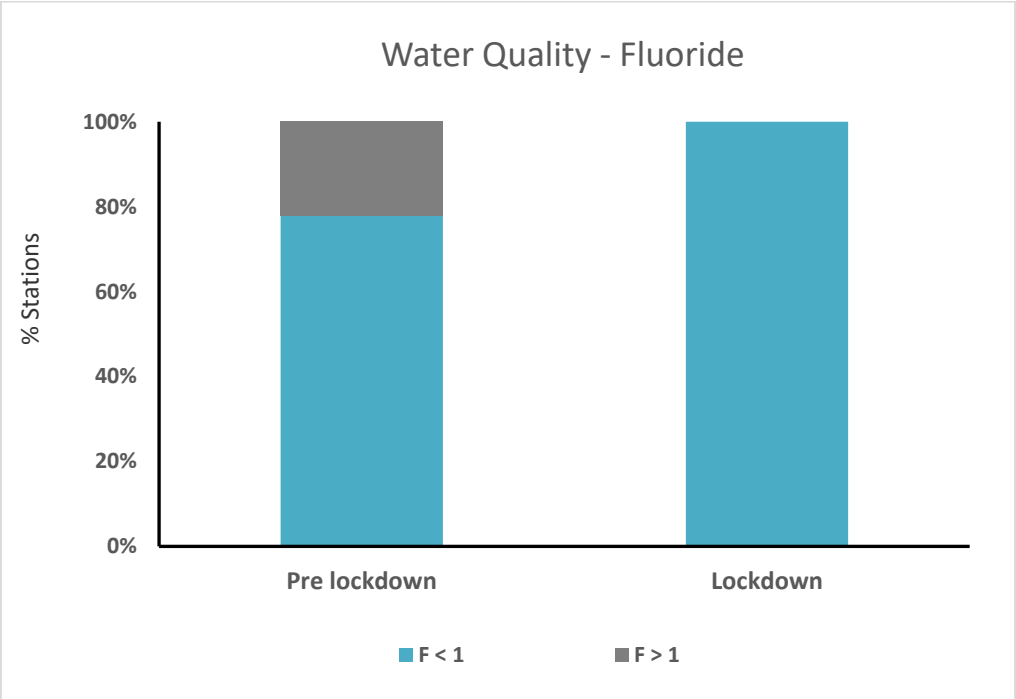

Figure 13a: Graph showing the status of Water Quality in Indian Rivers in terms of Fluoride.

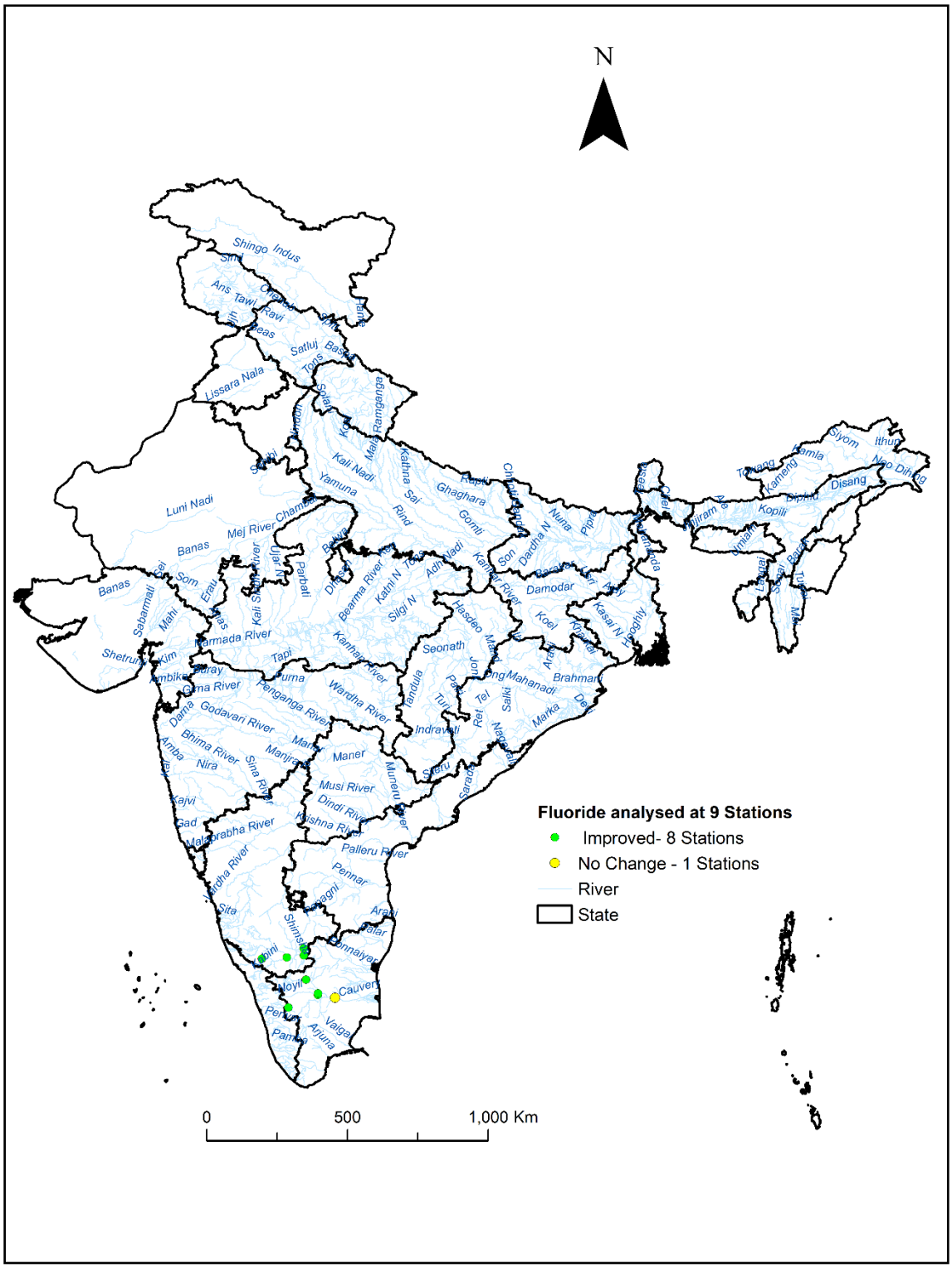

Figure 13b: Map showing the status of Water Quality in Indian Rivers in terms of Fluoride.

Table 16: Status of Water Quality in Indian Rivers in terms of Fluoride.

S.No.	Site	River	Fluoride pre lockdown (mg/L)	Fluoride during lockdown (mg/L)	WQ Status
1	Ambarampalayam	Bharathapuzha	0.2	0.13	Improved
2	Elunuthimangalam	Noyyal	1.1	0.85	Improved
3	Kodumudi	Cauvery	0.4	0.38	Improved
4	Kokkedoddy	Arkavathy	1.1	0.95	Improved
5	Kollegal	Cauvery	0.29	0.222	Improved
6	Musiri	Cauvery	0.4	0.4	No Change
7	Savandapur	Bhavani	0.3	0.28	Improved
8	T. Bekuppe	Arkavathi	0.68	0.555	Improved
9	T.Narasipur	Kabini	0.25	0.21	Improved

6.11 Status of Water Quality in Indian Rivers in terms of Chloride (Cl)

The prescribed limits for Chloride as per Drinking Water Quality standards BIS: 10500:2012 is 250 mg/L. 33 number of pre-lockdown period samples of Chloride were taken for comparison. 31 samples were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Chloride for all samples was "4.2 to 618 mg/L". 42 number of lockdown period samples of Chloride were taken for comparison. All samples except 3 were within acceptable limit as per drinking water quality standards BIS: 10500:2012. The obtained range of Chloride for all samples was "3.5 to 574.4 mg/L" (Figure 14a).

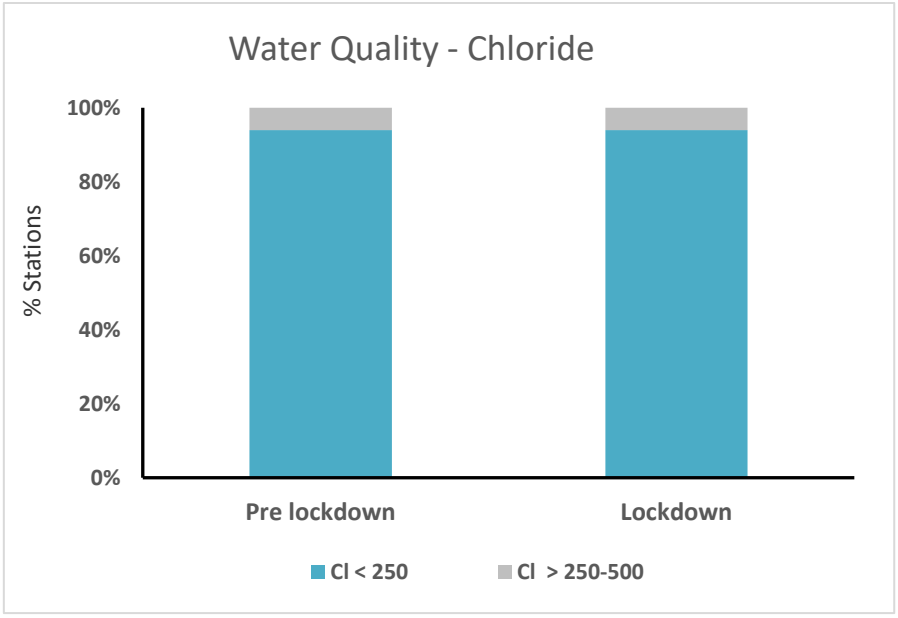

Figure 14a: Graph showing the status of Water Quality in Indian Rivers in terms of Chloride.

On perusal, it was seen that 33 samples of same location were comparable. Water quality has improved at 23 locations in terms of value of Chloride while at 1 location namely Mataji site of River Mahi there was no change. Water Quality has decreased at 9 stations in terms of Chloride but there is only marginal increase in Chloride values which are within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012 (Figure 14b). The details thereof given in Table 17.

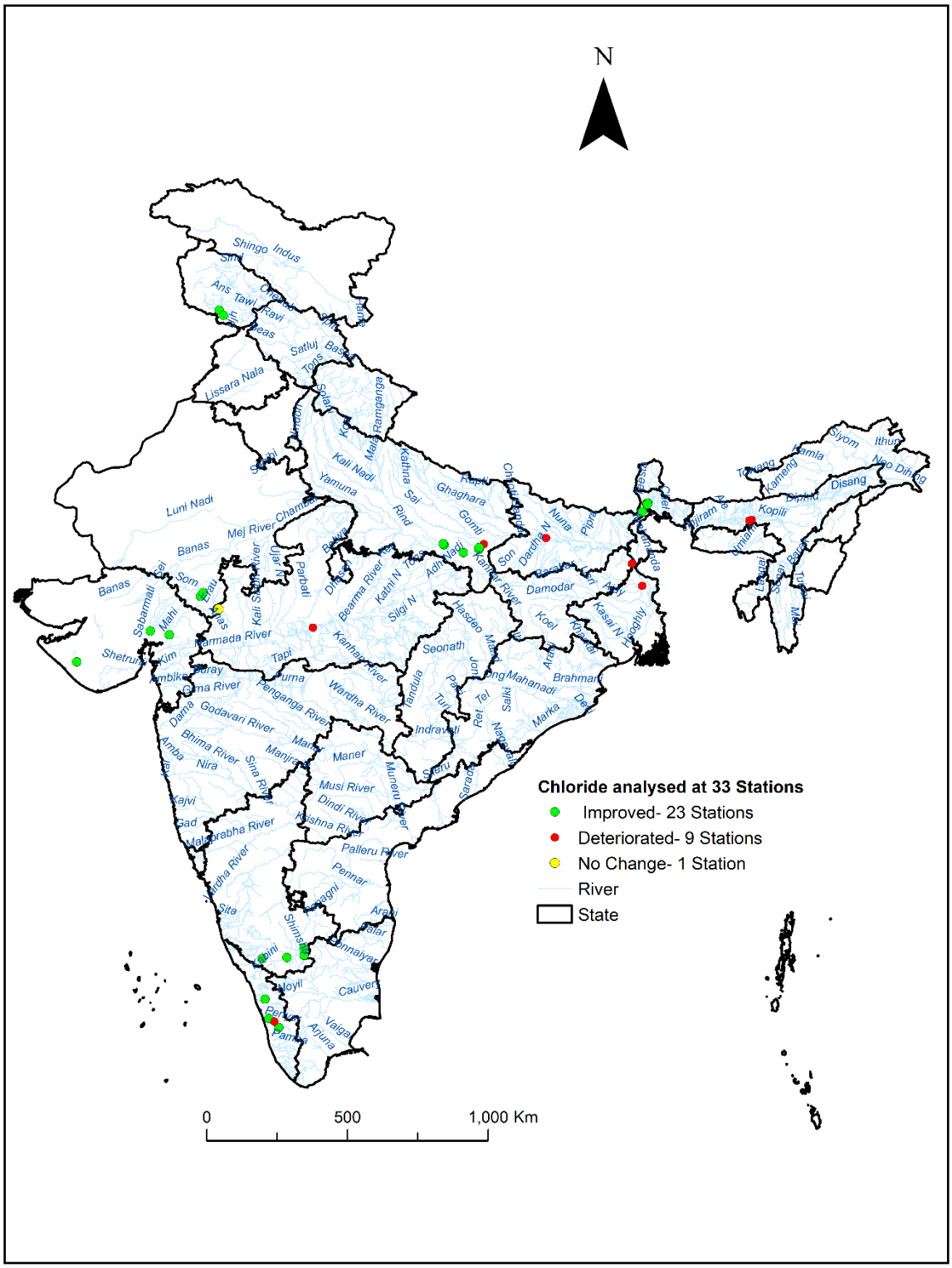

Figure 14b: Map showing the status of Water Quality in Indian Rivers in terms of Chloride.

Table 17: Status of Water Quality in Indian Rivers in terms of Chloride.

S.No.	Site	River	Chloride pre lockdown	Chloride during lockdown	WQ Status
			(mg/L)		
1	Akhnoor	Chenab	23.02	13.01	Improved
2	Arangaly	Chalakudy	20.9	5.9	Improved
3	Baluaghat	Ganga	54.74	57.01	Deteriorated
4	Berhampore	Bhagirathi	14.89	35.56	Deteriorated
5	C.S-97 A, Farakka	Ganga	33.86	41.18	Deteriorated
6	Chhatnag Allahabad	Ganga	35.2	31.35	Improved
7	Farakka/(HR)	Feeder Canal	14.89	35.56	Deteriorated
8	Gandhighat	Ganga	24	44.8	Deteriorated
9	Ganod	Bhadar	484	424.2	Improved
10	Guwahati DC court	Brahamaputra	6.13	12.37	Deteriorated
11	Hoshangabad	Narmada	7.24	7.8	Deteriorated
12	Jammu Tawi	Tawi	25.02	19.02	Improved
13	Kalampur	Kaliyar	27.4	6.6	Improved
14	Khanpur	Mahi	56.2	46	Improved
15	Kokkedoddy	Arkavathy	225.1	209	Improved
16	Kollegal	Cauvery	27	25	Improved
17	Mataji	Mahi	34.4	34.4	No Change
18	Matigara	Balason	18	5.9	Improved
19	Mirzapur	Ganga	55.14	52.27	Improved
20	Neeleswaram	Periyar	4.2	4.3	Deteriorated
21	Noukaghat	Mahananda	22	9.1	Improved
22	Paderdibadi	Mahi	55.2	51.1	Improved
23	Pandu	Brahmaputra	5.29	12.37	Deteriorated
24	Ramamangalam	Muvattupuzha	7.3	6.6	Improved
25	Rangeli	som	62.2	56	Improved
26	Shastri Bridge	Ganga	33.84	21.05	Improved
27	Sonapurhat	Mahananda	12	5.9	Improved
28	T. Bekuppe	Arkavathi	209.5	160	Improved
29	T.Narasipur	Kabini	27	25	Improved
30	V.S. Bridge	Ganga	56.63	54.14	Improved
31	Varanasi	Ganga	55.05	54.34	Improved
32	Vautha	Sabarmati	618	318	Improved
33	Champasari	Mahananda	20	5.5	Improved

6.12 Status of Water Quality in Indian Rivers in terms of Alkalinity

The prescribed limits for Alkalinity as per Drinking Water Quality standards BIS: 10500:2012 is 200 mg/L. 13 number of pre-lockdown period samples of Alkalinity were taken for comparison. All samples except 2 were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Alkalinity for all samples was "0 to 406 mg/L". 21 number of lockdown period samples of Alkalinity were taken for comparison. All samples except 2 were within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. The obtained range of Alkalinity for all samples was "7.4 to 355.8 mg/L" (Figure 15a).

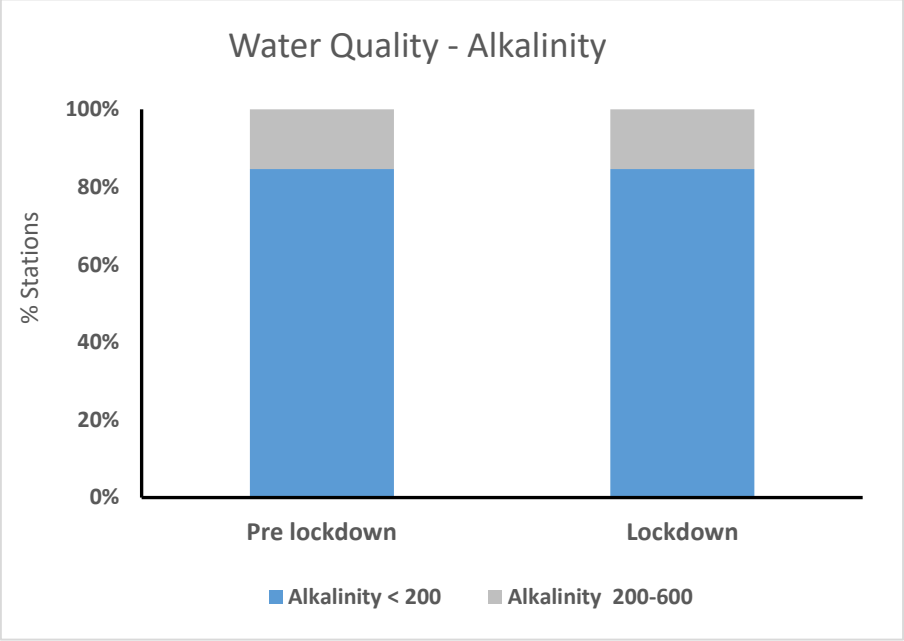

Figure 15a: Graph showing the status of Water Quality in Indian Rivers in terms of Alkalinity.

On perusal, it was seen that 13 samples of same location were comparable. Water quality in terms of value of Alkalinity has improved at 9 locations while water quality has deteriorated at 4 locations but there is only marginal increase in Alkalinity values which are within acceptable limit as per Drinking Water Quality standards BIS: 10500:2012. In general, the range of the Alkalinity value improved during lockdown period (Figure 15b). The details thereof given in Table 18.

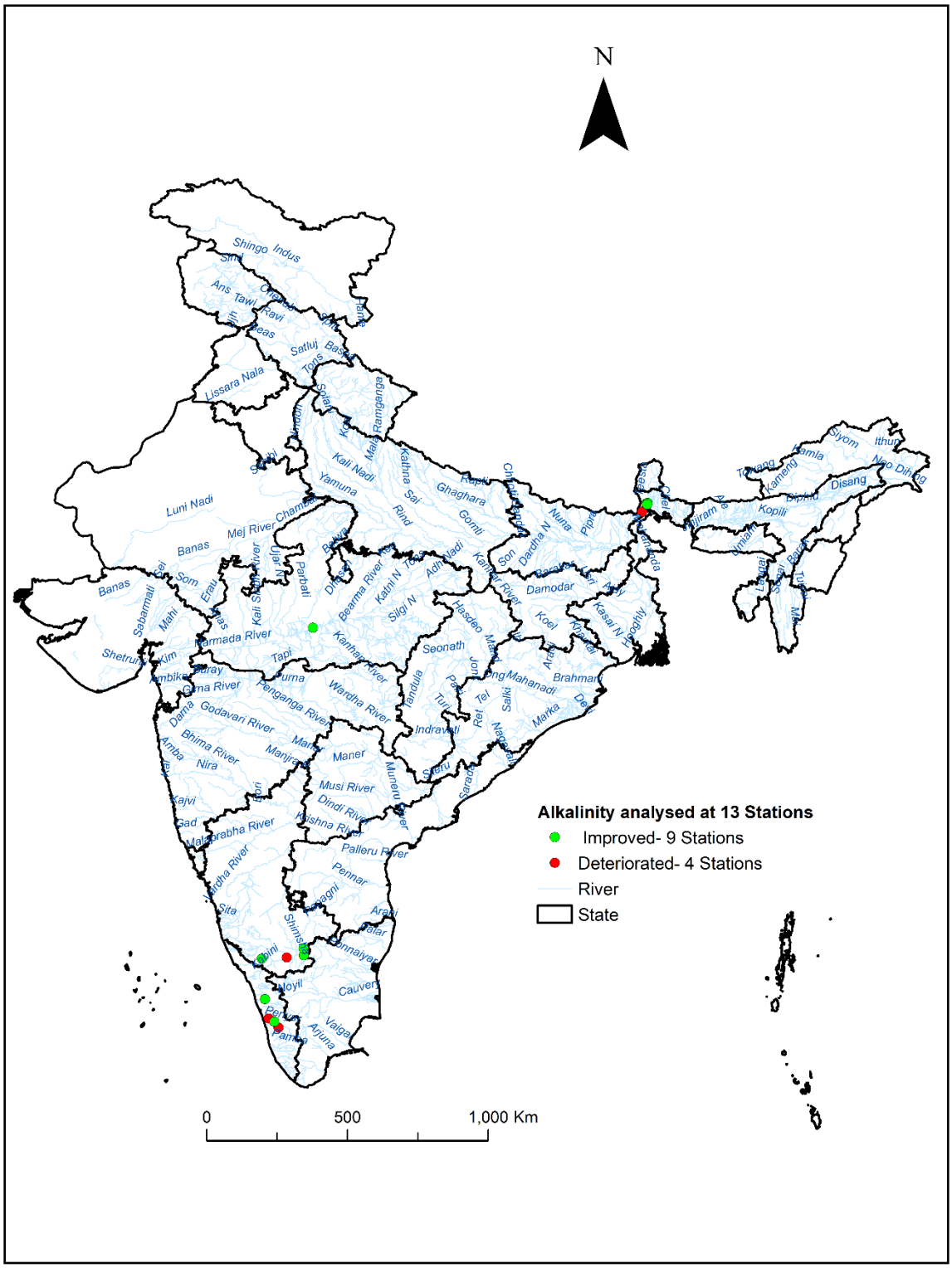

Figure 15b: Map showing the status of Water Quality in Indian Rivers in terms of Alkalinity.

Table 18: Status of Water Quality in Indian Rivers in terms of Alkalinity.

S.No.	Site	River	Alkalinity pre lockdown	Alkalinity during lockdown	WQ Status
			(mg/L)		
1	Arangaly	Chalakudy	10	10.7	Deteriorated
2	Hoshangabad	Narmada	132.3	103.84	Improved
3	Kalampur	Kaliyar	0	13.1	Deteriorated
4	Kokkedoddy	Arkavathy	382	278.8	Improved
5	Kollegal	Cauvery	150	106.55	Improved
6	Matigara	Balason	43.93	29	Improved
7	Neeleswaram	Periyar	11	7.4	Improved
8	Noukaghat	Mahanada	92.38	91	Improved
9	Ramamangalam	Muvattupuzha	12	11.5	Improved
10	Sonapurhat	Mahananda	36.23	41	Deteriorated
11	T. Bekuppe	Arkavathi	406	355.88	Improved
12	T.Narasipur	Kabini	137	149	Deteriorated
13	Champasari	Mahananda	79.1	36.96	Improved

7. Summary: Basin-wise

7.1 Brahmputra Basin

River Brahmputra: Water Quality of the River Brahmputra was monitored at sites Bhomoraguri, Pandu and Guwahati D. C. Court (Figure 16). At Bhomoraguri site of river Brahmaputra, water quality has deteriorated in terms of Dissolved Oxygen (DO). At Pandu site of river Brahmaputra, water quality has improved in terms of TDS and EC with a considerable decrease in Turbidity value. At Guwahati D. C. Court site of River Brahmaputra, there is a considerable decrease in Turbidity value which indicates that the water is clearer and the value of COD during the lockdown period is improved as compared to the same period in the preceding year. The details thereof given in Table 19.

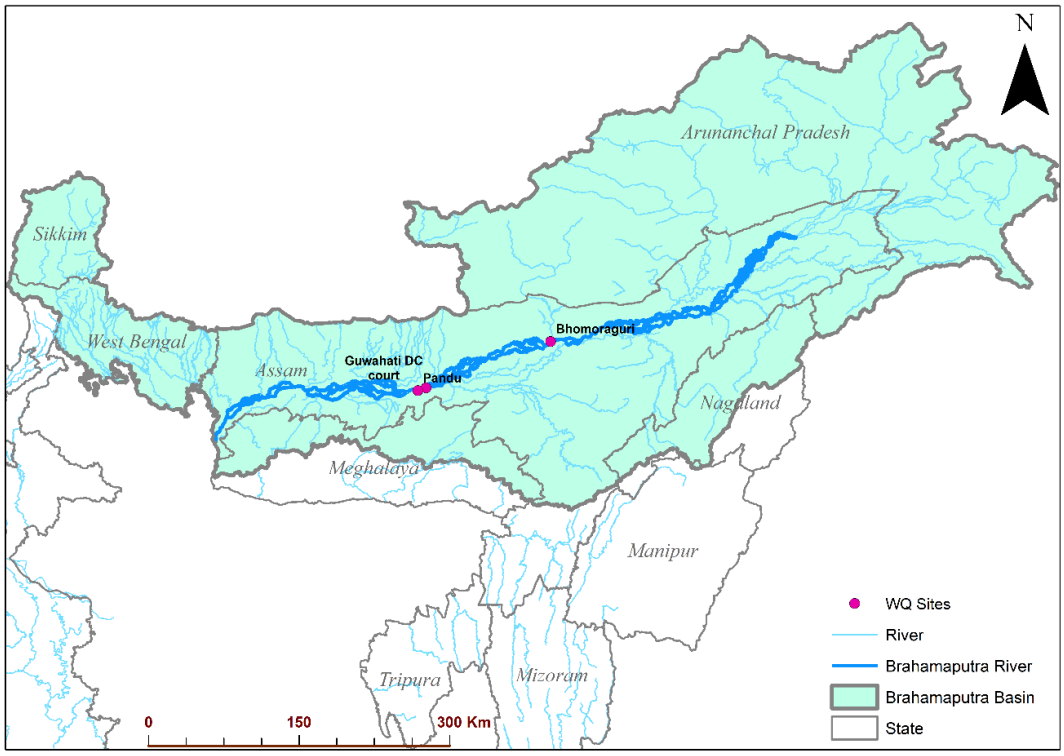

Figure 16: Map showing the water quality sites of River Brahmaputra monitored during lockdown

Table 19: Status of Water Quality of Brahmaputra River during Lockdown

S.NO	Site	River	Water Quality Status in terms of					
			DO	EC	COD	Cl	TDS	Turbidity
1	Bhomoraguri	Brahmaputra	Deteriorated					
2	Pandu	Brahmaputra	Deteriorated	Improved	Deteriorated	Deteriorated	Improved	Improved
3	Guwahati DC court	Brahmaputra	Deteriorated	Deteriorated	Improved	Deteriorated	Deteriorated	Improved

7.2 Brahmani and Baitarni Basin

River Brahmani: Water Quality of the River Brahmani was monitored at sites Panposh, Gomlai, Talcher and Jenapur (Figure 17). Water quality has improved in terms of EC at sites Panposh, Gomlai and Jenapur and pH values has improved at sites Gomlai and Talcher of River Brahmani. The details thereof given in Table 20.

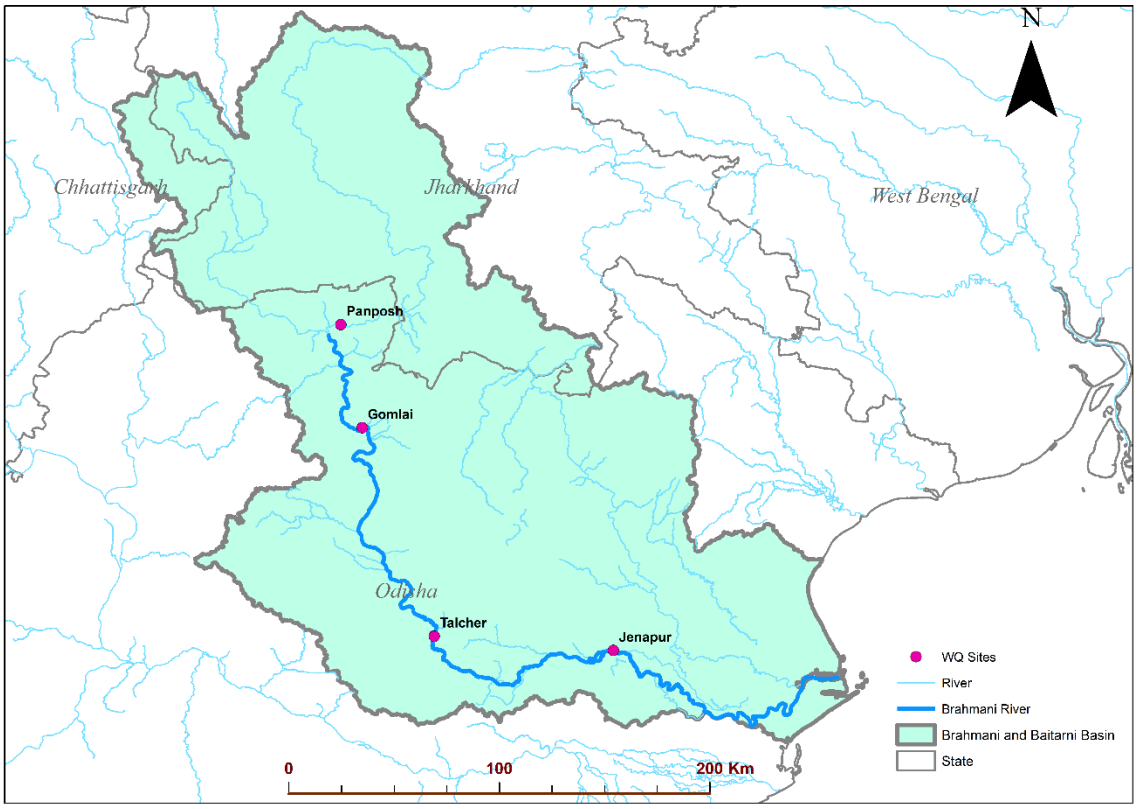

Figure 17: Map showing the water quality sites of River Brahmani monitored during lockdown

Table 20: Status of Water Quality of Brahmani River during Lockdown

S.NO	Site	River	Water Quality Status	
			pH	EC
1	Panposh	Brahmani	Deteriorated	Improved
2	Gomlai	Brahmani	Improved	Improved
3	Talcher	Brahmani	Improved	-
4	Jenapur	Brahmani	Deteriorated	Improved

River Baitarani: Water Quality of the River Baitarani was monitored at sites Champua and Anandpur (Figure 18). Water quality has improved in terms of pH but EC values has increased at site Anandpur. No appreciable changes in water quality of river were noticed. The details thereof given in Table 21.

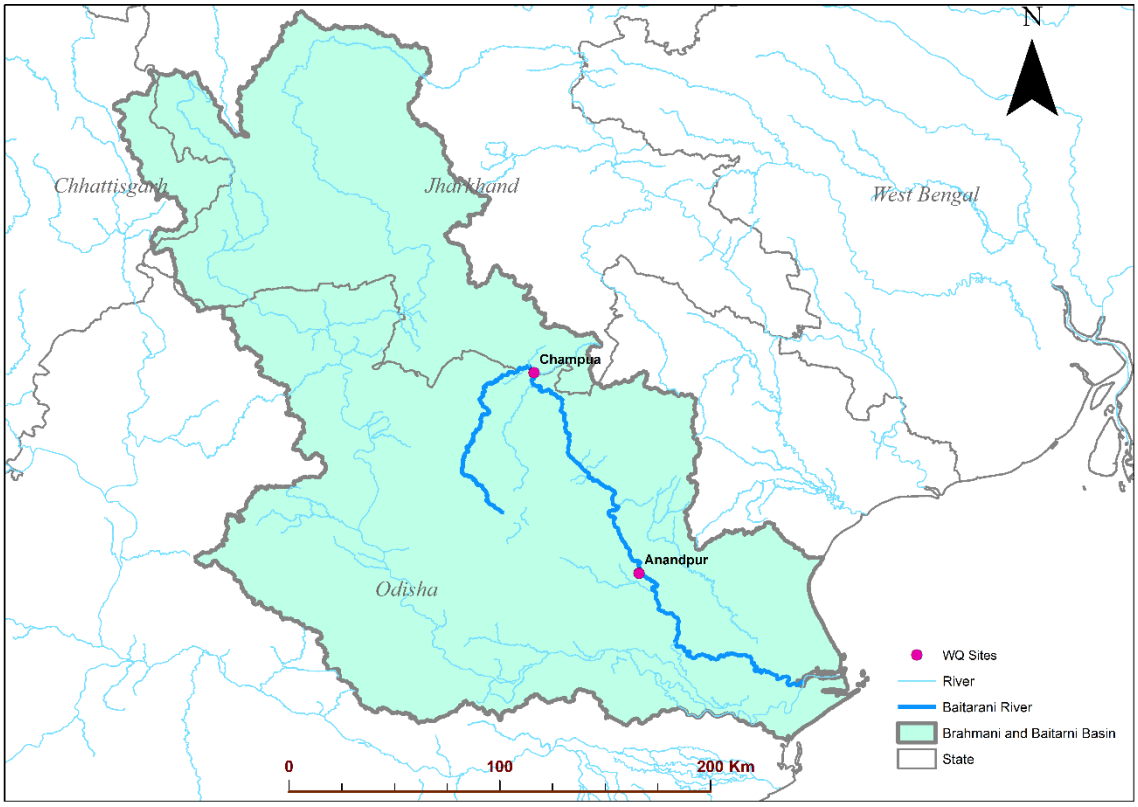

Figure 18: Map showing the water quality sites of River Baitarani monitored during lockdown

Table 21: Status of Water Quality of Baitarani River during Lockdown

S.NO	Site	River	Water Quality Status	
			pH	EC
1	Champua	Baitarni	-	-
2	Anandpur	Baitarni	Improved	Deteriorated

7.3 Cauvery Basin

River Cauvery: Water Quality of the River Cauvery was monitored at sites Kollegal, Kodumudi and Musiri (Figure 19). Water quality has improved at Kollegal Site of Cauvery River in terms of BOD, COD, Chloride, Alkalinity, Fluoride, Total Coliform and EC. At Site Kodumudi of River Cauvery, DO, Fluoride and EC value is comparatively improved and coliform count is improved significantly. At site Musiri of River Cauvery, DO, EC and Total Coliform values are improved comparatively but the fluoride value has no change. The details thereof given in Table 22.

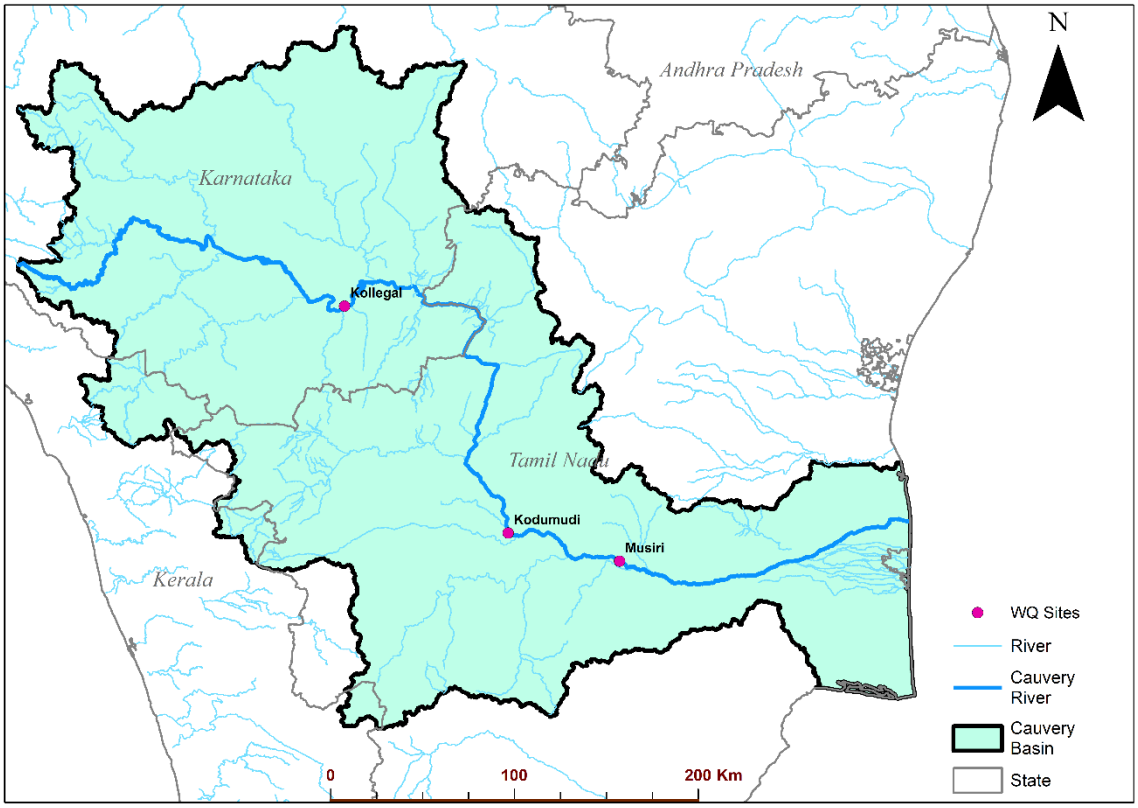

Figure 19: Map showing the water quality sites of River Cauvery monitored during lockdown

Table 22: Status of Water Quality of Cauvery River during Lockdown

S.No.	Site	River	Water Quality Status in terms of								
			pH	DO	BOD	EC	COD	Cl	Alkalinity	F	Total Coliform
1	Kollegal	Cauvery	-	Deteriorated	Improved	Improved	Improved	Improved	Improved	Improved	Improved
2	Kodumudi	Cauvery	Deteriorated	Improved	-	Improved	-	-	-	Improved	Improved
3	Musiri	Cauvery	Deteriorated	Improved	-	Improved	-	-	-	No Change	Improved

River Arkavathi: Water Quality of the River Arkavathi was monitored at sites T Bekuppe and Koggedoddy (Figure 20). Water quality has improved in terms of BOD, COD, Chloride, Alkalinity and EC values at both the sites. The value of DO has improved at T. Bekuppe site and Total coliform has improved at Kokkedoddy site of River Arkavathi. The details thereof given in Table 23.

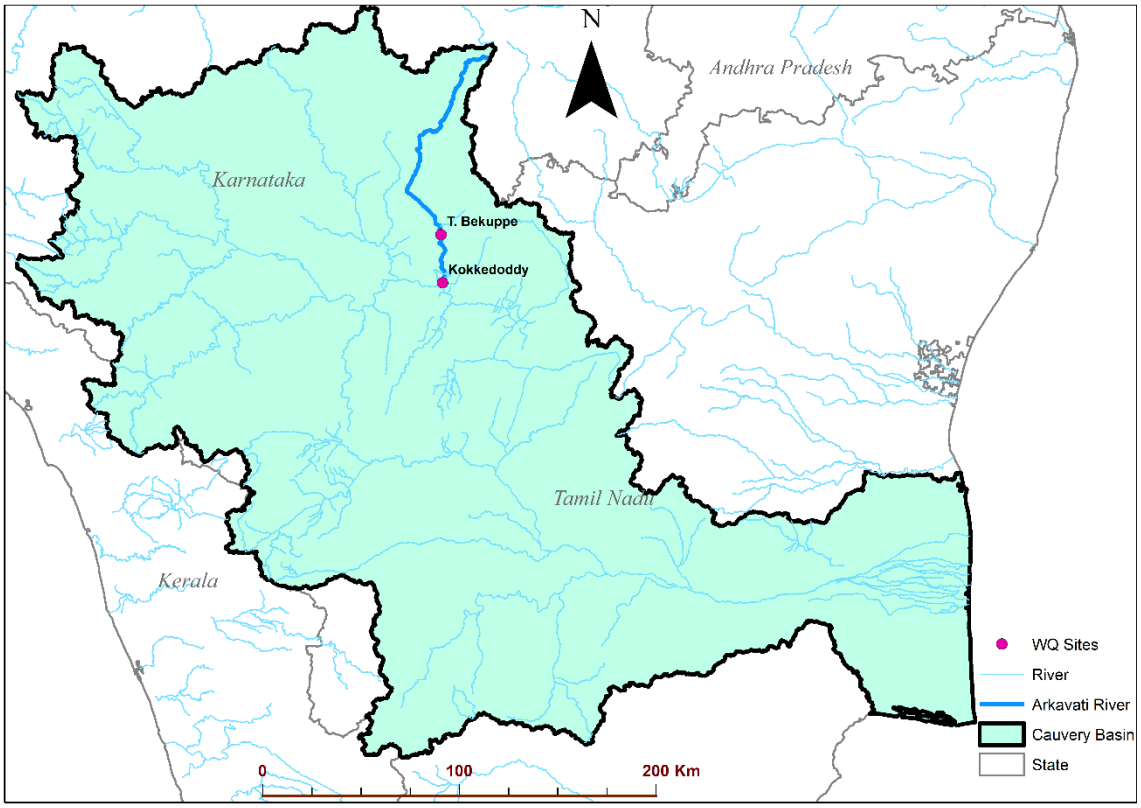

Figure 20: Map showing the water quality sites of River Arkavathi monitored during lockdown

Table 23: Status of Water Quality of Arkavathi River during Lockdown

S.NO	Site	River	Water Quality Status in terms of							
			DO	BOD	EC	COD	Cl	Alkalinity	Fluoride	Total Coliform
1	T. Bekuppe	Arkavathi	Improved	Improved	Improved	Improved	Improved	Improved	Improved	Deteriorated
2	Kokkedoddy	Arkavathi	Deteriorated	Improved	Improved	Improved	Improved	Improved	Improved	Improved

River Noyyal: Water Quality of the River Noyyal was monitored at site Elunuthimangalam (Figure 21). The values of pH, DO and Fluoride have been improved during the lockdown. Total coliform value is improved significantly and value of EC has shown considerable improvement from 4153 to 2103 µmhos/cm and falls within limits of Class E. The details thereof given in Table 24.

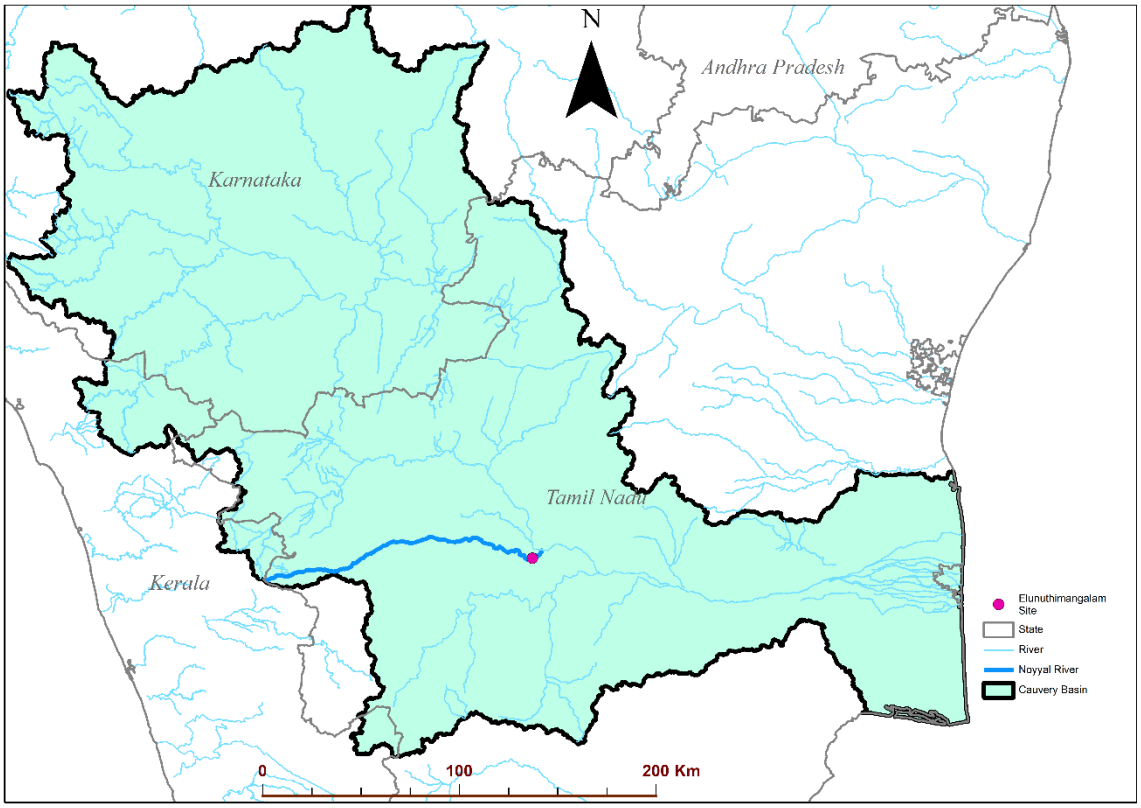

Figure 21: Map showing the water quality sites of River Noyyal monitored during lockdown

Table 24: Status of Water Quality of Noyyal River during Lockdown

S.NO	Site	River	Water Quality Status				
			DO	pH	EC	Fluoride	Total Coliform
1	Elunuthimangalam	Noyyal	Improved	Improved	Improved	Improved	Improved

7.4 Ganga Basin

River Ganga: Water Quality of the Holy River Ganga was monitored at sites Rishikesh, Kanpur, Shastri Bridge, Chattang Allahbad, Mirzapur, V. S. Bridge, Varanasi, Baluaghat, Saidpur, Ghazipur, Gandhighat and CS 97A Farakka (Figure 22).

At Rishikesh (Uttarakhand), water quality of the River Ganga has been improved as Dissolved Oxygen (DO) value has increased tremendously. In Uttar Pradesh at Sites Kanpur, Shastri Bridge, Chattang Allahbad, Mirzapur, V S Bridge, Varanasi, Baluaghat, Saidpur, and Ghazipur; water Quality of the River Ganga has been improved in terms of Dissolved Oxygen (DO), Biochemical oxygen demand (BOD) and Total Coliform (TC). DO values are comparatively higher from the values obtained before lockdown. The values of Biochemical oxygen demand (BOD) and Total Coliform (TC) have decreased in month of April 2020 from value obtained before lockdown. At Gandhighat Patna on the holy river Ganga, DO values of river water is increased significantly. However, water quality has been deteriorated at site CS 97A Farakka in terms of DO, BOD and Cl. The details thereof given in Table 25.

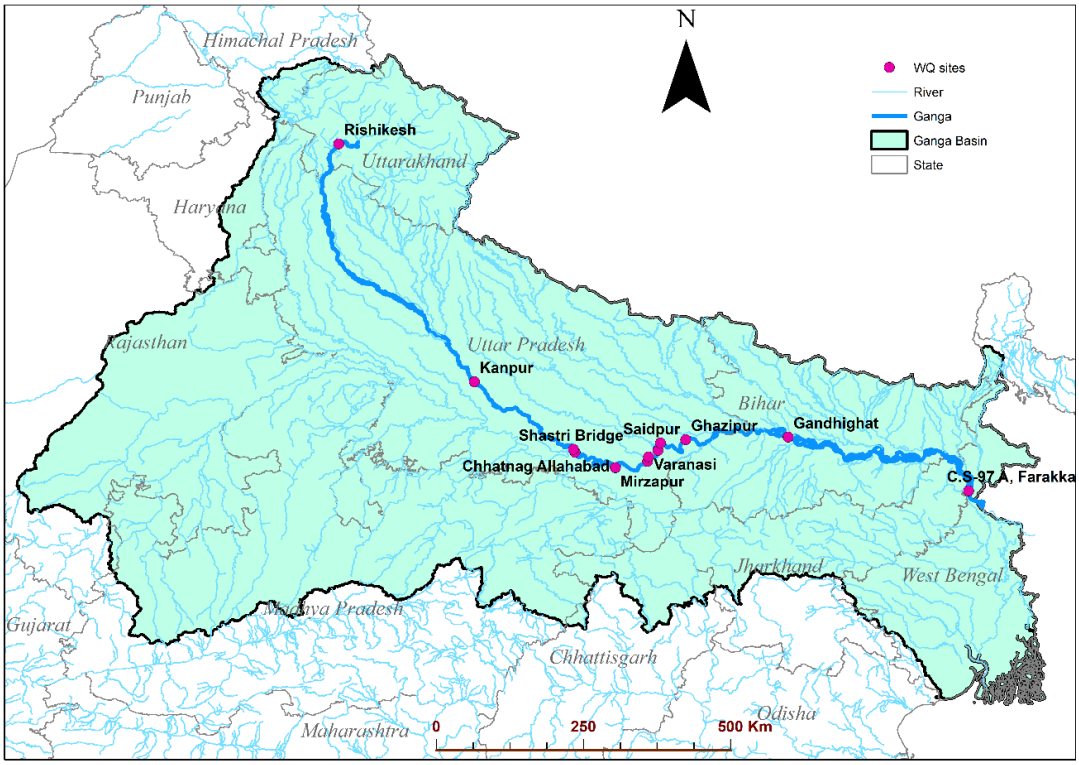

Figure 22: Map showing the water quality sites of River Ganga monitored during lockdown.

Table 25: Status of Water Quality of Ganga River during Lockdown

S.No	Site	State	Water Quality Status							
			pH	DO	BOD	TC	TDS	EC	COD	Cl
1	Rishikesh	Uttarakhand		Improved						
2	Kanpur	Uttar Pradesh		Improved						
3	Shastri Bridge	Uttar Pradesh	Deteriorated	Improved	Improved	Improved		Improved	Improved	Improved
4	Chhatnag Allahabad	Uttar Pradesh	Deteriorated	Improved	Improved	Improved		Improved	Improved	Improved
5	Mirzapur	Uttar Pradesh	Deteriorated	Improved	Improved	Improved		Deteriorated	Deteriorated	Improved
6	V.S. Bridge	Uttar Pradesh	Improved	Improved	Improved	Improved		Deteriorated	Improved	Improved
7	Varanasi	Uttar Pradesh	Deteriorated	Improved	Improved	Improved		Deteriorated	Improved	Improved
8	Baluaghat	Uttar Pradesh	Deteriorated	Improved	Improved	Improved		Deteriorated	Improved	Deteriorated
9	Saidpur	Uttar Pradesh	Deteriorated	Improved	Improved	Improved				
10	Ghazipur	Uttar Pradesh	Deteriorated	Improved	Improved	Improved				
11	Gandhighat	Bihar	Deteriorated	Improved			Improved	Improved		Deteriorated
12	C.S-97 A, Farakka	West Bengal	Improved	Deteriorated	Deteriorated					Deteriorated

River Yamuna: Water Quality of the River Yamuna was monitored at sites Poanta, Kalanaur, Mawi, Delhi rly. Bridge, Mathura gokul barrage, Agra Poiyaghat, Etawaha, Hamirpur and Pratappur sites of Yamuna (Figure 23).

Water quality of the River Yamuna has been improved in terms of D.O. values of river water. It is particularly observed at sites Poanta, Kalanaur, Mawi, Delhi rly. bridge and Mathura gokul barrage Poiyaghat, Etawaha, Hamirpur and Pratappur sites of Yamuna River. The details thereof given in Table 26.

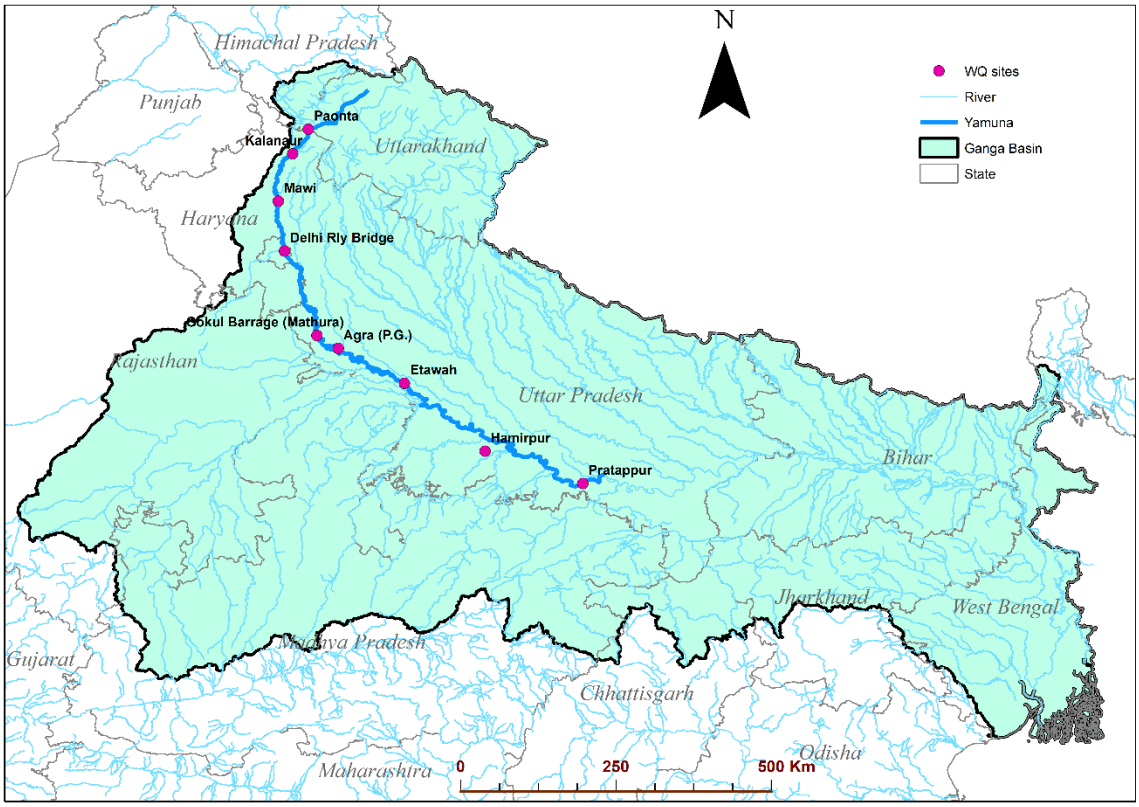

Figure 23: Map showing the water quality sites of River Yamuna monitored during lockdown.

Table 26: Status of Water Quality of Yamuna River during Lockdown

S.NO	Site	State	River	Water Quality Status in terms of DO
1	Paonta	Himachal Pradesh	Yamuna	Improved
2	Kalanaur	Uttar Pradesh	Yamuna	Improved
3	Mawi	Uttar Pradesh	Yamuna	Improved
4	Delhi Rly Bridge	Delhi	Yamuna	Improved
5	Gokul Barrage (Mathura)	Uttar Pradesh	Yamuna	Improved
6	Agra (P.G.)	Uttar Pradesh	Yamuna	Improved
7	Etawah	Uttar Pradesh	Yamuna	Improved
8	Hamirpur	Uttar Pradesh	Yamuna	Improved
9	Pratappur	U.P.	Yamuna	Improved

River Gomti: Water Quality of the River Gomti was monitored at sites Sultanpur and Maighat during the lockdown (Figure 24). The values of DO, BOD and Total Coliform have been improved at sites Maighat and Sultanpur of River Gomti. However, in terms of pH there was not much change. The details thereof given in Table 27.

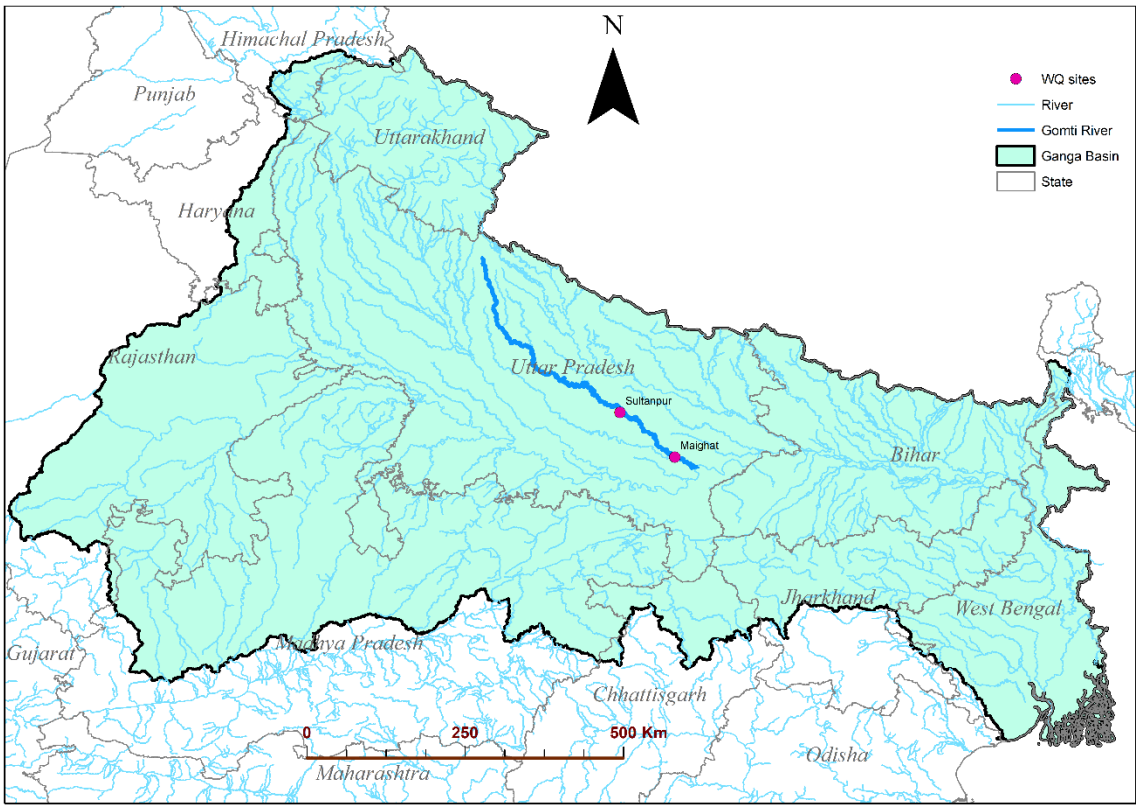

Figure 24: Map showing the water quality sites of River Gomti monitored during lockdown.

Table 27: Status of Water Quality of Gomti River during Lockdown

S.NO	Site	River	Water Quality Status				
			pH	DO	BOD	TC	COD
1	Sultanpur	Gomti	No Change	Improved	Improved	Improved	Deteriorated
2	Maighat	Gomti	Deteriorated	Improved	Improved	Improved	Deteriorated

River Mahananda: Water Quality of the River Mahananda was monitored at sites Noukaghat, Sonapur and Champasari during the lockdown (Figure 25). At Noukaghat site, DO value has a significant increase in lockdown period and EC, Chloride and Alkalinity value has a significant decrease in lockdown period. At Sonapur site, DO value has a significant increase in lockdown period whereas pH, COD and Chloride values have a significant decrease in lockdown period. At Champasari site, DO value has decreased in lockdown period but pH, EC, COD, Alkalinity and Chloride values have a significant improvement in lockdown period. The details thereof given in Table 28.

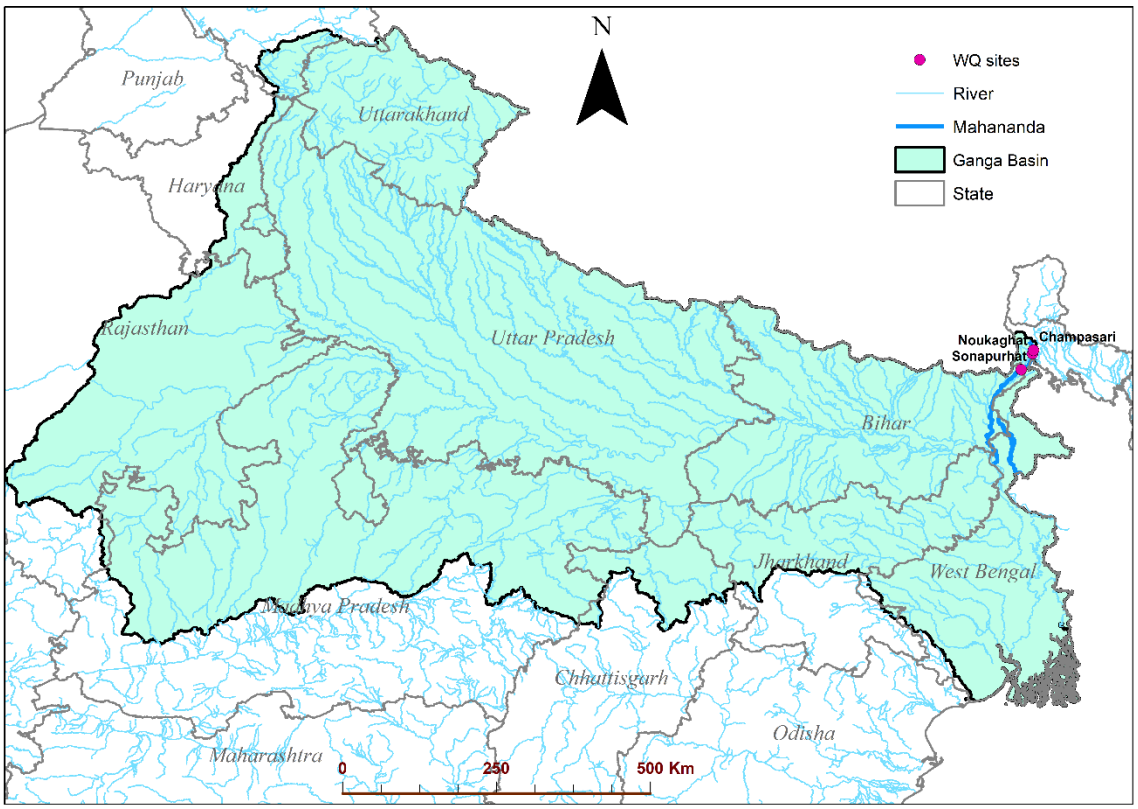

Figure 25: Map showing the water quality sites of River Mahananda monitored during lockdown

Table 28: Status of Water Quality of Mahananda River during Lockdown

S.NO	Site	River	Water Quality Status					
			pH	DO	EC	COD	Cl	Alkalinity
1	Noukaghat	Mahananda	Deteriorated	Improved	Improved	No Change	Improved	Improved
2	Sonapurhat	Mahananda	Improved	Improved	Deteriorated	Improved	Improved	Deteriorated
3	Champasari	Mahananda	Improved	Deteriorated	Improved	Improved	Improved	Improved

River Bhagirathi: Water Quality of the River Bhagirathi was monitored at site Berhampore during the lockdown (Figure 26). Water quality has improved in terms of DO and there is a significant decrease in the value of pH and EC during the lockdown period as compared to the value obtained in the preceding year.

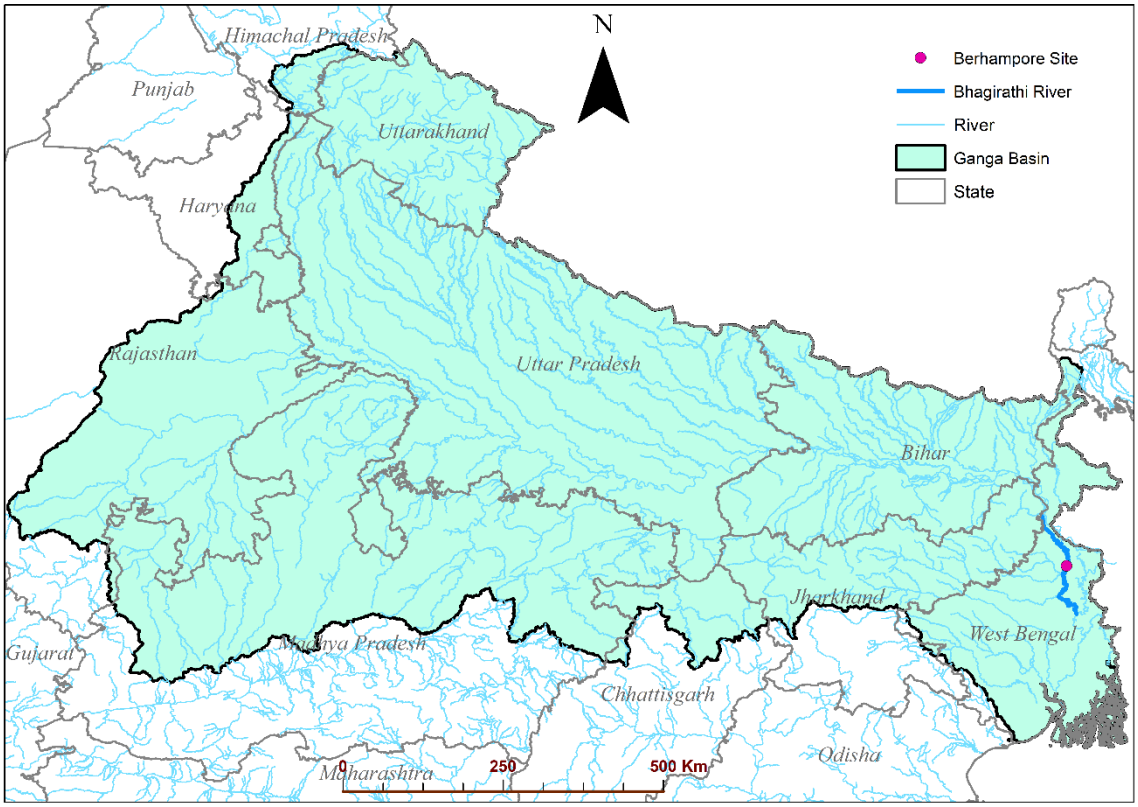

Figure 26: Map showing the water quality sites of River Bhagirathi monitored during lockdown

River Tons: Water Quality of the River Tons was monitored at sites Meja Road and Satna during the lockdown (Figure 27). The values of pH, DO, BOD and Total Coliform have been improved at sites Meja Road and Satna of River Tons. However, the values of COD have been deteriorated. The details thereof given in Table 29.

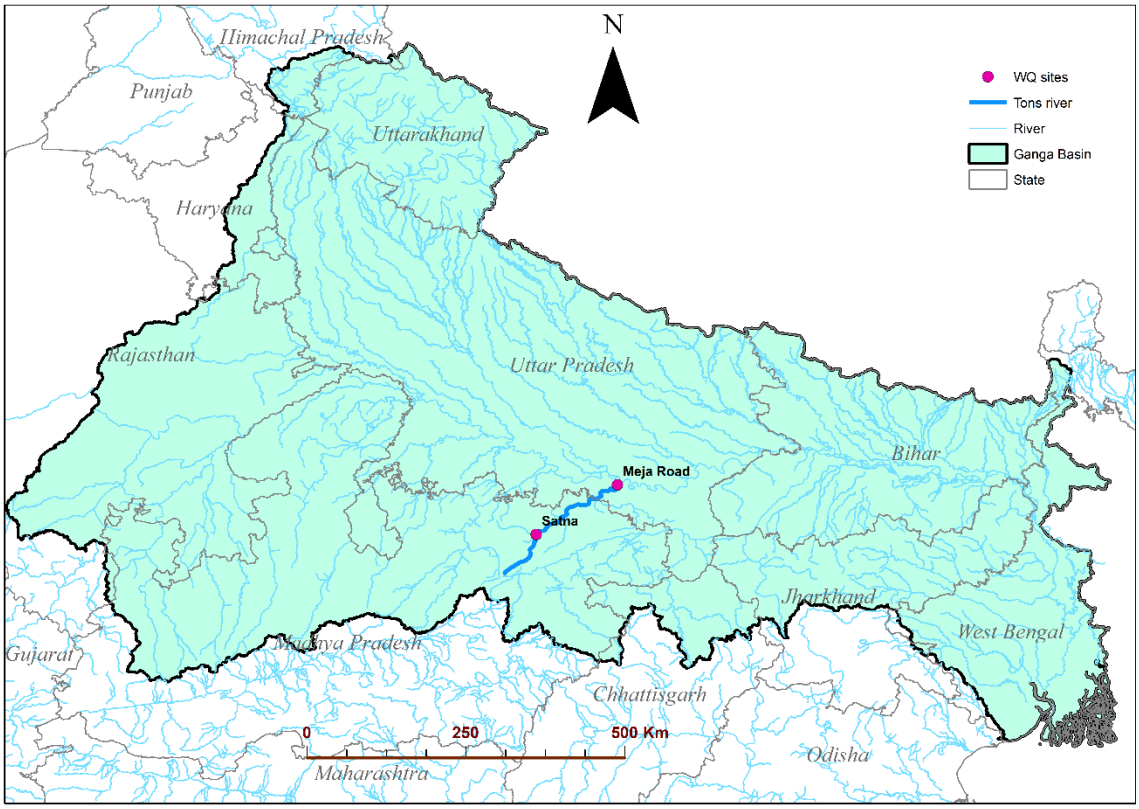

Figure 27: Map showing the water quality sites of River Tons monitored during lockdown.

Table 29: Status of Water Quality of Tons River during Lockdown

S.NO	Site	River	Water Quality Status in terms of				
			pH	DO	BOD	TC	COD
1	Meja Road	Tons	Improved	Improved	Improved	Improved	Deteriorated
2	Satna	Tons	Improved	Improved	Improved	Improved	Deteriorated

River Ghaghara: Water Quality of the River Ghaghara was monitored at site Ayodhya during the lockdown (Figure 28). Water quality of the River Ghaghara has been improved in terms of D.O. values of river water.

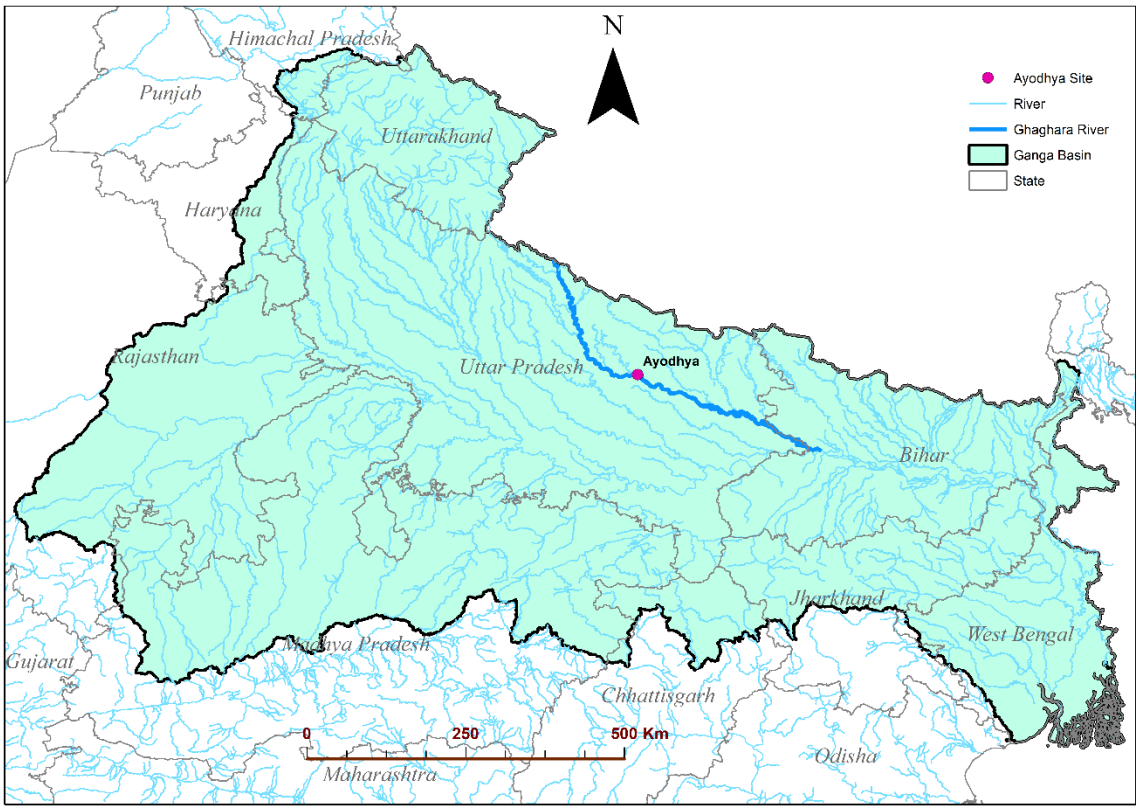

Figure 28: Map showing the water quality sites of River Ghaghara monitored during lockdown.

River Rapti: Water Quality of the River Rapti was monitored at site Birdghat during the lockdown (Figure 29). Water quality of the River Rapti has been improved in terms of D.O. values of river water.

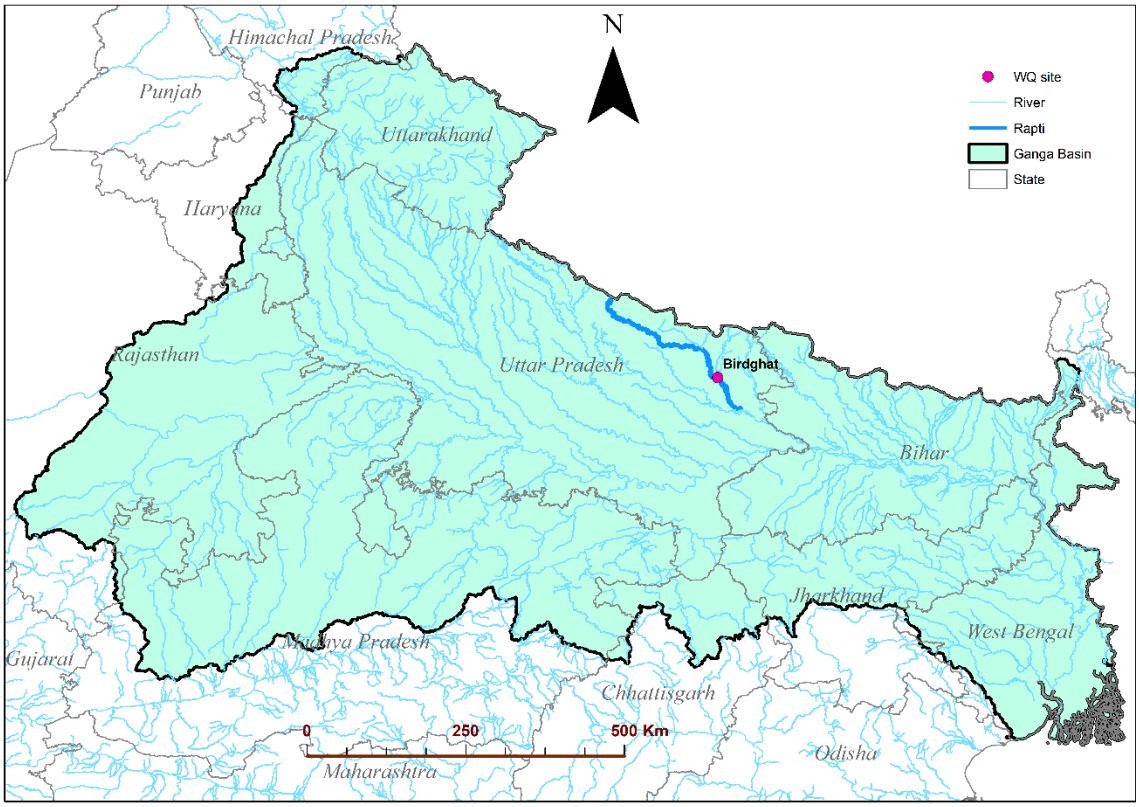

Figure 29: Map showing the water quality sites of River Rapti monitored during lockdown

7.5 Godavari Basin

River Godavari: Water quality of the River Godavari was monitored at sites Perur, Polavaram and Bhadrachalam during the lockdown (Figure 30). Water Quality has improved in terms of Electrical Conductivity (EC) as its value in river water is decreased at Perur, Polavaram and Bhadrachalam sites of Godavari River during lockdown period. In terms of pH, water quality has some positive effect at Bhadrachalam site and Perur site. In terms of DO, water quality has some positive effect only at Bhadrachalam site of River Godavari. The details thereof given in Table 30.

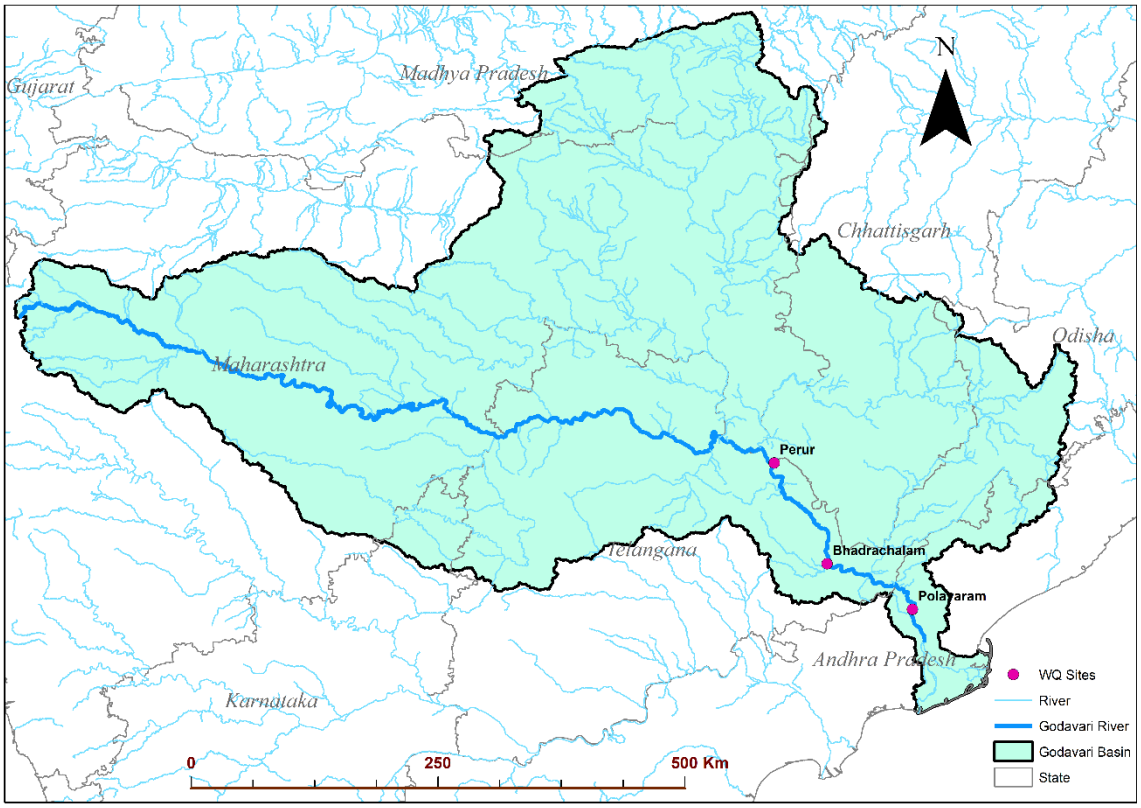

Figure 30: Map showing the water quality sites of River Godavari monitored during lockdown

Table 30: Status of Water Quality of Godavari River during Lockdown

S.No.	Site	River	Water Quality Status in terms of		
			pH	DO	EC
1	Perur	Godavari	Improved	Deteriorated	Improved
2	Bhadrachalam	Godavari	Improved	Improved	Improved
3	Polavaram	Godavari	Deteriorated	Deteriorated	Improved

River Indravati: Water quality of the River Indravati was monitored at sites Jagdalpur and Nowrangpur during the lockdown (Figure 31). The Electrical Conductivity value of river water is decreased at Nowrangpur site of Indravati River while the DO values of river water is increased at Jagdalpur site and Nowrangpur Site. The details thereof given in Table 31.

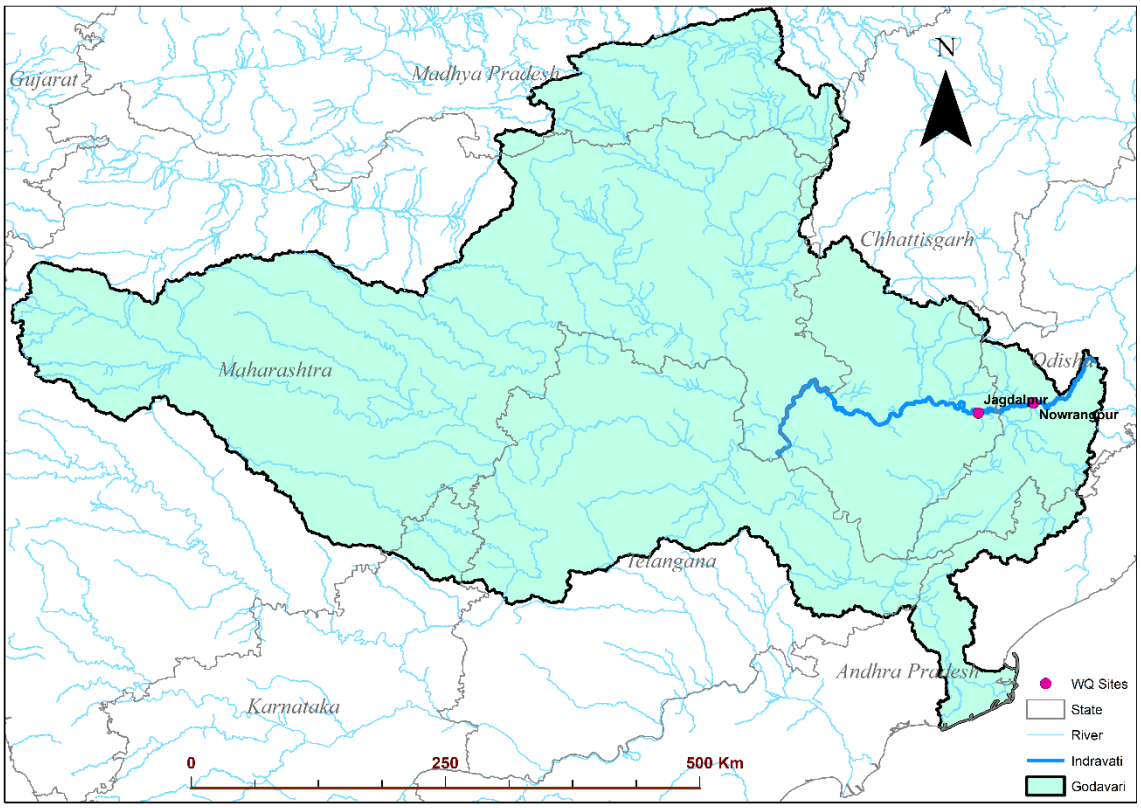

Figure 31: Map showing the water quality sites of River Indravati monitored during lockdown

Table 31: Status of Water Quality of Indravati River during Lockdown

S.No.	Site	River	Water Quality Status in terms of		
			pH	DO	EC
1	Jagdalpur	Godavari/Indravati	Deteriorated	Improved	Deteriorated
2	Nowrangpur	Godavari/Indravati	No Change	Improved	Improved

River Wainganga: Water quality of the River Wainganga was monitored at sites Keolari, Kumhari and Ashti during the lockdown (Figure 32). Water quality has improved in terms of DO at sites Kumhari and Ashti as the values of DO are comparatively higher from value obtained before lockdown. Values of pH and EC has decreased at Ashti site of Wainganga River. The details thereof given in Table 32.

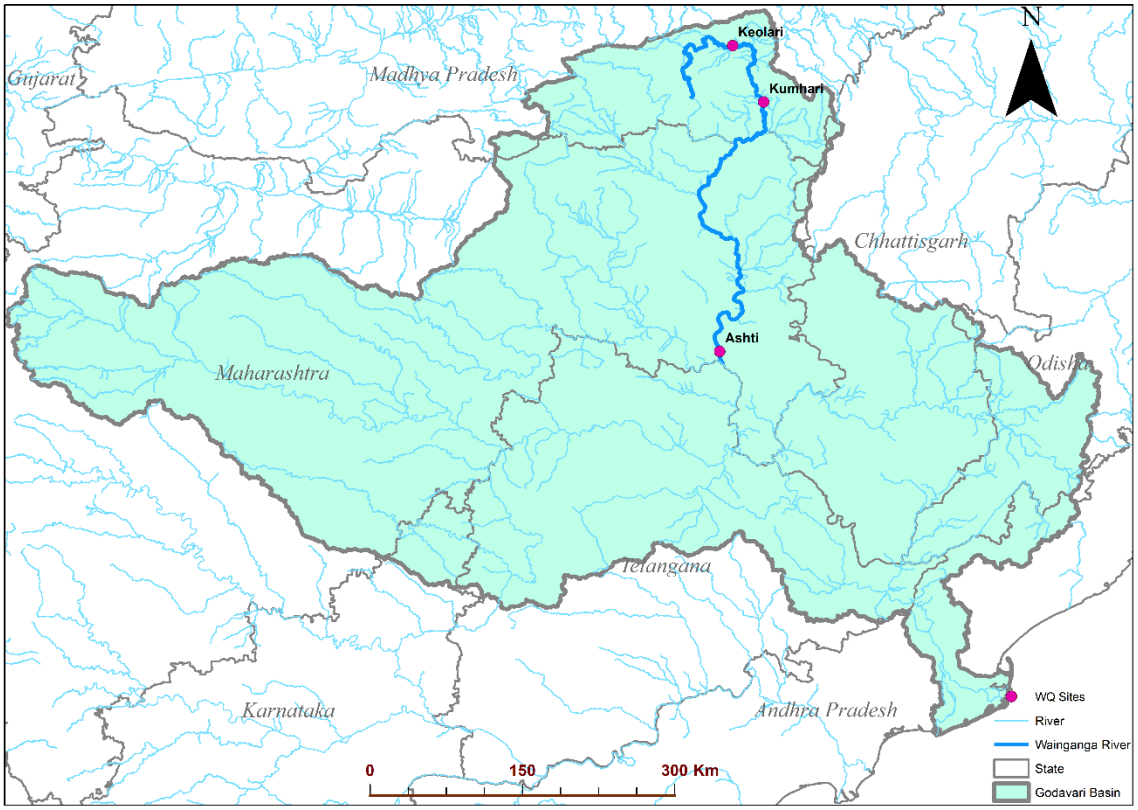

Figure 32: Map showing the water quality sites of River Wainganga monitored during lockdown

Table 32: Status of Water Quality of Wainganga River during Lockdown

S.NO	Site	River	Water Quality Status in terms of		
			pH	DO	EC
1	Keolari	Wainganga	-	-	-
2	Kumhari	Wainganga	Deteriorated	Improved	Deteriorated
3	Ashti	Wainganga	Improved	Improved	Improved

River Wardha: Water quality of the River Wardha was monitored at sites Hivra, Bamni and Sakmur during the lockdown (Figure 33). Water quality has improved in terms of DO at sites Bamni, Sakmur and Hivra as the values of DO are comparatively higher during lockdown from last few years as well as are slightly higher as compared to before lockdown. Values of EC have improved at Bamni and Sakmur sites. The details thereof given in Table 33.

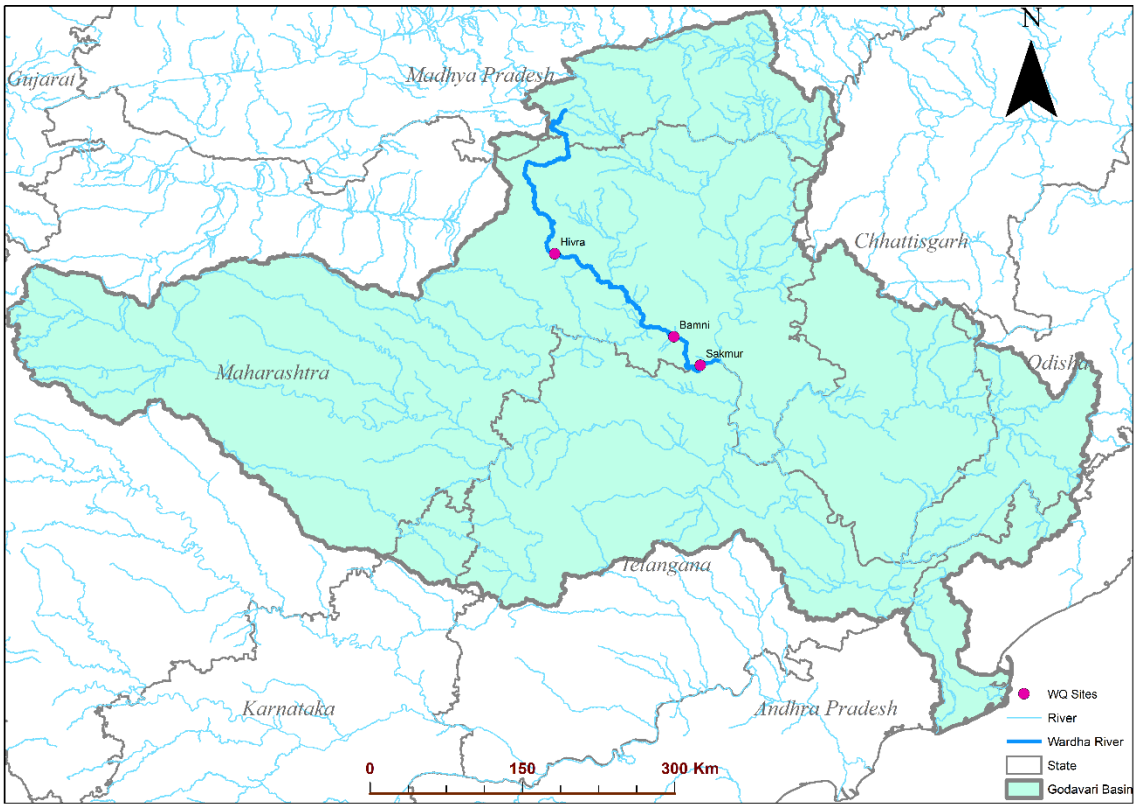

Figure 33: Map showing the water quality sites of River Wardha monitored during lockdown

Table 33: Status of Water Quality of Wardha River during Lockdown

S.NO	Site	River	Water Quality Status in terms of		
			pH	DO	EC
1	Hivra	Wardha	-	Improved	-
2	Bamni	Wardha	Deteriorated	Improved	Improved
3	Sakmur	Wardha	Deteriorated	Improved	Improved

7.6 Indus Basin

River Chenab: Water quality of the River Chenab was monitored at site Akhnoor during the lockdown (Figure 34). Water quality has improved at Akhnoor Site of Chenab River in terms of Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Electrical Conductivity (EC), Chemical Oxygen Demand (COD), Total Hardness and Chloride (Cl). However, in terms of pH there was not much change. The details thereof given in Table 34.

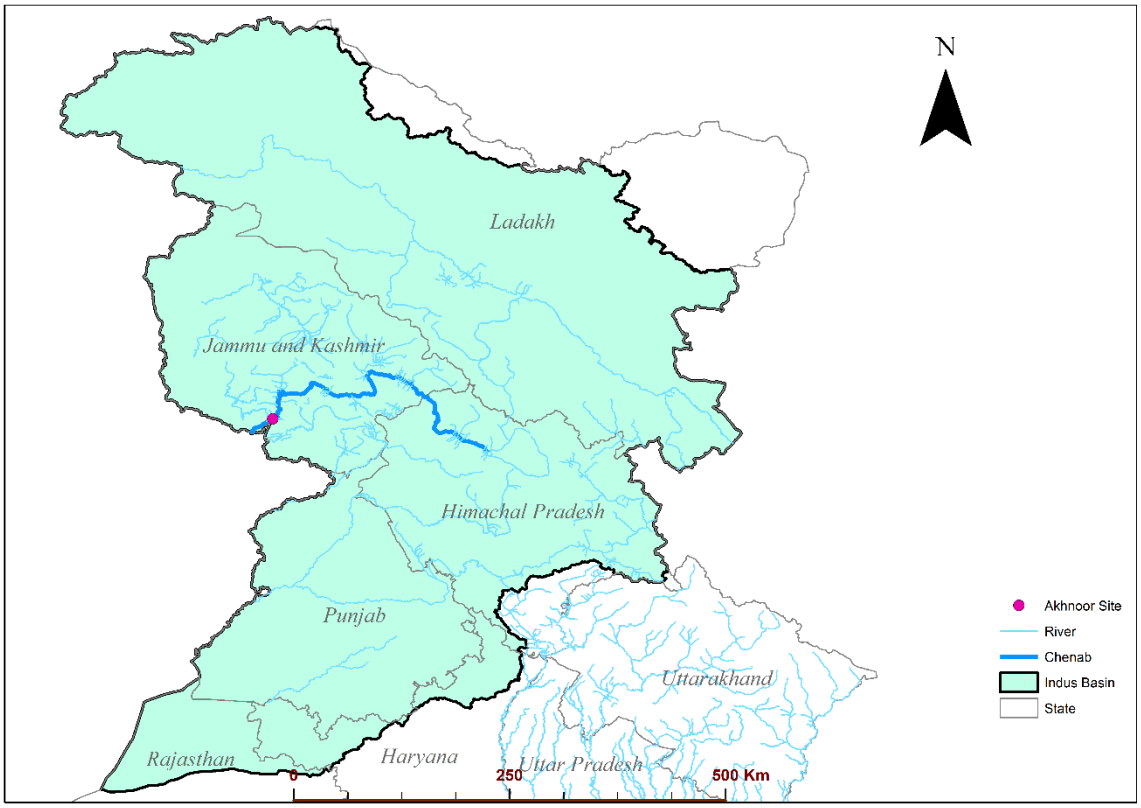

Figure 34: Map showing the water quality sites of River Chenab monitored during lockdown

Table 34: Status of Water Quality of Chenab River during Lockdown

S.No.	Water Quality Status in terms of	Result
1	pH	Deteriorated
2	DO	Improved
3	BOD	Improved
4	EC	Improved
5	COD	Improved
6	Total Hardness	Improved
7	Cl	Improved

River Tawi: Water quality of the River Tawi was monitored at site Jammu during the lockdown (Figure 35). Water quality has improved at Jammu Site of Tawi River in terms of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Chloride (Cl). The details thereof given in Table 35.

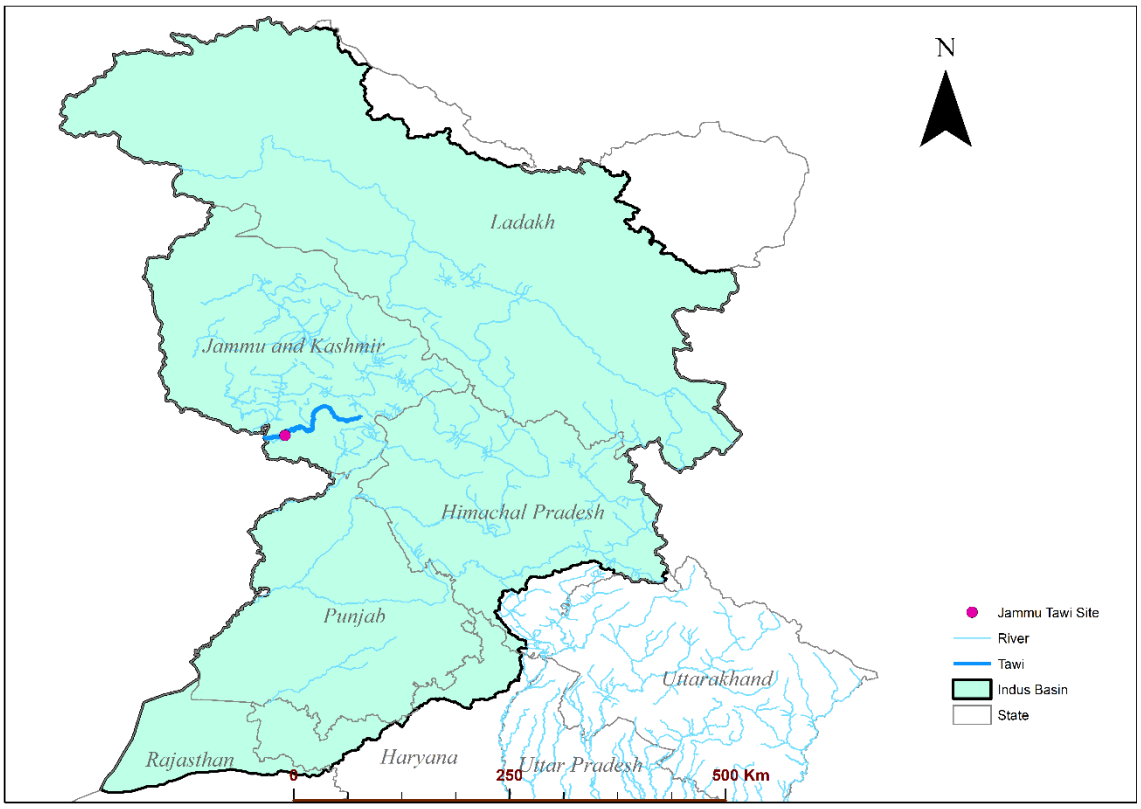

Figure 35: Map showing the water quality sites of River Tawi monitored during lockdown.

Table 35: Status of Water Quality of Tawi River during Lockdown

S.No.	Water Quality Status in terms of	Result
1	pH	Deteriorated
2	DO	Deteriorated
3	BOD	Improved
4	EC	Deteriorated
5	COD	Improved
6	Total Hardness	Deteriorated
7	Cl	Improved

7.7 Krishna Basin

River Krishna: Water quality of the River Krishna was monitored at sites Karad, Arjundwad, Kurundwad Wadenapally and Vijaywada during the lockdown (Figure 36). DO values have been increased in the lockdown period at Karad, Arjundwad and Wadenapally site of Krishna River. However, DO values have been decreased at sites Kurundwad and Vijaywada. Water quality has improved in terms of pH at Arjundwad, Kurundwad, Vijaywada and Wadenapally site. Water quality has improved in terms of Electrical Conductivity (EC) at Karad, Kurunwad, Vijaywada, and Wadenapalli site of Krishna River as its value in river water is decreased in lockdown period. The details thereof given in Table 36.

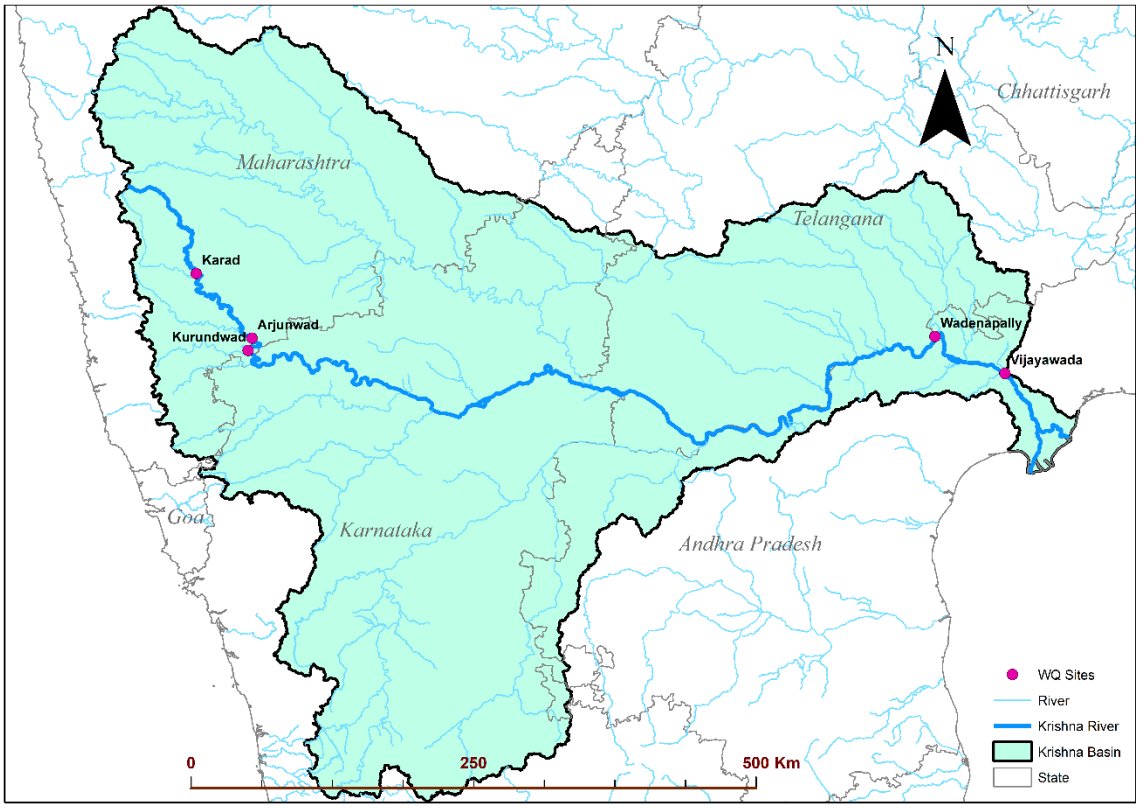

Figure 36: Map showing the water quality sites of River Krishna monitored during lockdown.

Table 36: Status of Water Quality of Krishna River during Lockdown

S.No.	Site	River	Water Quality Status in terms of		
			pH	DO	EC
1	Karad	Krishna	Deteriorated	Improved	Improved
2	Arjunwad	Krishna	Improved	Improved	Deteriorated
3	Kurundwad	Krishna	Improved	Deteriorated	Improved
4	Wadenapally	Krishna	Improved	Improved	Improved
5	Vijayawada	Krishna	Improved	Deteriorated	Improved

River Musi: Water quality of the River Musi was monitored at site Dameracherla (Figure 37). Water quality of River Musi has been improved as Electrical Conductivity value of river water is significantly decreased but there is no significant change in pH values during the lockdown period.

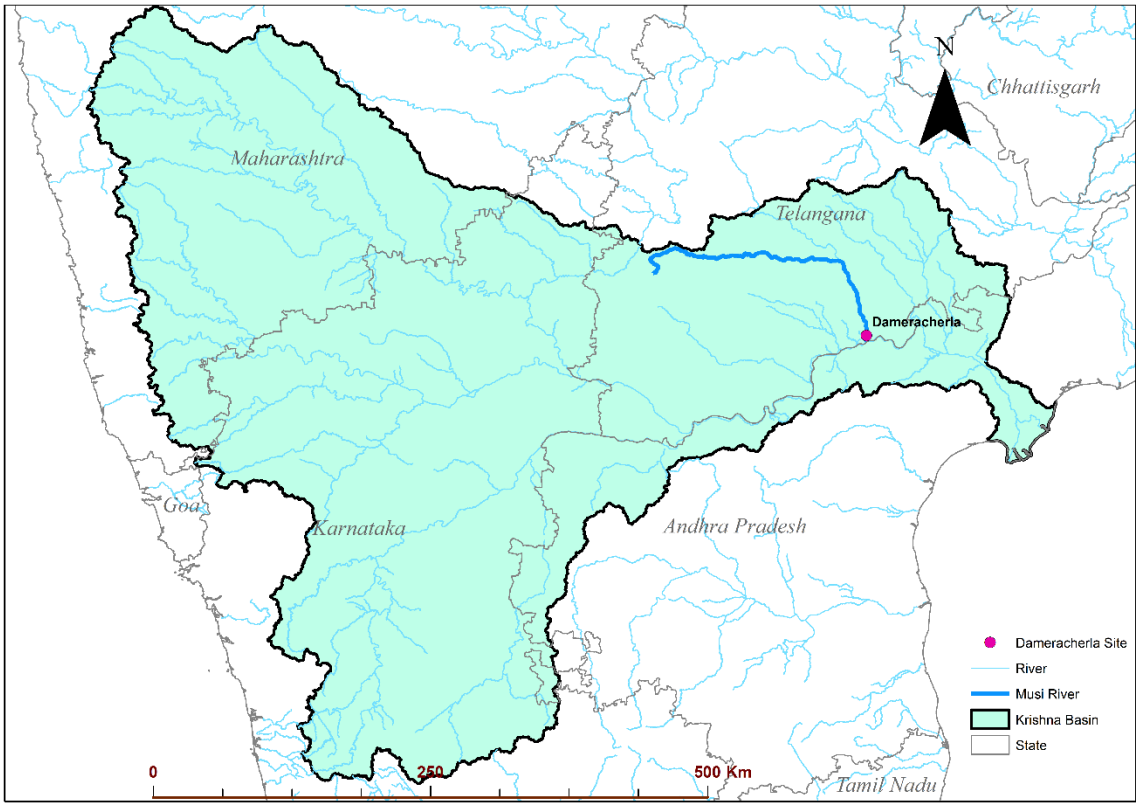

Figure 37: Map showing the water quality sites of River Musi monitored during lockdown.

7.8 Mahi Basin

River Mahi: Water quality of the River Mahi was monitored at sites Mataji, Paderdibadi and Khanpur (Figure 38). Water quality has improved in terms of pH, DO and COD at all three sites of Mahi river as DO values have a significant increase, pH and COD value has a significant decrease. Water quality has improved in terms of Total Dissolved Solids (TDS) and Electrical Conductivity (EC) at Matai and Paderdibadi sites of Mahi River. Chloride values have a slight decrease in lockdown period at Khanpur and Paderdibadi sites. The details thereof given in Table 37.

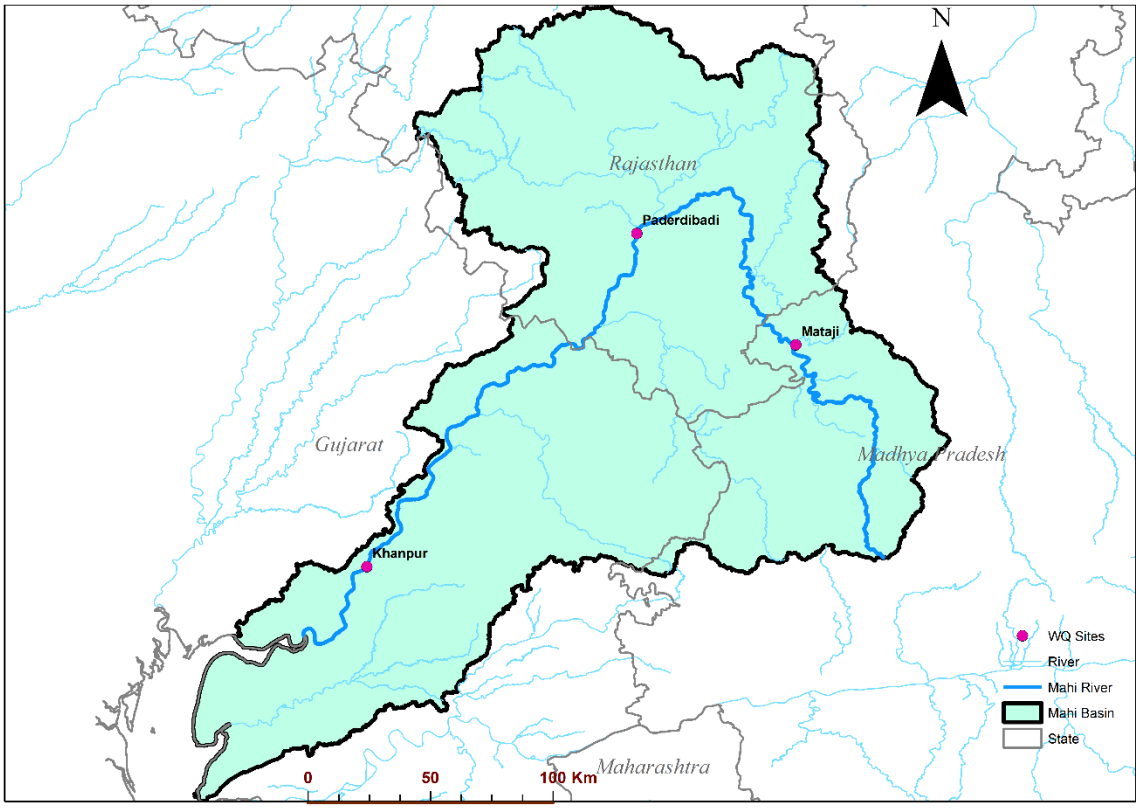

Figure 38: Map showing the water quality sites of River Mahi monitored during lockdown.

Table 37: Status of Water Quality of Mahi River during Lockdown

S.NO	Site	River	Water Quality Status in terms of						
			pH	DO	TDS	EC	COD	Cl	Turbidity
1	Mataji	Mahi	Improved	Improved	Improved	Improved	Improved	No Change	Deteriorated
2	Paderdibadi	Mahi	Improved	Improved	Improved	Improved	Improved	Improved	Deteriorated
3	Khanpur	Mahi	Improved	Improved	Deteriorated	Deteriorated	Improved	Improved	Deteriorated

7.9 Mahanadi Basin

River Mahanadi: Water quality of the River Mahanadi was monitored at site Basantpur during the lockdown (Figure 39). Water quality has considerably improved at Basantpur in terms of EC but value of pH has no significant change.

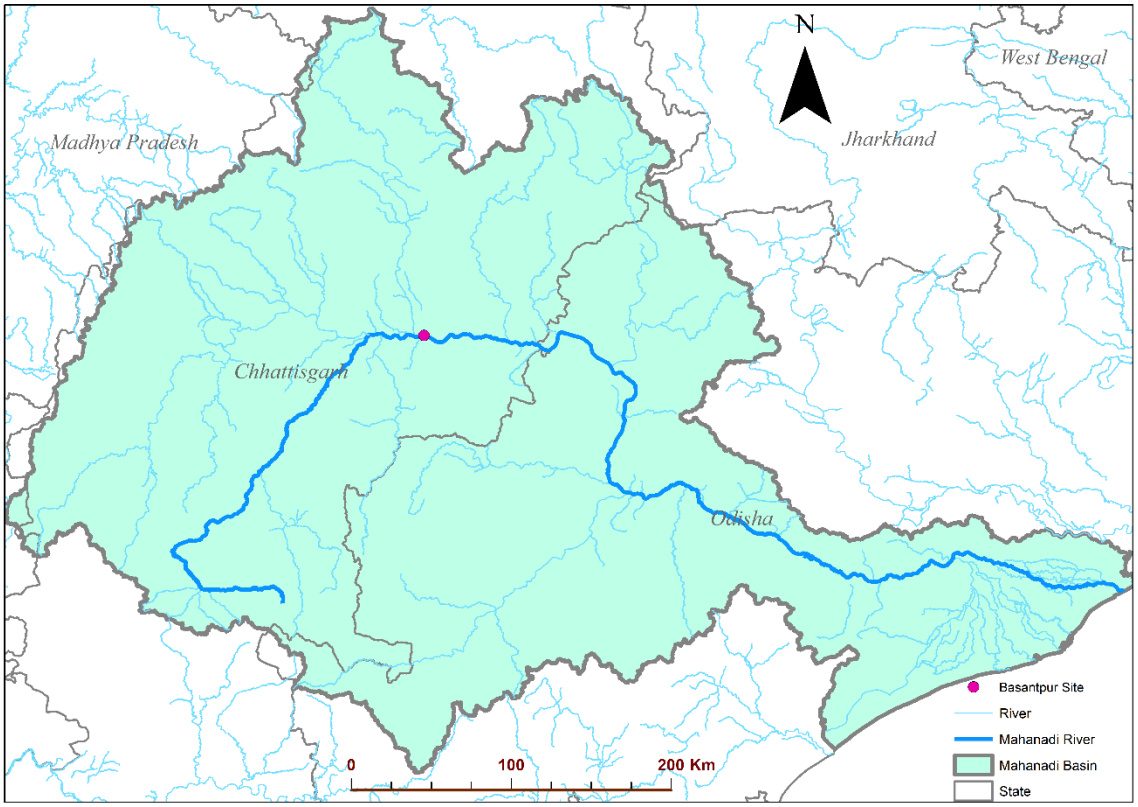

Figure 39: Map showing the water quality sites of River Mahanadi monitored during lockdown.

7.10 Narmada Basin

River Narmada: Water quality of the River Narmada was monitored at site Hoshangabad during the lockdown (Figure 40). Comparing the last 10 years average data of site Hoshangabad at the start of May with the data observed during lockdown; the value of DO has increased significantly, the values of pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total hardness, Alkalinity and Biochemical Oxygen Demand (BOD) have improved and the turbidity reported nil which indicates that river water is clearer.

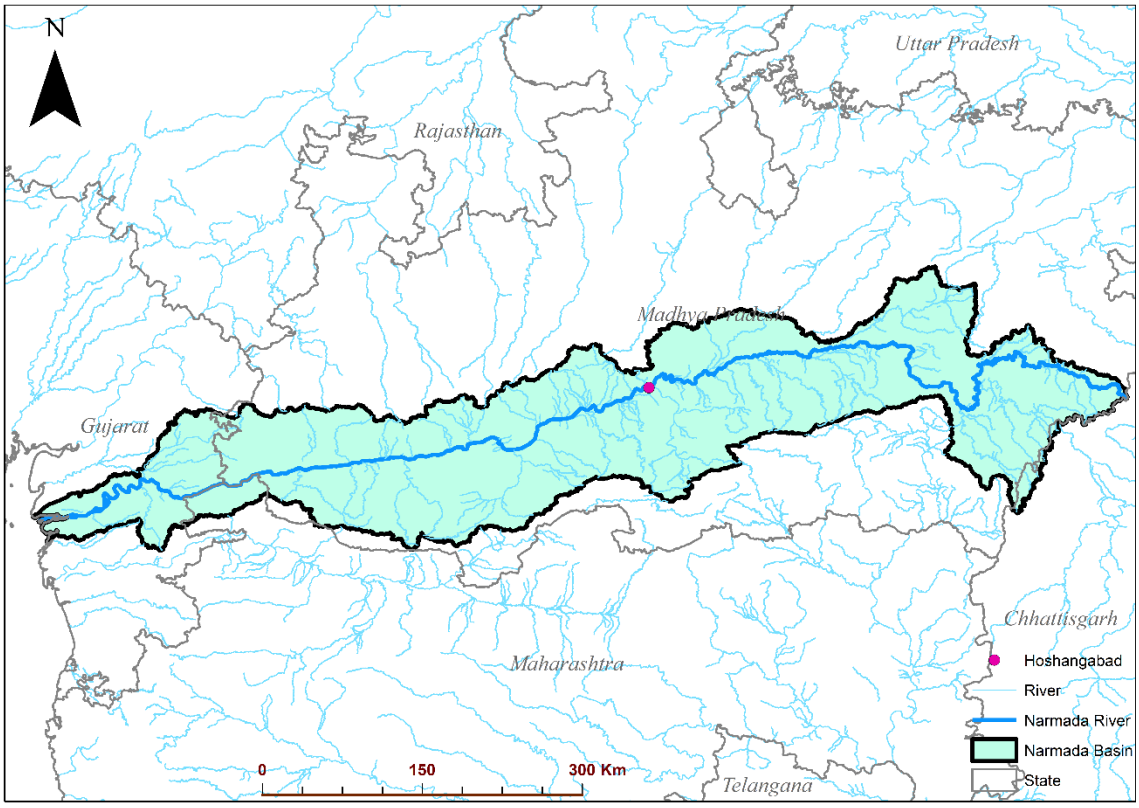

Figure 40: Map showing the water quality sites of River Narmada monitored during lockdown.

7.11 West flowing rivers from Tadri to Kanyakumari Basin

River Periyar: Water quality of the River Periyar was monitored at site Neeleswaram during the lockdown (Figure 41). Water quality has slightly improved in terms of pH, Dissolved Oxygen (DO), BOD, Electrical Conductivity (EC), Total Hardness and Alkalinity.

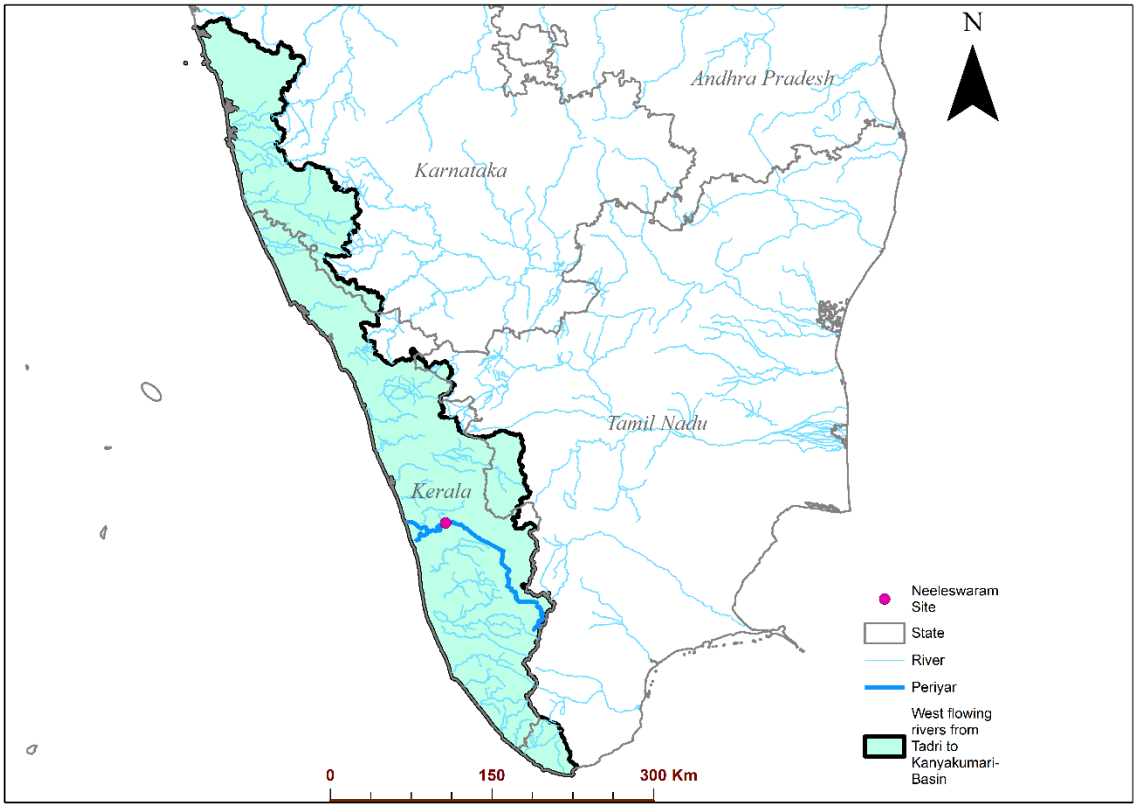

Figure 41: Map showing the water quality sites of River Periyar monitored during lockdown.

7.12 Sabarmati Basin

River Sabarmati: Water quality of the River Sabarmati was monitored at site Vautha during the lockdown (Figure 42). Water Quality has improved significantly in terms of Electrical Conductivity (EC), Chemical Oxygen Demand (COD), Chloride and Turbidity. Values of DO, pH and TDS also show the improvement.

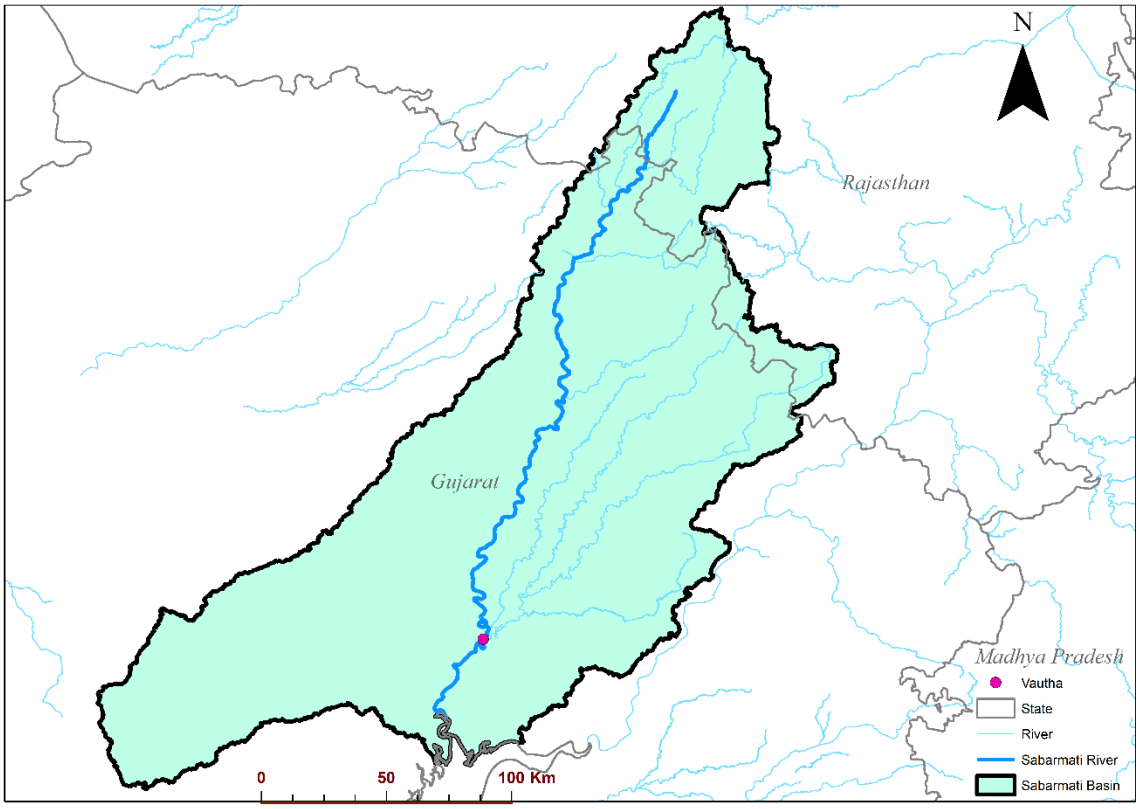

Figure 42: Map showing the water quality sites of River Sabarmati monitored during lockdown

7.13 Subarnarekha Basin

River Subarnarekha: Water quality of the River Subarnarekha was monitored at site Jamshedpur, Muri, Ghatsila and Jamsholaghat during the lockdown (Figure 43). pH and EC parameters were monitored during lockdown, however no appreciable changes in water quality of river were observed.

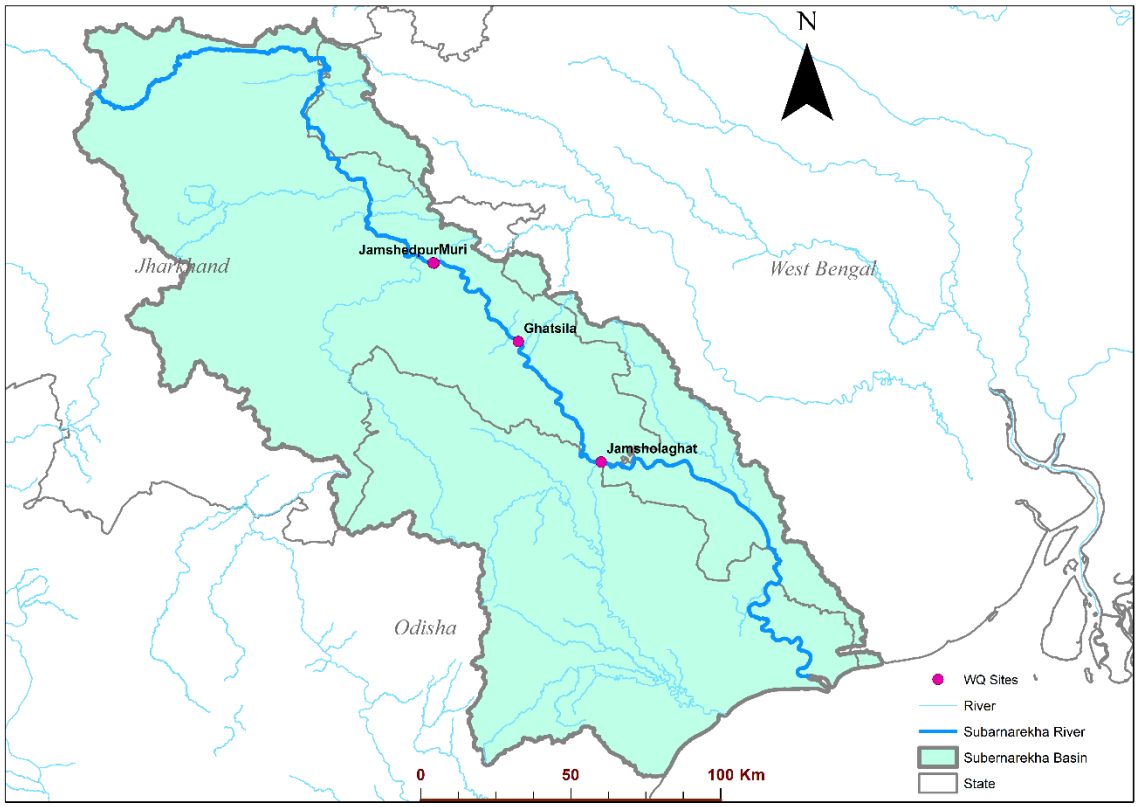

Figure 43: Map showing the water quality sites of River Subarnarekha monitored during lockdown.

Table 38: Status of Water Quality of Subarnarekha River during Lockdown

S.No	Site	River	Water Quality Status	
			pH	EC
1	Jamshedpur	Subarnarekha	Deteriorated	Improved
2	Muri	Subarnarekha	Deteriorated	Deteriorated
3	Ghatsila	Subarnarekha	Improved	Deteriorated
4	Jamsholaghat	Subarnarekha	-	Improved

8. Conclusion

In the lockdown period, Central Water Commission (CWC) has monitored Water Quality (WQ) of rivers at 128 key locations covering major river basins in India. As per analysis of WQ data for these 128 stations for the lockdown period; it was found that out of 96 stations, the values of Dissolved Oxygen (DO) at 77 stations are comparatively improved during the lockdown period as compared to the pre lockdown values. Similarly, water quality has considerably improved at 28 stations out of 34 stations in terms of Biochemical Oxygen Demand (BOD). The values of Total Coliform at 24 stations out of 26 stations have a significant decrease. Chemical Oxygen Demand (COD) values have a significant decrease in lockdown period at 23 WQ sites out of 37.

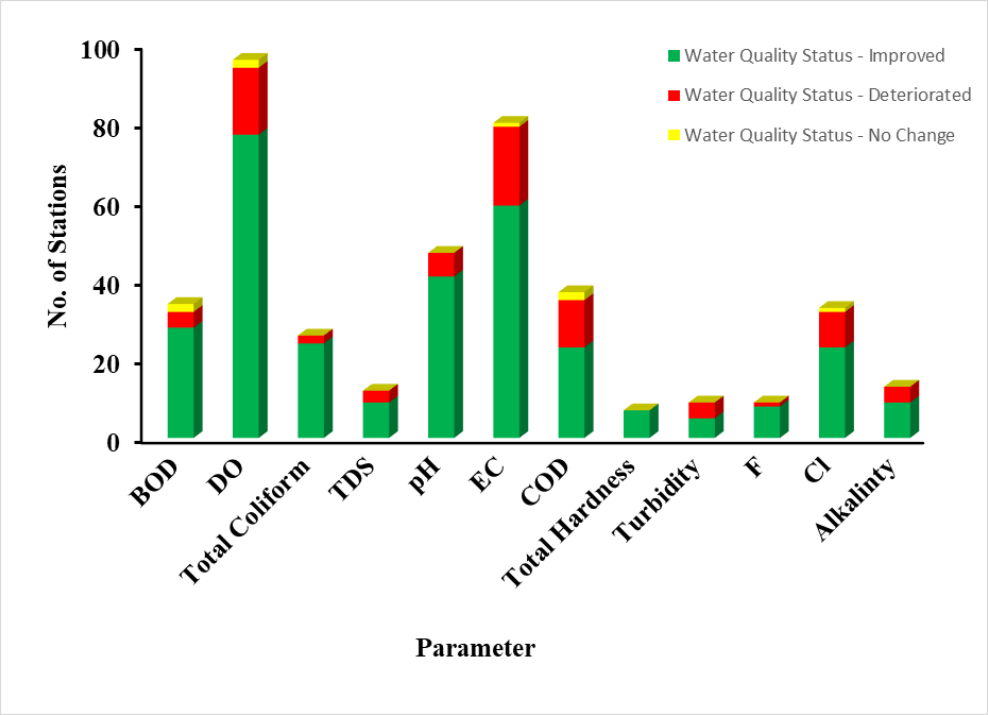

Figure 44: Graph showing the overall water quality status.

Further, out of 47 locations the values of pH were improved at 41 locations. Electrical Conductivity have a significant decrease at 59 locations out of 80 in lockdown period and there is a considerable decrease in the value of Total Dissolved Solids (TDS) at 9 WQ sites out of

12 sites during the lockdown period. There is a considerable decrease in turbidity value at 5 locations out of 9 which indicates that the water is clearer.

The values of Fluoride have improved at 8 locations out of 9 and the values of Chloride have a significant decrease at 23 locations out of 33 in lockdown period. At 7 locations value of Total hardness were improved while alkalinity values improved at 9 locations out of 13 during the lockdown. The analysis of WQ data for these various stations during the lockdown period is summarized in Figure 44 and Table 39.

Table 39: Overall status of water quality during Lockdown

Parameter	Total No. of Stations	Water Quality Status			% of Stations Reported Improved WQ
		Improved	Deteriorated	No Change	
BOD	34	28	4	2	82.35
DO	96	77	17	2	80.21
Total Coliform	26	24	2	0	92.31
TDS	12	9	3	0	75.00
pH	47	41	6	0	87.23
EC	80	59	20	1	73.75
COD	37	23	12	2	62.16
Total Hardness	7	7	0	0	100.00
Turbidity	9	5	4	0	55.56
F	9	8	1	0	88.89
Cl	33	23	9	1	69.70
Alkalinty	13	9	4	0	69.23

As per CPCB water quality criteria as *Class-A* Drinking Water Source without conventional treatment but after disinfection; *Class-B* Outdoor bathing (Organized) and *Class-C* Drinking water source after conventional treatment and disinfection; four parameters namely pH, DO,

BOD and Total Coliform were analysed for lockdown period which shows a considerable overall improvement for DO, BOD and Total Coliform (Figure 45).

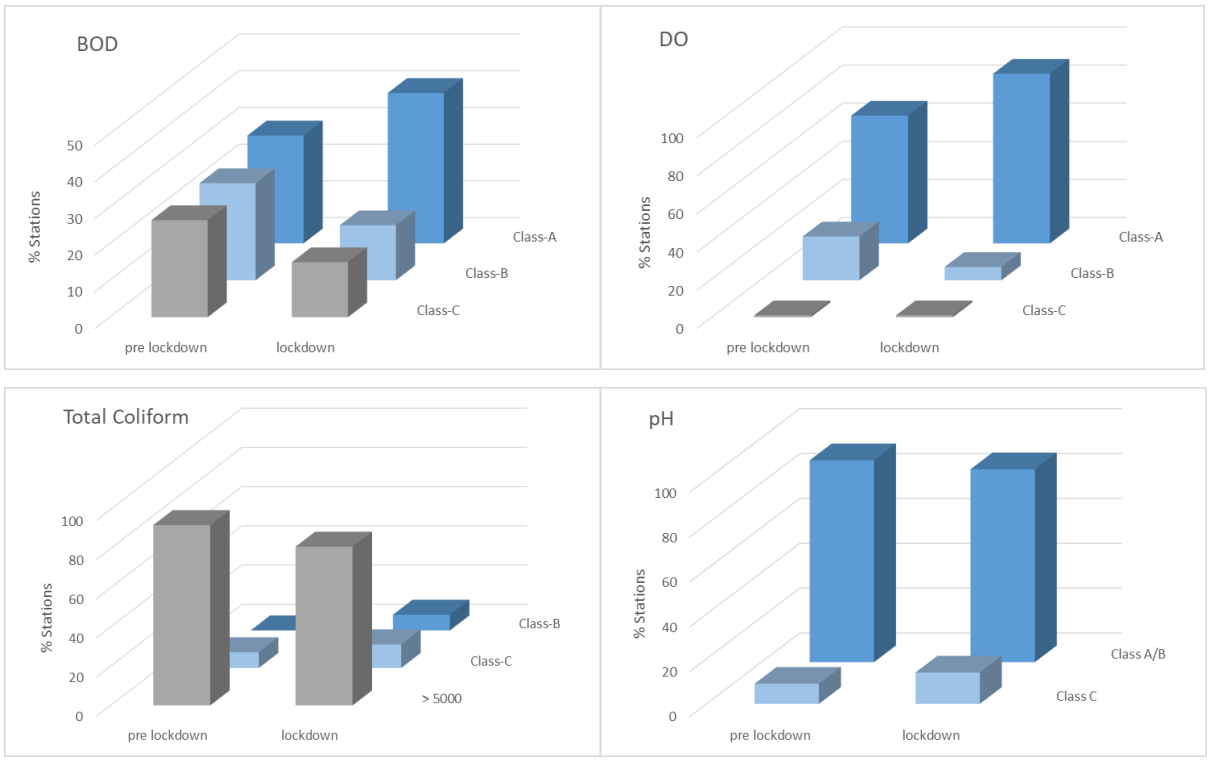

Figure 45: Graphs showing analysis results as per CPCB standards for Designated Best Use (For D and E class, there is no limits specified for DO, BOD and Total Coliform).

The shutting down of the industries that discharge effluents in rivers and lack of anthropogenic activity due to nationwide lockdown has had a positive effect on water quality of Indian Rivers at most of the places. However, water quality is deteriorated at some locations which may be attributed to discharge of untreated or partially treated sewage due to the improper functioning of STPs in view of closure of almost all working places during nationwide lockdown.

Further, Central Water Commission (CWC) has also monitored Gauge & Discharge (GD) at 57 locations covering major river basins during lockdown. Out of 57 GD sites, there was no significant changes in water level and discharge at 48 sites on Indian River. However, it was also concluded that remaining 8 GD sites shown increase in water level and discharge due to unseasonal rainfall that was observed in some parts of India during lockdown period.

9. Way Forward

It is known that water quality of the Indian rivers has been adversely affected by human activities and also by unregulated enormous discharge of industrial waste waters into riverine system. The effluent discharge from the industry in localized areas due to this water pollution is creating situations which are dangerous to health of human and aquatic life. Effective and efficient implementation of water pollution control laws and regulations should be promoted. Effluent released from industries should be treated chemically and biologically before it finds its way into Rivers. There is an urgent need for stringent policy and monitoring for effluents discharged from agriculture and industry into rivers.

In scenarios such as nationwide lockdown when the decision-making process requires immediate interpretation of water quality data, sensor-based system becomes a necessity for collecting data instantaneously for real-time water quality monitoring of Rivers. The sensor-based system may be implemented as a supplement to our lab-based system.

10. References

1. Times of India “how-lockdown-has-been-a-gift-for-river-ganga”- article-75569852
2. India Today “coronavirus-lockdown-India-fresh-air-clean-rivers” article 1669726
3. India Today “lockdown impact ganga water in Haridwar becomes fit to drink after decades” -1669576-2020-04-22
4. The Hindu “lockdown due to covid-19 how our waterbodies are cleaner”-article 31518267
5. Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring - Second Edition © 1992, 1996 UNESCO/WHO/UNEP ISBN 0 419 21590 5 (HB) 0 419 21600 6 (PB).
6. A Report on Impact of Lockdown on Water Quality of River Ganga, CPCB, APRIL 2020.
7. Assessment of Impact of Lockdown on Water Quality of Major Rivers, CPCB, SEP-2020.
8. IoT Based Real-time River Water Quality Monitoring System, Procedia Computer Science, Volume 155, 2019, Pages 161-168.
9. Real-Time Water Quality Monitoring with Chemical Sensors, Sensors 2020, *20*(12), 3432.
10. CPCB Guidelines Water Quality Monitoring-2017
11. CWC, Field Water Analysis Manual- January, 2020

Annexure I

Water Quality Laboratories in CWC

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

Annexure II

Water Quality parameters analysed by CWC in Level-I, II and III laboratories

S. No	Level-1	Level-II	Level-III
1	Temperature	Temperature	Temperature
2	Color	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		Ammonia (Nitrogen)	Ammonia (Nitrogen)
20		Nitrate	Nitrate
21		Nitrite	Nitrite
22		Phosphate	Phosphate
23		Silicate	Silicate
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			Alpha Endosulphan, Beta Endosulphan,
38			Aldrin, Dieldrin,
39			Carbaryl (Carbamate),
40			Malathian, Methyl Parathian,
41			Anilophos, Chloropyriphos

Contribution

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11. Shri Ashok Kumar Trivedi, ARO, UMGWQL, Varansai
12. Shri P. Rajan, ARO, Hydrology division, Chennai
13. Shri Shishupal, ARO MGD-1, Lucknow
14. Mrs. Priyadharsini, ARO, SRD, Coimbatore
15. Shri K.P.Gireendran, ARO, Mahi Division, Gandhinagar
16. Shri Tanmoy Kar, ARO, Tapi Division, Surat
17. Shri Kamalesh Pal, SRA, LBD, Jalpaiguri.
18. Shri Abhijit Nandan, SRA, LBD, Jalpaiguri.
19. Shri Yash Kumar, SRA, UMGWQL, Varansai
20. Shri Ajay Kumar Singh, SRA, UMGWQL, Varansai
21. Smt. Madhuri Saroj, SRA, UMGWQL, Varansai
22. Shri Abhishek Kumar, SRA, UMGWQL, Varansai
23. Shri Kotagiri Sasidhar, SRA, SWRD, Kochi
24. Shri Atmakuru Janardhan, SRA SWRD, Kochi
25. Shri Angad Kumar, SRA, Chenab Division, Jammu
26. Shri Shashikant Meena, SRA, LYWQL, Agra
27. Shri Vasu Dhanavath, SRA, LYWQL, Agra
28. Shri Ankit Kumar Maurya, SRA, Narmada Division, Bhopal
29. Shri Saileswar Nayek, SRA, Mahanadi Division, Burla
30. Shri Anup Kumar Sharma, SRA, Mahanadi Division, Burla
31. Shri A.K Behera, SRA, ERWQL Bhubaneswar
32. Shri Maneesh T P, SRA, SRD, Coimbatore

33. Shri Burri .lagadecsh Yadav, SRA, SRD, Coimbatore
34. Shri Srikanth Reddy Alla, SRA, SRD, Coimbatore
35. Shri Rajat Sharma, SRA, MGD-1, Lucknow
36. Shri Utsa Sen, SRA, Mahi Division, Gandhinagar
37. Mrs. Shikha Sharma, SRA, Mahi Division, Gandhinagar
38. Miss Malika Kumar, SRA, Tapi Division, Surat
39. Shri Vinit Kumar Sharma, SRA, Tapi Division, Surat
40. Shri Rishabh Pachouri, SRA, Kanpur site, MGD-1, Lucknow
41. Smt. Ponung Taki, SDE, NEID-III Itanagar
42. Shri D. K. Jawale, Extra Assistant Director, Narmada Division, Bhopal
43. Shri Siddhatha Riccharia, JE, Lower Wainganga Sub Division, Chandrapur
44. Shri Sumit Kumar Sharma, JE, Wardha Sub Division, Chandrapur
45. Shri Deepak Kumar, JE, Penganga Sub Division, Yavatmal
46. Shri Neelesh Pawer, JE, Upper Waingangā Sub Division, Nagpur
47. Shri Deepak Kumar, JE, UYD, Delhi
48. Shri Kuldeep, JE, UYD, Delhi
49. Shri Lokender Kumar, JE, UYD, Delhi
50. Shri Rituraj, JE, UYD, Delhi
51. Shri Vimal Kishore, JE, NEID-II, Aizawl
52. Shri Arpit Srivastava, JE, NEID-II, Aizawl
53. Shri Avinash Kumar, JE/NEID-III, Itanagar
54. Shri J. C. Sahu, JE, UTUM Sub-Division, Siliguri.
55. Shri Kannadasan, JE, CD, Bengaluru
56. Shri Pankaj Goyal, JE, Chenab Division, Jammu
57. Shri Amit Kumar, JE, Chenab Division, Jammu.
58. Shri Reshma Sunil, JE, Neeleshwaram, SWRD, Kochi
59. Shri Khushi Ram Meena, JE, Etawah, LYD, Agra
60. Shri Nishant, JE, Pratappur, LYD, Agra
61. Shri Sandeep Singh, JE, Hamirpur, LYD, Agra
62. Shri Devendra Meena, JE, Banda, LYD, Agra
63. Shri Kuldeep, JE, Auraiya, LYD, Agra
64. Shri Bhagirathi, JE, Agra (Poiya Ghat), LYD, Agra
65. Shri Harikesh Meena, JE, Dholpur, LYD, Agra
66. Shri Vikalp Sharma, JE, Narmada division, Bhopal

67. Shri Ekamsh Patidar, JE, Narmada Division, Bhopal
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70. Shri J. C. Sahu, JE, UTUM Sub-Division, Siliguri.
71. Shri Vinit Kumar Sharma, Junior Engineer, Narmada Division, Bhopal
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75. Shri Raj Nath Ram, Obr.Gr. D, MD, Burla
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79. Shri Jaswant Singh, Work Sarkar, Gr. II
80. Shri Virender Singh, Work Sarkar, Gr. II
81. Shri Suresh Kumar, Work Sarkar, Gr II
82. Shri Jogeswar Singh, W/S-II, ERD, Bhubaneshwar
83. Shri Kashiram Dewangan, MTS, MD, Burla
84. Shri Santosh Kumar Bargah, MTS, MD, Burla
85. Shri Shibu Vaidya, SWA, NEID-II, Aizawl
86. Shri D C Basavaraj, SWA, CD, Bengaluru
87. Shri Suresh Rai, SWA, Ramamangalam, SWRD, Kochi
88. Shri Pradeep Kumar, SWA, Kalampur, SWRD, Kochi
89. Shri Nithin Babu, SWA, Arangaly, SWRD, Kochi
90. Shri Manoj Kumar Sinha, SWA, CD, Bengaluru
91. Shri Prabhudayal, SWA, Narmada division, Bhopal
92. Shri Boudh Prasad Katel, SWA, Narmada Division, Bhopal
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94. Shri D Satyawarti, SWA, MD, Burla
95. Shri Davinder Singh, SWA, MD, Burla
96. Shri Raj Kumar Tamboli, SWA, MD, Burla
97. Shri Manharan Dhimar, SWA, MD, Burla
98. Shri Bapu Sanjay Charoskar, SWA, MD, Burla
99. Shri Gorelal Vastrakar, SWA, MD, Burla
100. Shri Ram Hari Kaiwartya, SWA, MD, Burla

101. Shri G.B. Dip, SWA, MD, Burla
102. Shri D.C. Mahaling, SWA, MD, Burla
103. Shri S K Gajpal, SWA, MD, Burla
104. Shri Rajen Soren, SWA, ERD, Bhubaneshwar
105. Shri Bharat Majhi, SWA, ERD, Bhubaneshwar
106. Shri Harmohan Rout, SWA, ERD, Bhubaneshwar
107. Shri Bikram Majhi, SWA, ERD, Bhubaneshwar
108. Shri Sanjay Kumar, SWA, Ayodhya, MGD-1, Lucknow
109. Shri Vijay Pal Singh, SWA, UYD, Delhi
110. Shri S.D. Unniyal, SWA, UYCR, Dehradun
111. Shri Suraj Pal Meena, SWA, UYCR, Dehradun