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Assessment of Impact of Lockdown on Water Quality of Major Rivers

CENTRAL POLLUTION CONTROL BOARD
Ministry of Environment, Forest & Climate Change
Parivesh Bhawan, East Arjun Nagar
DELHI-110032

Website : www.cpcb.nic.in

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पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार
CENTRAL POLLUTION CONTROL BOARD
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FOREWORD

On 24th March 2020, Government of India (GoI) has imposed a nationwide lockdown as a preventive measure and to restrict contagion's spread against the COVID-19 pandemic and further extended the lockdown. During lockdown period, movement of public, transportation, commercial and industrial activities have been restricted strictly. The lockdown had a positive impact on the environment. Few rivers are able rejuvenate naturally to some extent in view of no industrial wastewater discharge, mass bathing, disposal of puja materials, washing of clothes or cattles, closing of hotels/restaurants and non-operation of other commercial centres, places of worship, etc.

In order to assess the water quality of all major rivers, Central Pollution Control Board (CPCB) conducted sampling in association with State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs). A comparative assessment of water quality in 19 major rivers during pre-lockdown (March 2020) and during lockdown (April 2020) were carried out w.r.t parameters such as pH, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO) and Faecal Coliform (FC) at the locations being monitored under National Water Quality Monitoring Programme (NWMP). The analysis of collected samples revealed improvement in terms of reduced organic pollution and increased saturation level in case of few rivers, however, bacterial load continued to be predominant especially along the urban centres due to continued flow of treated/partially treated sewage. Overall a marginal improvement was observed in water quality of the monitored major rivers.

The Co-operation extended by State Pollution Control Boards (SPCBs), Pollution Control Committees (PCCs) in this endeavour is appreciated. Special efforts made by my colleagues in the Board specially Shri J. Chandra Babu, Scientist 'E', Shri A. Sudhakar, DH, WQM-I; Mrs. Suniti Parashar, Sc 'C'; and officials of WQM-I Division. Contribution of other officials involved in preparation of this report directly or indirectly under overall supervision of Dr. Prashant Gargava, Member Secretary, CPCB is also acknowledged.

I wish this report will be useful to the concerned stakeholders and readers. This report is also expected to help in taking suitable policy decisions towards restoration of wholesome of all water bodies in the Country.

(Shiv Das Meena)

Dated : 18.09.2020

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ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
CPCB	-	Central Pollution Control Board
CWC	-	Central Water Commission
DO	-	Dissolved Oxygen
FC	-	Fecal Coliform
GoI	-	Government of India
GPI	-	Grossly Polluting Industries
Km	-	Kilometre
MLD	-	Million Litres per day
MoEF & CC	-	Ministry of Environment, Forest and Climate Change
NABL	-	National Accreditation Board for Testing and Calibration Laboratories
NWMP	-	National Water Quality Monitoring Programme
PCCs	-	Pollution Control Committees
RTWQMS	-	Real Time Water Quality Monitoring Station
SPCBs	-	State Pollution Control Boards
TPD	-	Tonnes per day
WHO	-	World Health Organisation

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EXECUTIVE SUMMARY

Government of India (GoI) had imposed a nationwide lockdown since midnight of 24th March 2020 as a preventive measure to restrict contagion's spread against the Coronavirus (COVID-19) infections and thereafter extended further. During the lockdown period, human activities were restricted and most of the activities came to stand still. In view of the restrictions on industrial operations, industrial discharges reduced to minimum in most of the areas. Central Pollution Control Board (CPCB) requested SPCBs/PCCs to assess the water quality of 19 major rivers (viz., Beas, Brahmaputra, Baitarani & Brahmani, Cauvery, Chambal, Ganga, Ghaggar, Godavari, Krishna, Mahanadi, Mahi, Narmada, Pennar, Sabarmati, Sutlej, Swarnarekha, Tapi, Yamuna) at the existing monitoring locations under National Water Quality Monitoring Programme (NWMP), with a view to (i) study the impact of lockdown on water quality of major rivers due to restriction of activities in the country, (ii) compare the water quality of major rivers during pre-lockdown (March 2020) and lockdown period (April 2020), and (iii) assess water quality of major rivers for compliance to the parameters prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Accordingly, 20 State Pollution Control Boards (SPCBs) have participated in the assessment and collected water samples from 19 major rivers and analyzed the collected water samples for the parameters viz. pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Fecal Coliform (FC) and the results were compared with the Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Rules, 1986. *Major constraints while carrying out sampling by the SPCBs/PCCs is that all the existing monitoring locations under NWMP could not be monitored due to movement restrictions during lockdown.*

During the pre-lockdown period (March 2020), SPCBs have collected samples from 387 monitoring locations and 365 number of samples from the monitoring locations during lockdown (April 2020) and collected samples were analysed for the critical parameters. *During pre-lockdown (March 2020),* the analysis results revealed that 351 out of 387 monitored locations for DO, 375 monitored locations for pH, 315 monitored locations for BOD and 324 monitored locations for FC complied with Primary Water Quality Criteria for Outdoor Bathing. In summary, 299 out of 387 monitored locations complied (77.26 %) with criteria parameters listed under the Primary Water Quality Criteria for Outdoor Bathing. *During lockdown (April 2020),* The analysis of results showed that 331 out of 365 monitored locations for DO, 355 monitored locations for pH, 298 monitored locations for BOD and 299 monitored locations for FC are complying with the outdoor bathing water quality criteria. It was observed that 277 out of 365 monitored locations in April 2020 complied (75.89 %) with Primary Water Quality Criteria for Outdoor Bathing, which implies that there is no significant improvement in water quality of major rivers monitored in the country, during the lockdown period

Overall Observations on 19 Major Rivers Monitored during Pre-lockdown (March 2020) and Lockdown Period (April 2020): -

- Four rivers viz., Baitarani, Mahanadi, Narmada and Pennar showed 100 % compliance with the Primary Water Quality Criteria for Outdoor Bathing during Pre-lockdown and lockdown period.

- River Ghaggar failed to comply with the Primary Water Quality Criteria for Outdoor Bathing during Pre-lockdown and lockdown period.

- Water quality of two rivers viz., Sabarmati (55.6 %) and Mahi (92.9 %) remains unchanged in terms of compliance to Primary Water Quality Criteria for Outdoor Bathing during pre-lockdown and lockdown.

- Improvement in water quality w.r.t Primary Water Quality Criteria for Outdoor Bathing was noticed in case of 7 rivers viz., Brahmani (increase in compliance to the bathing criteria limits from 85 % to 100%), Brahmaputra (enhancement in compliance to the criteria limits from 87.5 % to 100 %), Cauvery (marginal improvement from 90.5 % to 96.97 %) , Godavari (increase in compliance from 65.8 % to 78.4 %), Krishna (improvement in compliance from 84.6 % to 94.4 %), Tapi (improved compliance from 77.8 % to 87.5 %) and Yamuna (increase in compliance from 42.8 % to 66.67 %) which may be attributed to (i) Minimal industrial effluent discharges in view of closure of almost all industries. (ii) No human activities involving disposal of worshipped puja materials and garbage. (iii) No anthropogenic activities such as outdoor bathing, washing of clothes, vehicle washing and cattle washing, no pilgrimage activities etc. during lockdown phase and (iv) The cattle movement was also reduced considerably reducing biological contamination of surface water bodies.

- Water quality has not improved during the lock down period in case of five rivers viz., Beas (reduced from 100 % to 95.45 %), Chambal (reduced compliance to the criteria limits from 75 % to 46.15 %), Ganga (reduced compliance to the criteria limits from 64.6 % to 46.2 %), Sutlej (reduction in % compliance from 87.1 to 78.3%) and Swarnarekha (reduction in % compliance from 80 % to 53.33 %) which may be attributed to (i) discharge of untreated or partially treated sewage; (ii) pollutant concentrations are usually at their highest levels due to negligible dry season flow; and (iii) no fresh water discharges from the upstream.

- Cent percent compliance was observed during lockdown w.r.t Primary Water Quality Criteria for Outdoor Bathing in case of 6 rivers (viz., river Baitarani, Brahmani, Brahmaputra, Mahanadi, Narmada and Pennar) which may be attributed to availability of adequate infrastructure for management of sewage in the catchment of the respective river bodies and might had adequate dilution.

C O N T E N T S

1 Introduction

1.1 Background

The COVID-19 global pandemic, caused by the novel coronavirus, is considered to be one of the most virulent diseases to have afflicted humankind. According to World Health Organisation (WHO), SARS-CoV-2 virus cases were first detected in December 2019, in China's Hubei province, subsequently declared as a Public Health Emergency of International Concern. With infections rising swiftly and no vaccine/treatment formulated, most nations had called for immediate and widespread lockdowns to curb the virus transmission. Government of India (GoI) had similarly imposed a nationwide lockdown since midnight of 24th March 2020 as a preventive measure to restrict contagion's spread against the Coronavirus (COVID-19) infections after a Janata Curfew on March 22, 2020 in the country. Initial period of lockdown was declared during the period 25th March 2020 to 14th April 2020 and extended further. During the lockdown period, human activities were restricted and most of the activities came to stand still. In view of the restrictions on industrial operations, industrial discharges expected to be reduced to minimum in most of the areas. Also, lockdown period offered a unique situation to carryout assessment of water quality of surface water bodies including major rivers in the Country as it provides an opportunity to re-comprehend and redesign existing frameworks and put in place robust mechanism to cleanse identified polluted river stretches. Therefore, Central Pollution Control Board (CPCB) in association with the State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs) have made an attempt for assessment of impact of lockdown on water quality of major rivers.

1.2 Objective

Main objectives of the study are (i) to study the impact of lockdown on water quality of major rivers due to restriction of activities in the country, (ii) to compare the water quality of major rivers during pre-lockdown (March 2020) and lockdown period (April 2020), and (iii) to assess water quality of major rivers for compliance to the parameters prescribed under Primary Water Quality Criteria for Outdoor Bathing.

1.3 Methodology and the Constraints

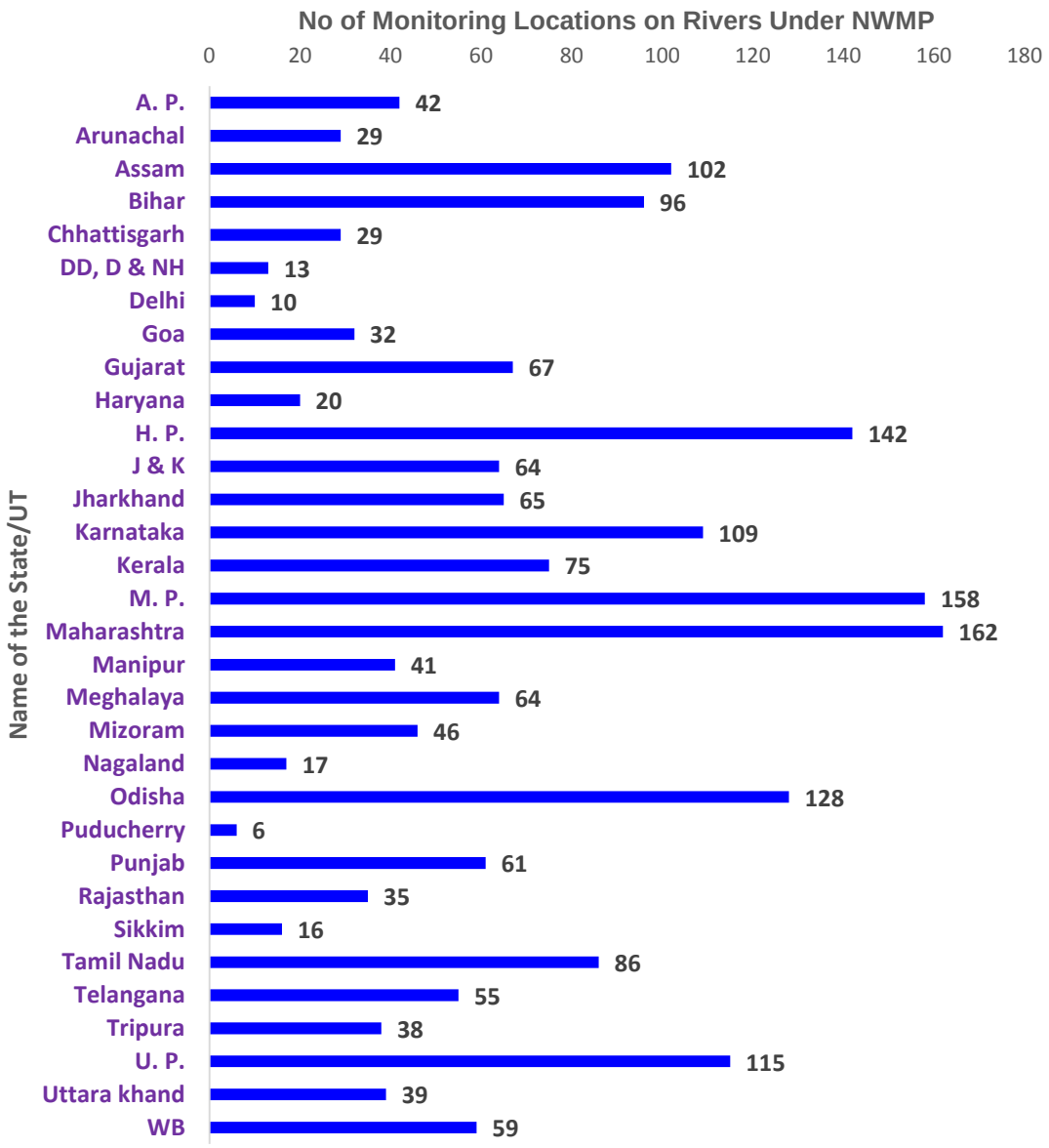
Central Pollution Control Board (CPCB) in association with SPCBs/PCCs has established a Water Quality Monitoring Network across the country

[called National Water Quality Monitoring Programme (NWMP)] with a view to prepare strategies including plans and requisite policies for prevention and control of water pollution. Present water quality monitoring network comprises 4111 locations which include surface and groundwater in 28 States and 8 Union Territories. Among these, 2021 locations are monitored on rivers under NWMP. The monitoring is carried out with a frequency of monthly, quarterly, half yearly and yearly basis depending on the type of water body, seasons and the location. State-wise and water body- wise water quality monitoring locations under NWMP is given at **Table 1.1.** State-wise distribution of water quality monitoring stations under NWMP is given at **Figure 1.1**

Table 1.1. State-wise Distribution of Water Quality Monitoring Locations under NWMP

Name of the State/UT	Rivers	GW	Lakes	Ponds	Tanks	Canals	Drains	STP	WTP	Creek/ Marine/ Sea/ Coastal Waters	TOTAL
Andhra Pradesh	42	33	3		1	6	4	1		11	101
Arunachal	29										29
Assam	102	64	6	27	1						200
Bihar	96	70	3	2							171
Chandigarh		7	1				3				11
Chhattisgarh	29	8	1	1							39
DD & DNH	13	12									25
Delhi	10	45	4			2	9		6		76
Goa	32	10	9			3		2		11	67
Gujarat	67	89	20	2	1	3		2		3	187
Haryana	20	29	3	1		14	1		3		71
Himachal Pradesh	142	49	5				23				219
Jammu and Kashmir	64	23	36				1				124
Jharkhand	65	3	4	4							76
Karnataka	109	2	80		95		1				287
Kerala	75	34	16	2		3		1			131
Lakshadweep		42		3							45
Madhya Pradesh	158	54	22	12	1						247
Maharashtra	162	50					10			34	256
Manipur	41	10	5	13		1					70
Meghalaya	64	13	7								84
Mizoram	46	26	1	2	1						76
Nagaland	17	10	2								29
Odisha	128	90	7	8		9	4	3		4	253
Puducherry	6	22	3								31
Punjab	61	46	3	3			9	8			130
Rajasthan	35	141	17	1		5					199
Sikkim	16							3			19
Tamil Nadu	86	22	8		1		5	16		5	143
Telangana	55	45	50	13	37		13	11			224
Tripura	38	57	8	10		7					120
Uttar Pradesh	115	40	2	2		1			2		162
Uttarakhand	39	19	2			4		3			67
West Bengal	59	68	13			2					142
TOTAL	**2021**	**1233**	**341**	**106**	**138**	**60**	**83**	**50**	**11**	**68**	**4111**

Figure 1.1 State-wise Distribution of River Water Quality Monitoring Locations under NWMP



In order to assess impact on water quality of major rivers due to lockdown, Central Pollution Control Board (CPCB) vide letter dated 09.04.2020 requested State Pollution Control Boards (SPCBs)/ Pollution Control Committees (PCCs) to carryout water quality of all major rivers **(Figure 1.2)** at the existing monitoring locations under NWMP and for further analysis of the collected samples in accordance with the Guidelines for Water Quality Monitoring, 2017 (GWQM, 2017) issued by Ministry of Environment, Forest and Climate Change (MoEF&CC).

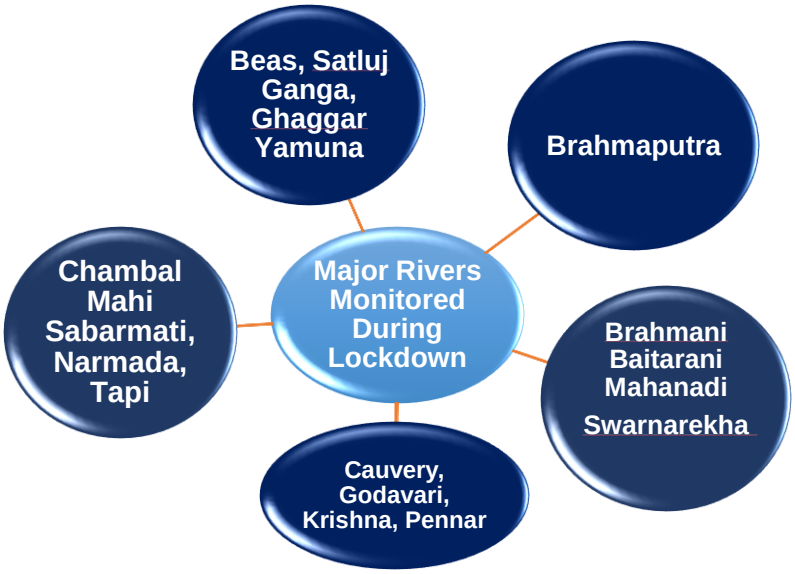


Figure 1.2. Major Rivers Monitored during Lockdown

SPCBs/PCCs have carried out analysis of collected water samples at laboratories of respective SPCBs/PCCs or National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited or laboratories approved under the Environment (Protection) Act, 1986. Analysis results received from SPCBs/PCCs till first week of June 2020 have been considered and prepared this report. Analysis results of March 2020 data (Pre-lockdown) are compared with April 2020 (lockdown) water quality data of all the monitored rivers. The critical water quality parameters viz. pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Fecal Coliform (FC) results were compared with the Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Rules, 1986 (**Annexure - I**).

Major constraints in carrying out sampling by the SPCBs/PCCs includes all the existing monitoring locations under NWMP could not be monitored due to movement restrictions during lockdown. Also, SPCBs/PCCs, generally do not monitor flow details under NWMP, therefore, this study is confined to comparison of water quality during the lockdown period (April 2020) with the pre-lockdown period (March 2020) to assess percent variation or increasing or decreasing trend in water quality only for bathing criteria parameters such as pH, DO, BOD and FC (excluding Fecal Streptococci) and also to assess compliance status with the Primary Water Quality Criteria for Outdoor Bathing notified under Environment (Protection) Amendment Rules, 2000. River-wise samples collected, water quality observed during pre-lockdown (March 2020) and lockdown period (April 2020), number of sampling locations complying with the Primary Water Quality Criteria for Outdoor Bathing, location-wise and parameter-wise variation or increasing or decreasing trend in water quality and other related details are given in subsequent paras of the report.

2 Impact of Lockdown on Water Quality of River Beas

2.1 About Beas River

The River Beas (Figure 2.1) originates from Beas Kund, near Rohtang Pass, on the southern end of the Pir Panjal Range of District Kullu in Himachal Pradesh (HP) and traverse a distance of 245 km in HP and merge with the river Sutlej at Harike Pattan, south of Amritsar, Punjab after traversing a total distance of 470 km.

Facts at a Glance

Major Towns *on the River Beas are Manali, Kullu, Shamshi, Bhunter in Himachal Pradesh State & Amritsar in Punjab.*

Major Districts *are Mandi. Hamirpur in HP State and Kapurthala, Gurdaspur & Hoshiarpur in Punjab State.*

Major Tributaries *of the Beas River are Bain, Banganga, Luni and Uhal, along with Banner, Chakki, Gaj, Harla, Mamuni, Parvati, Patlikuhlal, Sainj, Suketi and Tirthan.*

Major industrial Establishments *on the banks of river Beas within Punjab jurisdiction mainly comprises Brewery, Distillery, Sugar, Paper Board, Gluten, Thermal Power Plant and few Screening Plants.*

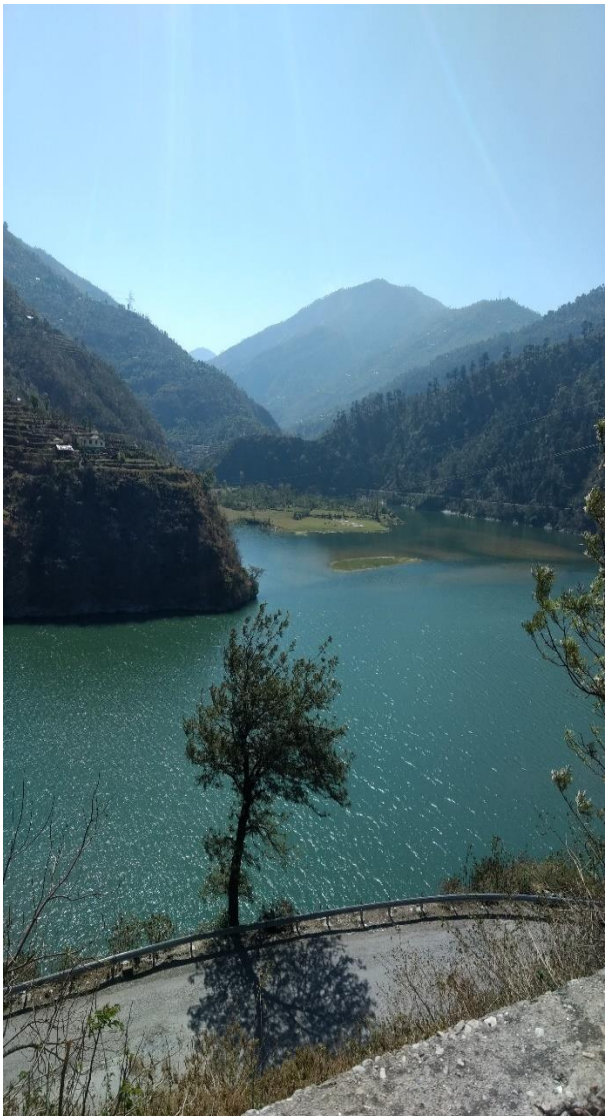


Figure 2.1 River Beas

2.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

Water quality of river Beas is monitored at 31 locations by Central Pollution Control Board (CPCB) in association with H.P. State Pollution Control Boards (HPSPCB) and Punjab Pollution Control Board (PPCB) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Beas is depicted in **Figure 2.2.**

Figure 2.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Beas

2.3 Analytical Results

Water quality of river Beas was carried out at 22 locations during pre-lockdown (March 2020) and 22 locations during lockdown period (April 2020) to assess the impact of lock-down on water quality of river Beas. **(Figure 2.3)**

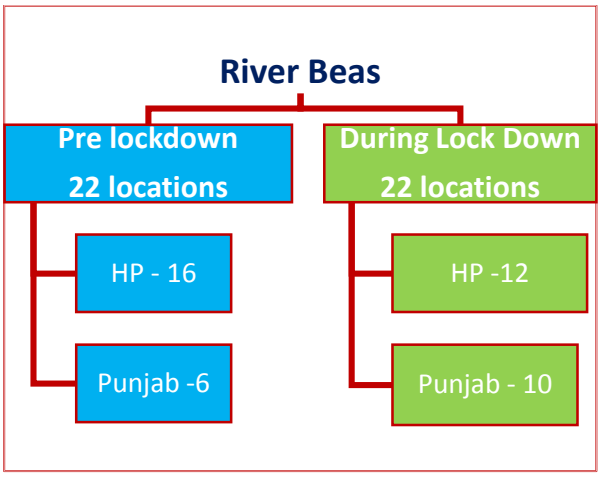


Figure 2.3 Water Quality Monitoring locations carried out during Pre-lockdown and Lockdown on river Beas

2.4 Observations

Based on the analytical results of the samples collected from river Beas, following findings/observations are made:

Himachal Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 16 monitored locations revealed that

Four critical parameters were in the ranges of pH (6.5 – 7.9), DO (8.4 – 9.7 mg/L), BOD (BDL mg/L) and FC (2 – 70 MPN/ 100mL) at all the 16 monitored locations.

Maximum DO (9.7 mg/L) was observed at U/s Mandi and minimum value of DO (i.e. 8.4 mg/L) at D/s Aut.

BOD was observed as (BDL) at all the 16 monitored locations

Maximum Faecal Coliform (70 MPN/ 100 mL) observed at D/s Mandi and minimum (2 MPN/ 100 mL) was observed at 5 monitored locations (viz, D/s Alampur, D/s Dehragopipur, D/s Pong Dam, D/s Jaisinghpur and D/s Nadaun Bridge, Village Bhadoli).

All 16 monitored locations were within the desirable limits for outdoor bathing criteria.

During the lock down period (April 2020)

The analysis results of 12 monitored locations revealed that

Four critical parameters were in the ranges of pH (7.4 – 8.2), DO (8.6 – 10 mg/L), BOD (BDL mg/L) and FC (8-49 MPN/ 100mL) .

Minimum DO (8.6 mg/L) was observed at D/s Dehragopipur and maximum DO (10.0 mg/L) was observed at D/s Manali.

BOD was observed as 'BDL' at all the 12 monitored locations.

Minimum FC (8 MPN/ 100 mL) was observed at D/s Dehragopipur and maximum FC (49 MPN/ 100 mL) was observed at D/s Mandi.

Overall Observations

Increasing trend for DO (4.2 -16.67 %) at 6 locations, FC (43.48-300 %) at 3 locations and BOD as 'BDL' at 12 monitored locations were osberved. Also, decreasing trend for DO (1.06 -5.15 %) at 6 locations, FC (30 - 30.3 %) at 4 locations and 'no' variation at 4 monitored locations. Water quality of river Beas in Himachal Pradesh conforms to the desired bathing water quality criteria during pre-lockdown and lockdown period at all the monitored locations.

Punjab-Observations

During the pre-lock down period (March 2020)

The analysis results of 6 monitored locations revealed

The analysed paramters were in the ranges of pH (7.6 – 8), DO (7.2 – 8.3 mg/L), BOD (1.2 – 1.6 mg/L) and FC (140 – 210 MPN/ 100mL).

Minimum DO (7.2 mg/L) was observed at 1 km D/s of Effluent Discharge Point at Mukerian and maximum DO (8.3 mg/L) was observed at U/s Goindwal,

Minimum BOD (1.2 mg/L) was observed at Harike and BOD as 1.6 mg/L at 1 km D/s of Effllluent Discharge Point at Mukerian.

Minimum FC (140 MPN/ 100 mL) was observed at G.T.Road Under Bridge, Near Kapurtala and maximum FC (210 MPN/ 100 mL) was at two locations viz, 100 m D/S Industrial Discharge, Goindwal and 1km D/s of Effluent Discharge Point at Mukerian.

All 6 monitored locations were complying with Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 10 monitored locatios revealed that

The four critical parameters were in the ranges of pH (7.5 – 8.1), DO (7.1 – 8 mg/L), BOD (1.1 –1.3 mg/L) and FC (36 - 170 MPN/ 100mL).

Minimum DO (7.1 mg/ L) was observed at 1km D/s of Effluent Discharge Point at Mukerian and Maximum DO (8.0 mg/L) was at Harike.

Minimum BOD (1.1 mg/L) was observed at 7 locations and maximum BOD (1.3 mg/L) was at 1km D/s Effluent Discharge Point at Mukerian and D/s Pathankot.

Minimum FC (36 MPN/ 100 mL) was observed at U/s Pathankot and maximum FC (170 MPN/ 100 mL) was observed at 1km D/s of Effluent Discharge Point at Mukerian.

All 10 monitored locations were found to be within the desirable limits for the criterial parameters prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend for the parameter DO (1.4 %) at 1 location, decreasing trend for DO (1.4 – 4.90 %) at 5 locations, BOD (13.3 -21.40 %) at 6 locations and FC (17.6 -47.6 %) at 6 locations were observed.

2.5 Overall Observations on Water River Beas (covering HP & Punjab States)

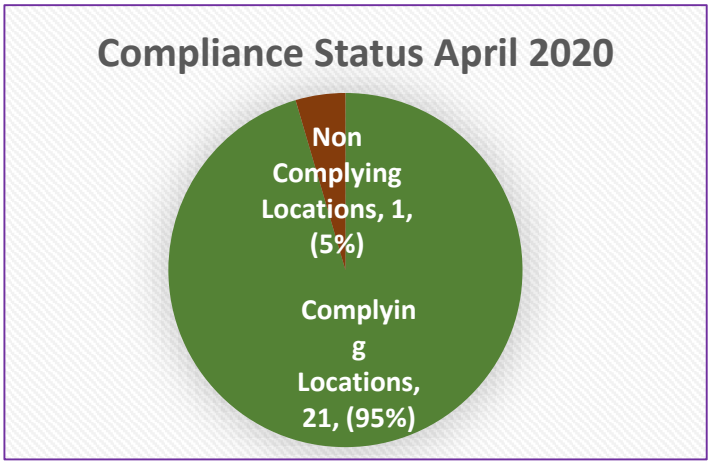


Figure 2.4 Overall Compliance Status of River Beas During Lockdown

Overall observations on river Beas revealed that

- *During lockdown, maximum DO (10 mg/L) was observed at D/s Manali and minimum DO (7.1 mg/L) at Mukerian. Maximum BOD (1.3 mg/L) was at 03 locations near Kapurthala, Mukerian & D/s Pathankot). Minimum BOD as 'BDL' at 12 locations while maximum FC was observed at Mukerian (170 MPN/100 mL) and minimum at Dehragopipur (08 MPN/100 mL).*

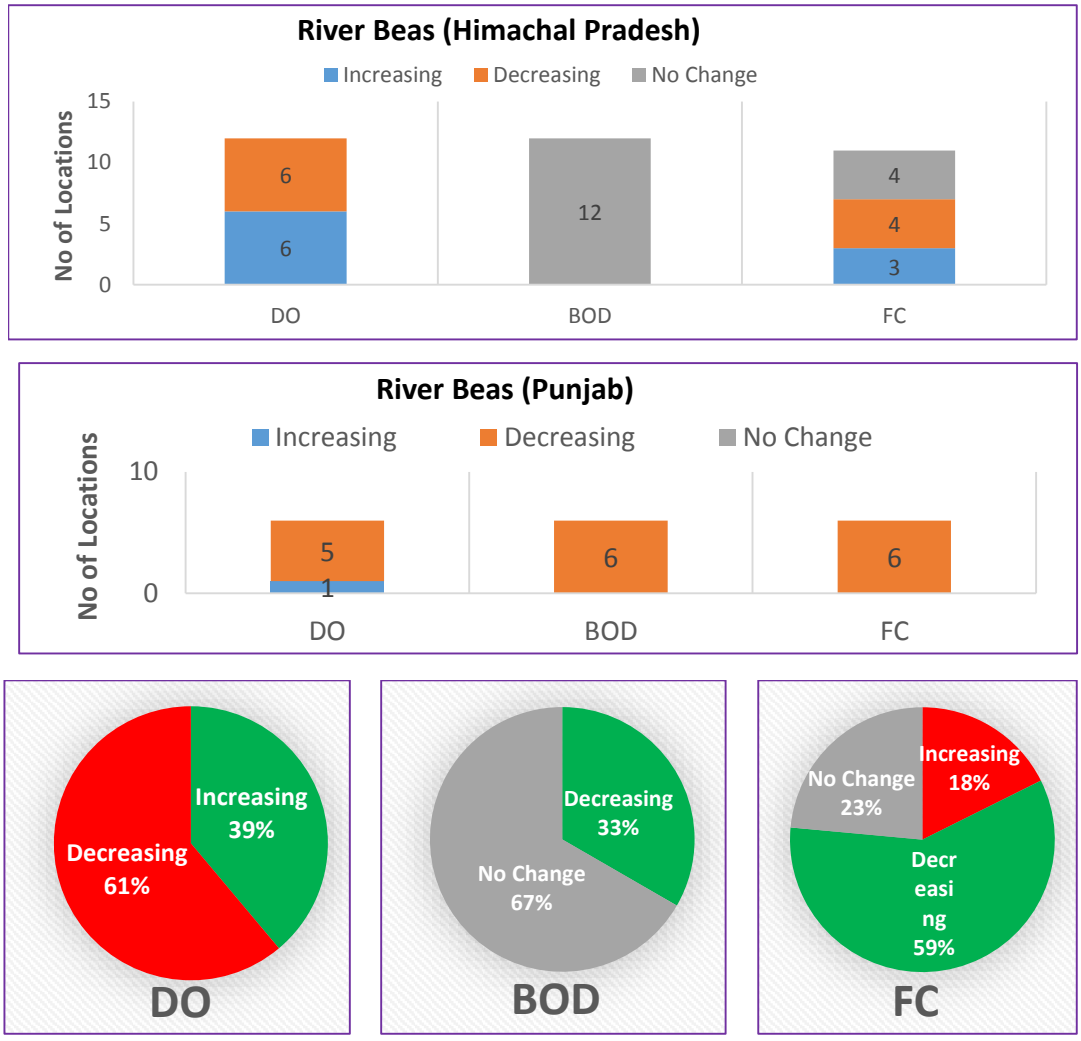
- *Decreasing trend for DO (1.06 - 5.15 %) at 11 locations, BOD (13.3 - 21.4 %) at 6 locations and FC (17.6 - 47.6 %) at 10 locations whereas 'consistent BOD' at 12 locations and 'no' variation in FC at 4 locations. Increasing trend was observed for DO (1.4 - 16.67 %) at 7 locations and FC (43.48 - 300 %) at 3 monitored locations.*

Overall compliance status of River Beas during lockdown for Primary Water Quality Criteria for Outdoor Bathing is given in ***Figure 2.4****.*

2.6 Water Quality Trend of River Beas

Water quality trend of river Beas as observed during pre-lockdown and lockdown is given in **Figure 2.5**

Figure 2.5 River Beas- Water Quality Trend During Pre (March 2020) and Lockdown Period (April 2020)



2.7 Conclusion

- *All the 22 monitored locations (100 %) during Pre-lockdown and 21 out of 22 monitored locations (95.45 %) during lockdown on river Beas were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing.*

3 Impact of Lockdown on Water Quality of River Baitarani

3.1 About River Baitarani

The Baitarani river **(Figure 3.1)** originates from Guptaganga hill ranges of Keonjhar district of Odisha. Total length of the river Baitarani is about 360 km and it serves as a boundary between Jharkhand and Odisha States up to confluence of Kangira river. It is east ward flowing rivers of peninsular India, flowing eastward and joining the Bay of Bengal. There is a large scale mining activity in Keonjhar and Jajpur districts. Both the rivers Brahmani and Baitarani outfall in the Bay of Bengal, forming a common delta.

Facts at a Glance

Major Towns or Cities *on the River Baitarani are Keonjhar, Naigarh, Chandbali in Odisha.*

Major Districts *are Keonjhar and Jajpur Districts in Odisha State.*

Major Tributaries *of Baitarani river are Budhi, Kanjori, Ambajhara, Mushal, Kusei, Salandi etc.,*

Major Industrial Establishments *on the banks of river Baitarani are mining activities*

Figure 3.1 River Baitarani

3.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of River Baitarani is monitored at 10 locations by Central Pollution Control Board (CPCB) in association with State Pollution Control Board, Odisha (OSPCB) under National Water Quality Monitoring Programme (NWMP). Distribution of Water Quality Monitoring Locations under NWMP within Odisha State on River Baitarani is depicted in **Figure 3.2**.

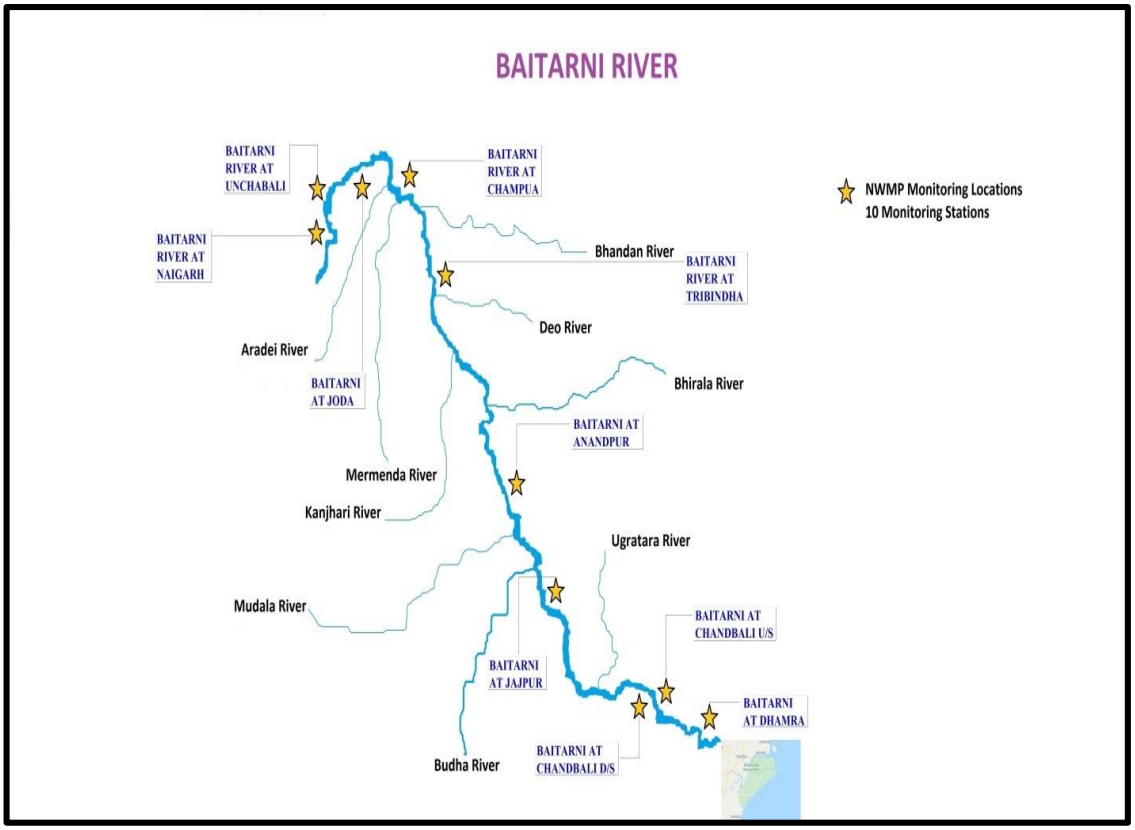


Figure 3.2: Distribution of Water Quality Monitoring Locations under NWMP on River Baitarani

3.3 Analytical Results

Water quality of river Baitarani was carried out at 10 locations during pre-lockdown and 09 locations during lockdown to assess the impact on water quality **(Figure 3.3)**.

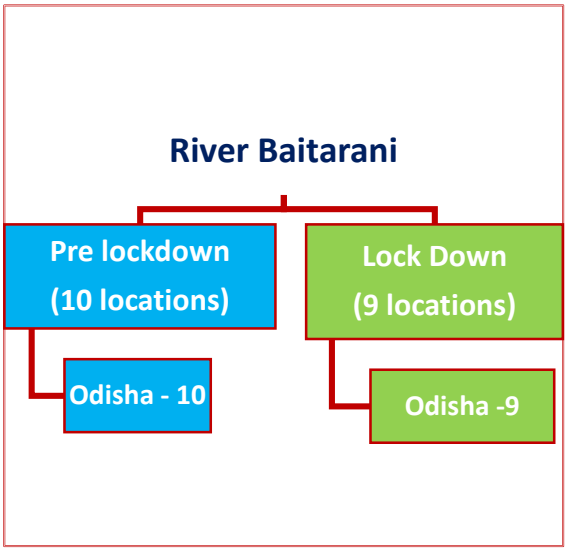


Figure 3.3. Water Quality Monitoring Locations carried out during Pre-Lockdown (March 2020) and Lockdown on river Baitarani

3.4 Observations

Based on the analytical results of the samples collected from river Baitarani, following findings/observations are made:

Odisha-Main Observations

During the pre-lock down period (March 2020)

The analysis results of the 10 monitored locations revealed that

Four critical parameters were in the ranges of pH (6.9 -7.4), DO (6.3 - 7.9 mg/L), BOD (0.2 - 1.8 mg/L) and FC (45 – 2400 MPN/100 mL).

Maximum DO (7.8 mg/L) was observed at Dhamra and minimum at Unchabali (6.3 mg/L). Maximum BOD (1.8 mg/L) was at Dhamra.

Maximum FC (2400 MPN/100mL) was observed at D/s Chandbali and minimum FC was at Naigarh (45 MPN/100mL).

All 10 monitored locations were within the desirable limits of the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of the 9 monitored locations revealed that

Four critical parameters were in the order of pH (7.3 - 7.8), DO (6.8 - 7.8 mg/L), BOD (0.1 - 0.8 mg/L) and FC (20 – 1400 MPN/100 mL).

Maximum DO (7.6 mg/L) was observed at Champua and minimum at U/s Chandbali (6.8 mg/L).

BOD was 'BDL' at 9 locations. Maximum FC (1400 MPN/100mL) was at Anandpur and minimum (20 MPN/100mL) at Jajpur.

At Anandpur, FC reduced from 2300 to 1400 MPN/100 mL (reduction 39 %) and also from reduced 1400 to 1300 MPN/100 mL (41.67 %) at Chandbali D/s.

All 09 monitored locations were within the desirable limits of Outdoor Bathing.

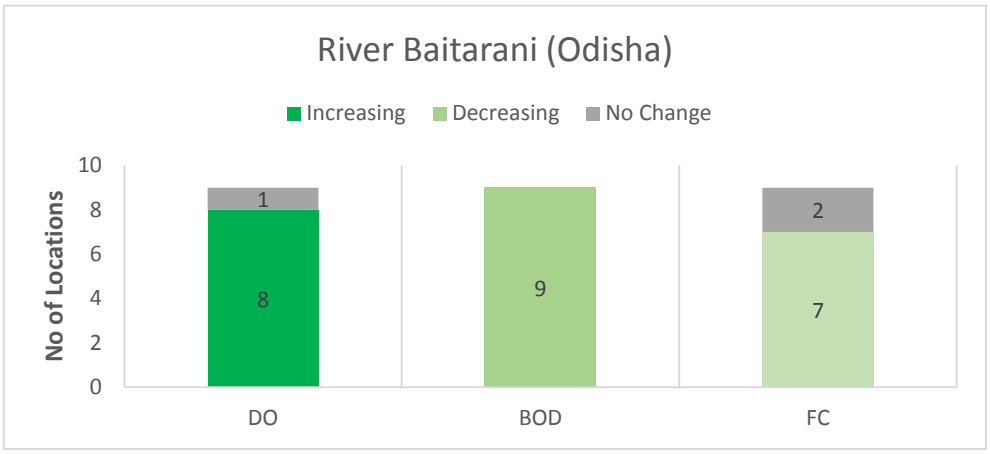
Overall Observation

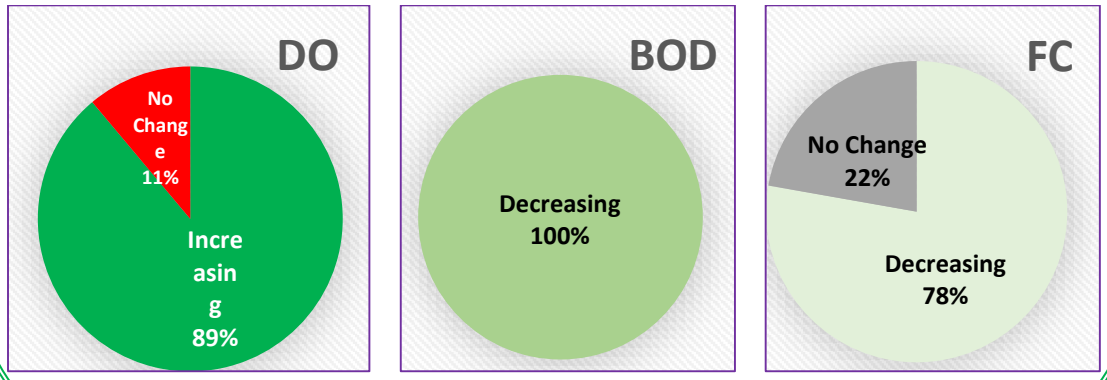
Increasing trend of DO (3 -12%) at 08 locations except at 1 monitored location (Chambali D/s), decreasing trend of BOD (38 -75%) at all 09 monitored locations whereas FC (33 -82%) at 07 monitored locations were observed. 'No' variation was observed w.r.t DO at 1 location and FC at 2 locations.

3.5 Water Quality Trend of River Baitarani

Water Quality trend of river Baitarani as observed during pre-lockdown and lockdown are given in **Figure 3.4**

Figure 3.4. River Baitarani- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





3.6 Conclusion

- *All the 10 monitored locations monitored during pre-lockdown as well as all 9 monitored locations monitored during lockdown on river Baitarani were found to be complying (100 % compliance) with the Primary Water Quality Criteria for Outdoor Bathing.*

4 Impact of Lockdown on Water Quality of River Brahmani

4.1 About Brahmani River

The Brahmani River**,** in north-eastern Odisha State, is formed by the confluence of the Sankh and South Koel rivers at Vedvyas. The Brahmani river **(Figure 4.1)** flows for 480 km and enroute join northern branches of the Mahanadi River, which then empties into the Bay of Bengal at Palmyras Point in Odisha. River Brahmani and Baitarani outfall in the Bay of Bengal, forming a common delta.

Source: https://en.wikipedia.org/wiki/Brahman

Figure 4.1 River Brahmani

Facts at a Glance

Major City or Town *on the bank River Brahmani is Talcher*

Major Districts *are Sundargarh, Deogarh, Angul, Dhenkanal, Cuttack, Jajpur and Kendrapara in Odisha State.*

Major Tributaries *of the Brahmani are Sankh and Koel*

Major industrial *establishments on the banks of river Brahmani are Aluminium, Thermal Power Plants and Mining operations.*

4.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of River Brahmani is monitored at 20 locations by Central Pollution Control Board (CPCB) in association with State Pollution Control Board, Odisha (OSPCB) under National Water Quality Monitoring

Programme (NWMP). Distribution of Water Quality Monitoring Locations Under NWMP within Odisha State on River Brahmani is depicted in **Figure 4.2.**

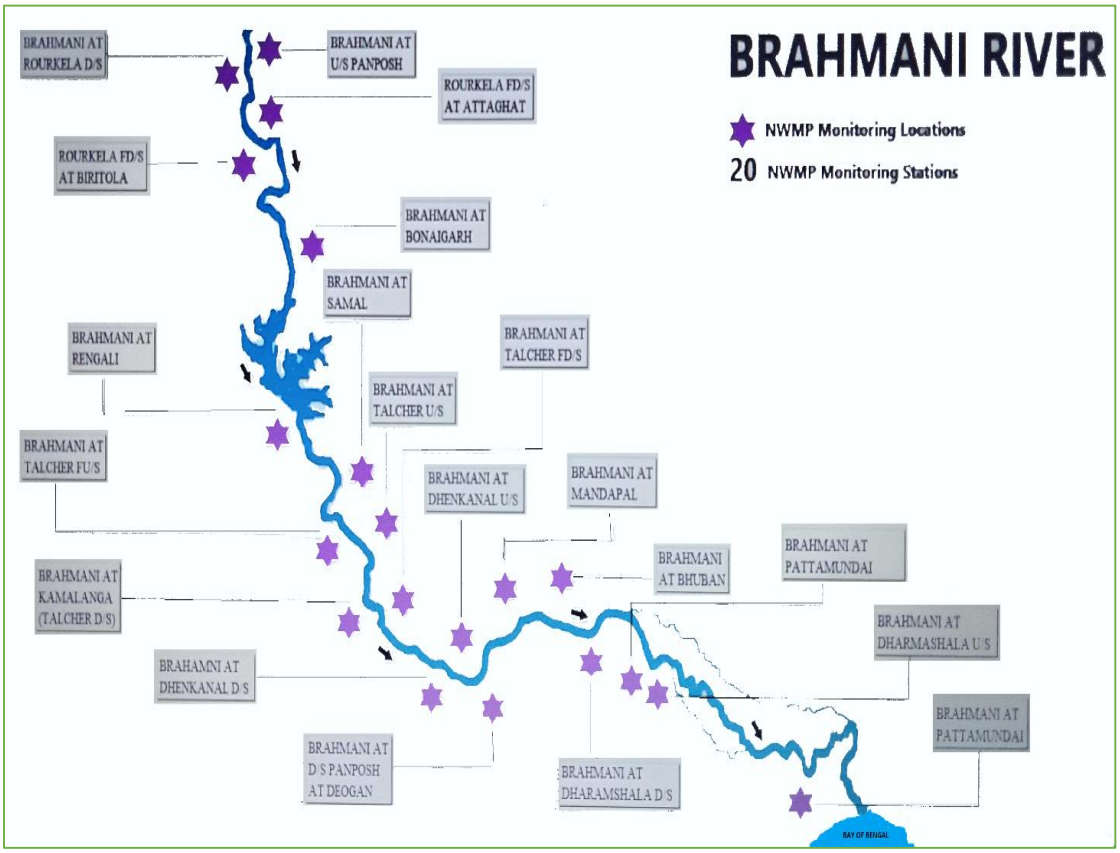


Figure 4.2: Distribution of Water Quality Monitoring Locations under NWMP within Odisha State on River Brahmani

4.3 Analytical Results

Water quality of river Brahmani was carried out at 20 locations during Pre-Lockdown and Lockdown period to evaluate the impact on water quality of river Brahmani **(Figure 4.3)**.

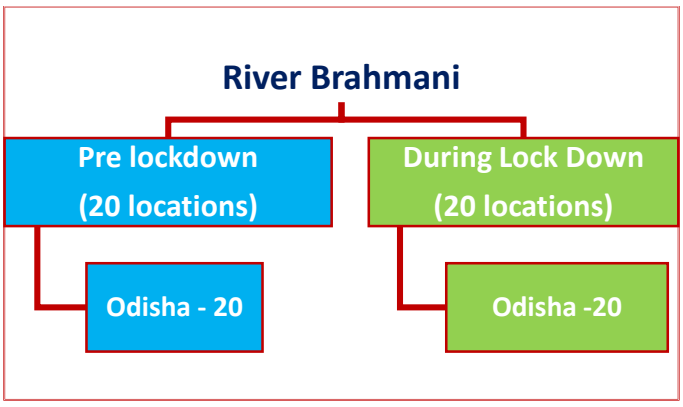


Figure 4.3 Water Quality Monitoring Locations Carried out during Pre-lockdown and Lockdown on river Brahmani

4.4 Observations

Based on the analytical results of the samples collected from river Brahmani, following findings/observations are made:

Odisha-Observations

During the pre-lock down period (March 2020)

The analysis results indicated that

The critical parameters were in the ranges of pH (6.8- 7.9), DO (4.6- 8.6 mg/L), BOD (BDL (0.5) – 24 mg/L) and FC (110 – 7900 MPN/100mL) at the 20 monitored locations..

Maximum DO (8.6 mg/L) was observed at Samal and minimum DO (4.6 mg/L) at D/s Panposh, Deogan.

Maximum BOD (24 mg/L) was at Kamalanga and minimum as 'BDL' (0.2 mg/L) at Dharamsala U/s, Jajpur District.

Maximum FC (7900 MPN/100 mL) was at D/s Panposh,Deogan and minimum (110 MPN/100 mL) at Rengali.

3 out of 20 monitored locations not complying to limits prescribed under Outdoor Bathing Criteria.

During the lock down period (April 2020)

The analysis results revealed that

Four critical parameters were in the order of pH (6.5 - 8.0), DO (5.4 - 8.4 mg/L), BOD (BDL (0.2) - 2.8 mg/L) and FC (1.5 – 2200 MPN/100 mL).

Maximum DO (8.4 mg/L) was at Samal and minimum DO (5.4 mg/L) at D/s Panposh, Deogan. Marginal reduction in DO from 8.6 to 8.4 mg/L.

Maximum BOD (2.8 mg/L) at D/s Panposh, Deogan and minimum as 'BDL' at 17 locations, indicates there is a considerable reduction in BOD.

Maximum FC (2200MPN/100mL) was at D/s Panposh,Deogan and minimum as 'BDL' at Rengali.

During lockdown, sinficant recuction in FC was observed at 3 locations (reduced from 7900 to 2200 MPN/100 mL at D/s Pamposh; from 3300 to 46 MPN/100mL at Kamalanga and 3300 to 700 MPN/100 mL at Rourkela D/s)).

All 20 monitored locations were complying to the Primary Water Quality Criteria for Outdoor Bathing. .

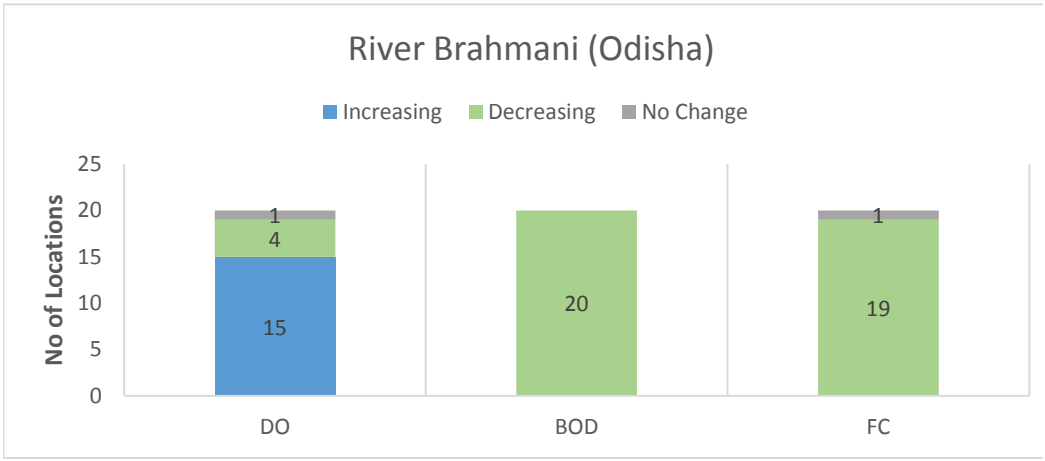
Overall Observations

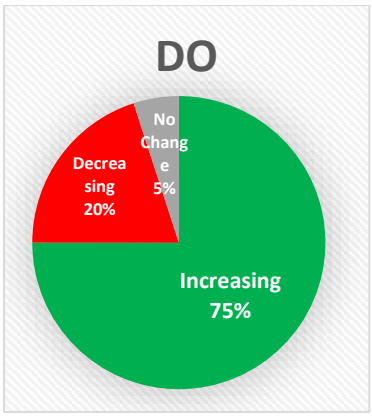
Increasing trend of DO (3% to 17%) at 15 locations whereas decreasing trend of DO (2-3%) at 4 locations, BOD (32%-96 %) at 20 locations and FC (5-99 %) at 19 monitored locations were observed. 'No' variation was observed w.r.t DO and FC at 1 location each. .

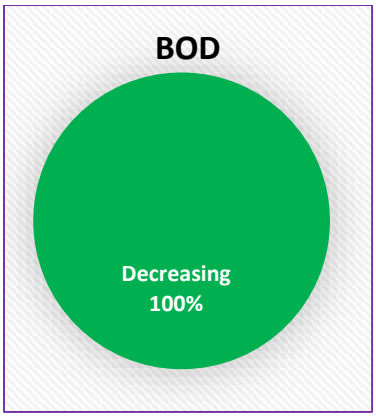
4.5 Water Quality Trend of River Brahmani

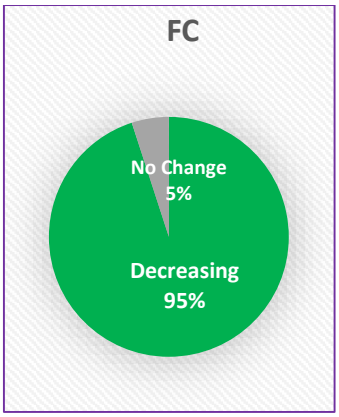
Water Quality trend of river Brahmani as observed during pre-lockdown and lockdown are given in **Figure 4.4**

Figure 4.4 River Brahmani- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)









4.6 Conclusion

- *17 out of 20 monitored locations during pre-lockdown (85 %), 20 out of 20 monitored locations during lockdown (100 %) are complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, overall improvement in water quality of River Brahmani was observed with respect to DO, BOD and FC parameters.*

5 Impact of Lockdown on Water Quality of River Brahmaputra

5.1 About Brahmaputra River

The Brahmaputra river originates from the Kailash ranges of Himalayas in Tibet and runs for about 2900 km through China, India and Bangladesh. After flowing through Tibet it enters India through Arunachal Pradesh and flows through Assam valley. After joining of two tributaries viz. the Dibang or Sikang and the Lohit, from here onwards the river is known as 'Brahmaputra', it then enters in Bangladesh and finally makes a delta along with river Ganga before its out fall in to Bay of Bengal. Out of the total length of 2900 km, its length in India is 916 Km. The major ion chemistry of the Brahmaputra is characterized by high bi-carbonate content and source rock influence. While higher values of Total Suspended Matter (TSM) than Total Dissolved Solids (TDS) during monsoon indicate predominance of physical weathering over chemical weathering, chemical weathering is relatively more pronounced during the dry season. On average, 60 % of the bicarbonates in the Brahmaputra water come from silicate weathering and the rest from the carbonates.

Facts at a Glance

Major Towns *on the banks of River Brahmaputra are Dibrugarh, Dhubri, Jorhat, Tezpur, Guwahati.*

Major Tributaries of river Brahmaputra *are the Dibang or Sikang, Lohit Subansiri, Ronganadi, Dikrong, Buroi, Borgong, Jiabharali, Dhansiri (North) Puthimari, Manas, Beki, Aie, Sonkosh while the Noadehing, Buridehing, Desang, Dikhow, Bhogdoi, Dhansiri (South), Kopilli, Kulsi, Krishnai, Dhdhnoi, Jinjiran are the main tributaries on the south bank of the river Brahmaputra.*

There are no major/minor industrial estate/cluster located on the 500 m periphery of the Brahmaputra river bank. Sewage generated from Tezpur and Guwahati City are directly discharged and are the major sources of pollution in river Brahmaputra.

Source:-https://www.sangbadpratidin.in/india/corona-lockdown-water-in-brahmaputra-river-looks-cleaner/

Figure 5.1 River Brahmaputra

5.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

Water quality of river Brahmaputra is evaluated at 11 locations by Central Pollution Control Board in association with Pollution Control Board, Assam under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Brahmaputra within Assam State is depicted in **Figure 5.2.**

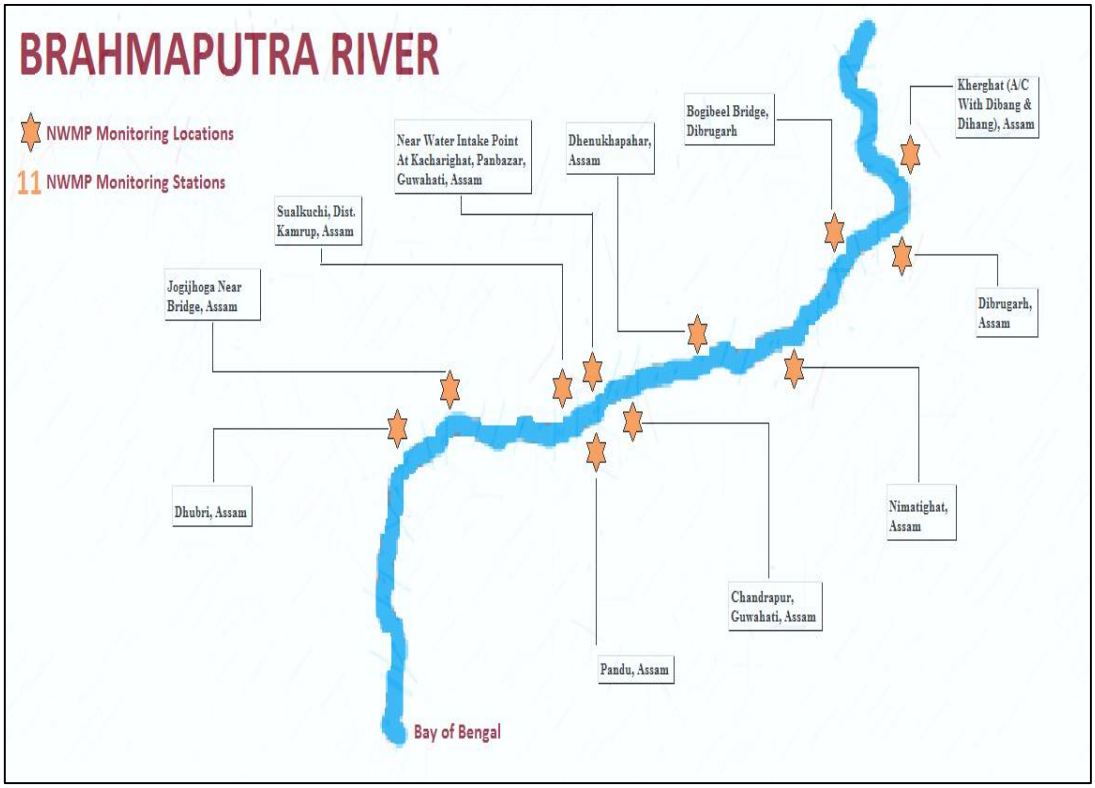


Figure 5.2 Distribution of Water Quality Monitoring Locations Under NWMP on River Brahmaputra within Assam State

5.3 Analytical Results

Water quality monitoring of river Brahmaputra was carried out at 8 locations during pre-lockdown and at 10 locations during lockdown period by Pollution Control Board, Assam to assess the impact on water quality of river Brahmaputra **(Figure 5.3)**

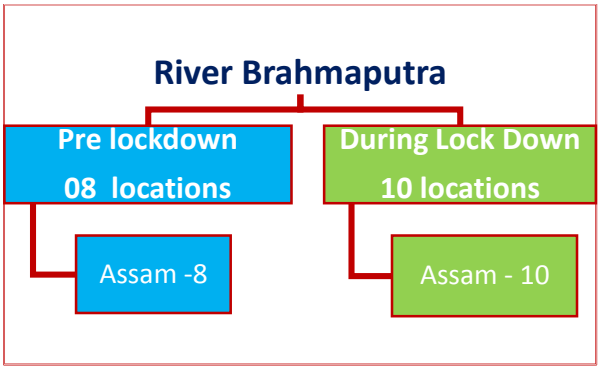


Figure 5.3 Water Quality Monitoring Locations Carried out during Pre-lockdown and Lockdown on river Brahmaputra

5.4 Observations

Based on the analytical results of the samples collected from river Brahmaputra, following findings/observations are made

Assam-Observations

During the pre-lock down period (March 2020)

The analysis results of four critical parameters revealed that

8 monitored locations were in the ranges of pH (7.6-8.1), DO (5.1-10.4 mg/L), BOD (1.6-2.4 mg/L) and FC (300-730 MPN/100 mL) (not analysed for one location).

7 out of 8 monitored locations were complying to the limits of Primary Water Quality Criteria for Outdoor Bathing.

Maximum DO (10.4 mg/L) at WIP, Kachar and minimum DO (5.1 mg/L) at Jogijhoga Nr Bridge was observed. Maximum BOD (2.4 mg/L) was at Dhubri and minimum BOD (1.6 mg/L) at 5 out of 8 monitored locations. Maximum FC was 730 MPN/100 mL at Pandu and minimum as 300 MPN/100 mL at 3 locations viz., Dibugarh, Nimatighat and at Chandrapur, Guwahati.

During the lock down period (April 2020)

The analysis results of 10 monitored locations revealed that

Four paramters were in the ranges of pH (7.4-7.9), DO (6.6-10.3 mg/L), BOD (1.1-2.1 mg/L) and FC (300-730 MPN/100 mL).

All 10 monitored locations were found complying with the Primary Water Quality Criteria for Outdoor Bathing.

Maximum DO (10.3 mg/L) at Pandu and minimum at Dhenukhapaha (6.6 mg/L). whereas maximum BOD was at Dhubri (2.1 mg/L) and minimum at Dhenukhapaha (1.1 mg/L).

Maximum FC (730 MPN/100 mL) at 02 locations (viz., Dhubri & Nr. Water Intake Point at Kachar) and minimum FC (300 MPN/100 mL) at 02 locations (viz., Chandrapur, Guwahati & at Sualkuchi, District Kamrup).

Reduction in FC was observed at a location Viz Pandu (50.68 %) and increase in FC at 2 locations from 610 to 730 MPN/100 mL.

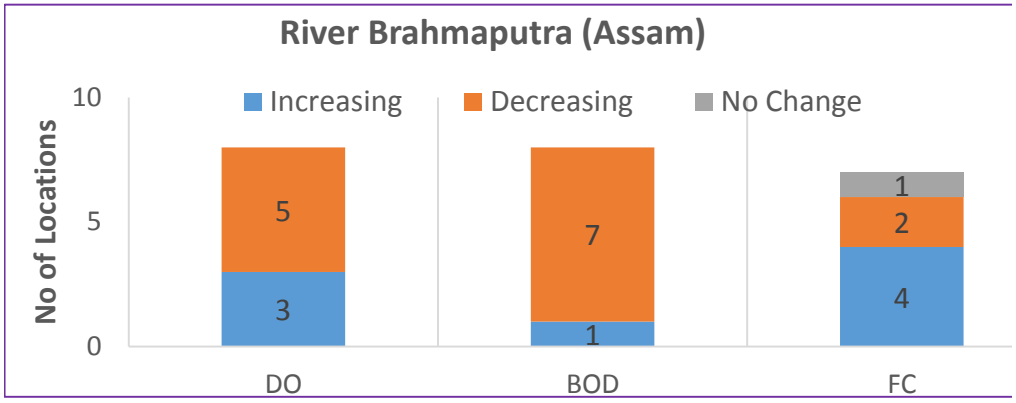
Overall Observations

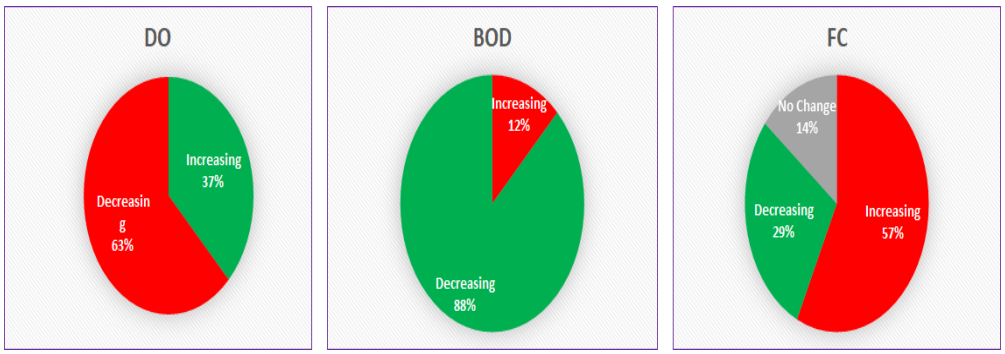
Decreasing trend of DO (2.5 -19.19 %) at 5 locations, BOD (5.6 -26.1%) at 7 locations and FC (50.68 -50.82%) at 02 locations. Increasing trend of DO (8.42 -41.18%) at 03 locations, BOD (12.5 %) at 1 location and FC (19.67 -20 %) at 4 locations were observed while 'No' variation in FC was observed at 1 location

5.5 Water Quality Trend of River Brahmaputra

Water Quality trend of river Brahmaputra as observed during pre-lockdown and lockdown are given in **Figure 5.4.**

Figure 5.4 River Brahmaputra- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





5.6 Conclusion

- *07 out of 08 monitored locations on river Brahmaputra during pre-lockdown period (March 2020) and all 10 monitored locations during lockdown period (April 2020) and overall, an improvement in water quality of river Brahmaputra was observed w.r.t the criteria parameters viz., DO, BOD and FC as well as 100 % compliance of all the monitored locations for the outdoor bathing criteria parameters was observed during lockdown period.*

6 Impact of Lockdown on Water Quality of River Cauvery

6.1 About Cauvery River

River Cauvery **(Figure 6.1)** originates from south-western part of Karnataka at Talakaveri on the Brahmagiri range in the Western Ghats, Kodagu District, Karnataka State. It traverses through Tamil Nadu (TN) before its outfall into the Bay of Bengal covering a total distance of about 800 km. Before emptying into the Bay of Bengal south of Cuddalore in Tamil Nadu, it distributes into a large number of distributaries forming a wide delta known as "Daksina Ganga". It is the third largest river after Godavari and Krishna in Southern India and the largest in the State of Tamil Nadu which, on its course, bisects the TN State into North and South.

Facts at a Glance

The Major Towns Industrialized cities include Bangalore (Karnataka) and the towns Mettur, Pallipalayam, Komarapalayam in Tamil Nadu followed by the districts of Mysore and Mandya in Karnataka; Erode, Namakkal and Salem in Tamil Nadu.

The Major Tributaries on the left bank of river Cauvery are Harangi, Hemavati, Shimsha, Arkavathy & right bank tributaries are river Lakshmana Tirtha, Kabini, Bhavani, Noyyal, Amaravati & Moyar

Major Industrial Establishments on the banks of river Cauvery mainly comprises chemical, dyeing, leather/tanneries, pulp & paper, sugar mills, printing and bleaching industries.

Figure 6.1 River Cauvery at Ajjibore, Mekedaatu (Karnataka)

6.2 Water Quality Monitoring Locations on River Cauvery under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Cauvery is monitored at 64 locations by Central Pollution Control Board (CPCB) in association with State Pollution Control Boards of Karnataka (at 24 locations) and Tamil Nadu (at 40 locations) under National Water Quality Monitoring Programme (NWMP). State-wise

Distribution of Water Quality Monitoring Locations under NWMP on River Cauvery is depicted in **Figure 6.2 and Figure 6.3.**

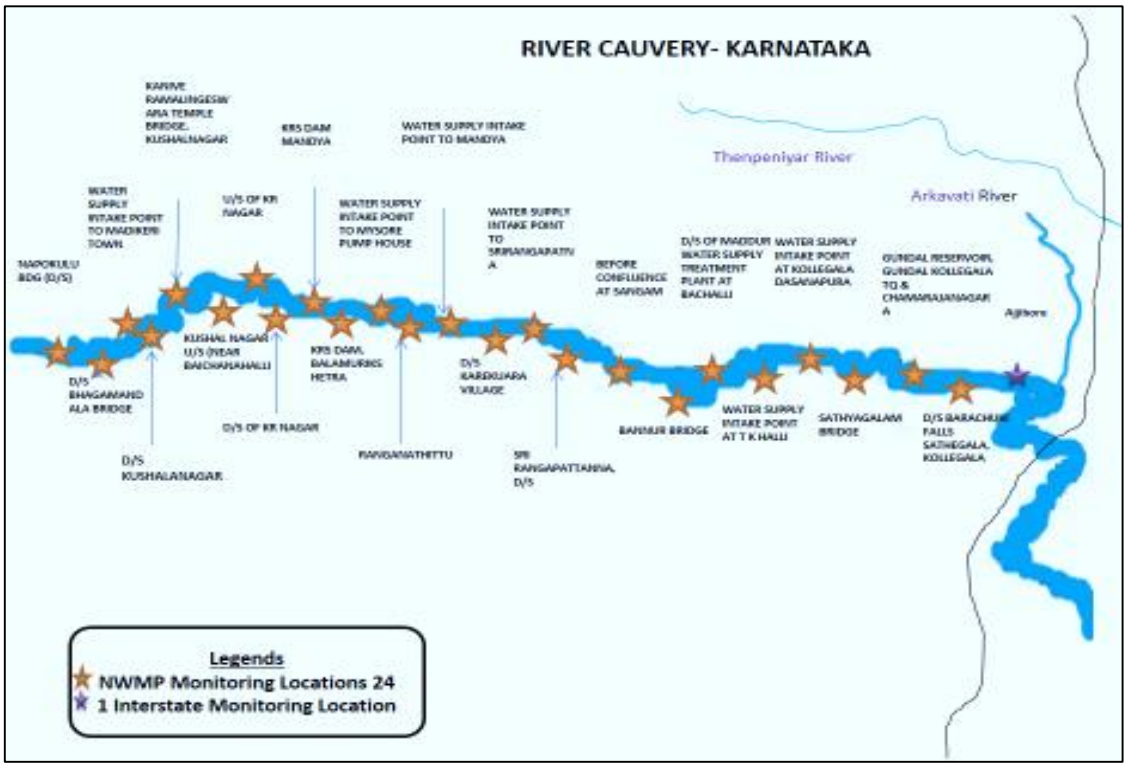


Figure 6.2: Water Quality Monitoring Locations under NMWP on River Cauvery (within Karnataka State)

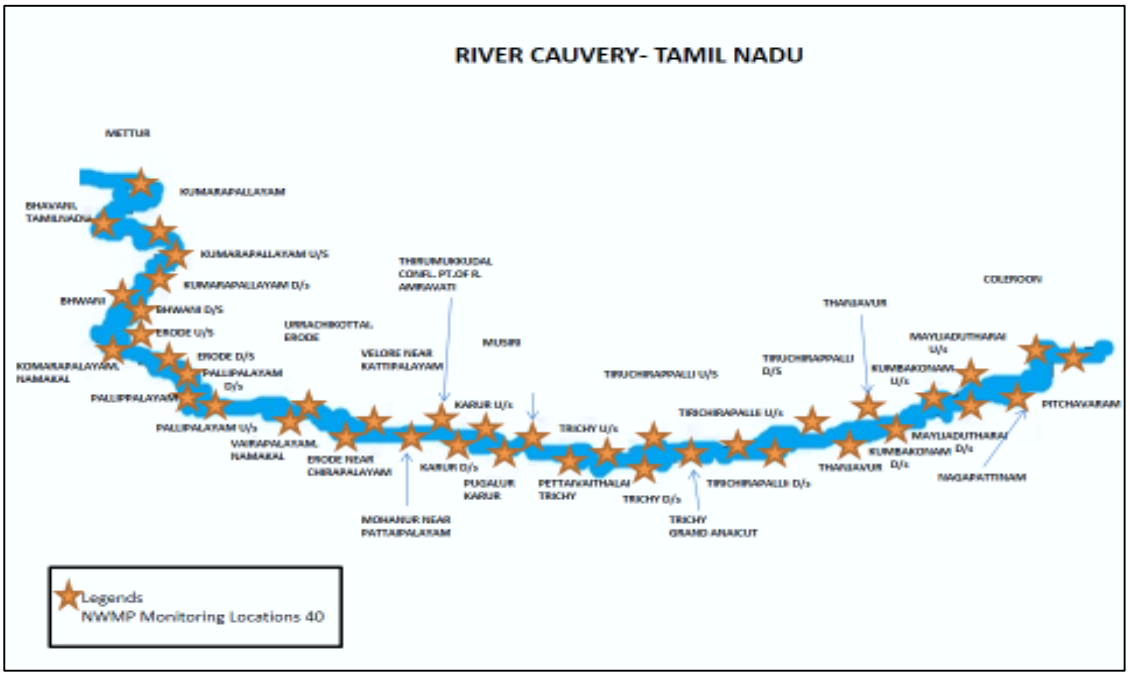


Figure 6.3: Water Quality Monitoring Locations under NMWP on River Cauvery (within Tamil Nadu State)

6.3 Analytical Results

Water quality of river Cauvery was carried out at 42 locations (Karnataka-22 and Tamilnadu-20) during Pre-Lockdown and at 33 locations (i.e., Karnataka (22) and Tamil Nadu (11)) during Lockdown period to assess impact on water quality. **(Figure 6.4).**

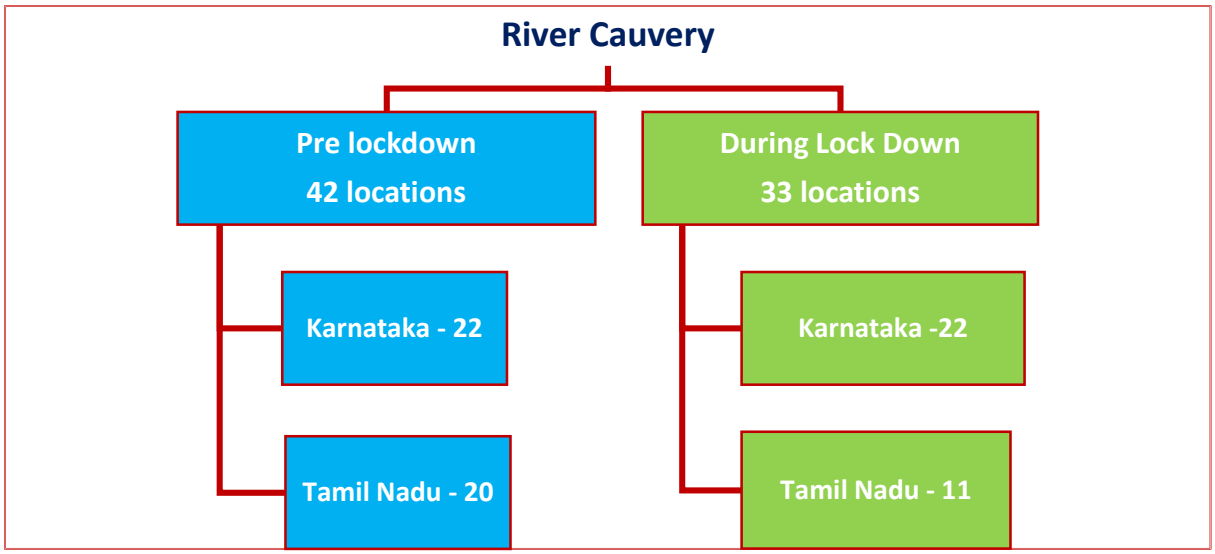


Figure 6.4. Water Quality Monitoring Locations carried out during Pre-lockdown and Lockdown on River Cauvery in Karnataka and Tamil Nadu

6.4. Observations

Based on the analytical results of the samples collected from river Cauvery, following findings/observations are made:

Karnataka - Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

Analysed critical parameters were in the ranges of pH (7.1-8.1), DO (6.3-7.0 mg/L), BOD (1.5-2.6 mg/L) and FC (40-700 MPN/100 mL) at the 22 monitored locations.

Maximum DO (7 mg/L) was at 3 locations including D/s Barachuki Falls and minimum DO (6.3 mg/L) at 3 locations including Intake Point to Srinranga Patna.

Maximum BOD (2.6 mg/L) was at Intake Point to Mandya and minimum BOD (1.5 mg/L) at 2 locations (Viz., at KRS Dam, Balamuri Kshetra, D/s Balachuri Falls, Kollegala).

Maximum FC (700 MPN/100 mL) at Srinranga Patna D/s and minimum (40 MPN/100 mL) at Kushalnagar, Beechanahalli.

All the 22 monitored locations were complying with the limits limits for Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results revealed that

Analysed parameters were in the order of pH (7.8-8.2), DO (6.6-7.8 mg/L), BOD (1.0-1.9 mg/L) and FC (27-320 MPN/100 mL) at the 22 monitored locations

Maximum DO (7.8 mg/L) was at Napoklu Bridge and minimum DO (6.8 mg/L) at Srinranga Patna D/s.

Maximum BOD (1.9 mg/L) was at Srinranga Patna and minimum BOD (1 mg/L) at 3 locations (Viz., at Napoklu Bridge , Intake Points to Madikeri and Mysore).

Maximum FC (320 MPN/100 mL) was at Ranganathittu and minimum (27 MPN/100 mL) at Kanive Ramalingeswara Temple Bridge, Kushalnagar.

FC at Srinranga Patna D/s redueced from 700 to 210 MPN/100 mL (reduction 70 %).

All the 22 monitored locations were within the desirable limits for Primary Water Quality Criteria for Outdoor Bathing.

Overall observations

Increasing trend of DO (1.54- 15.87 %) at 21 locations while decreasing trend of BOD (13.33 -50 %) at 20 locations and FC (15.78-76.09 %) at 21 locations were observed. 'No' variation was observed in DO (at 1 location), BOD (at 2 locations) and FC at 1 location.

Tamil Nadu - Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

Four critical parameters were in the range of pH (7.6-8.8), DO (2.1- 6.3 mg/L), BOD (2-7.5 mg/L) and FC (31-260 MPN/100 mL) at the 20 monitored locations.

Maximum DO (6.3 mg/L) was observed at Bhavani and minimum DO (2.1 mg/L) at Mayiladuthurai D/s.

Maximum BOD (7.5 mg/L) was observed at Mayiladuthurai D/s. Minimum BOD (2 mg/l) at 16 monitored locations.

Maximum FC (260 MPN/100 mL) observed at Vellore, Near Kattipalayam and minimum at Erode (31 MPN/100 mL).

16 out of 20 monitored locations were complying with the limits for Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results revealed that

Four critical parameters were in the range of pH (7.5-8.6), DO (6.0-6.9 mg/L), BOD (2.0 mg/L), FC (21-220 MPN/100 mL) at the 11 monitored locations

Maximum DO (6.9 mg/L) was at Vairapalayam and minimum DO (6 mg/L) at Mohanaur.

BOD (2 mg/L) was observed at all the 11 monitored locations. Maximum FC at Mohanur (200 MPN/100 mL) and minimum at Mettur (21 MPN/100 mL).

10 of 11 monitored locations complying to the limits for Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (3.45-15.53 %) at 11 locations while decreasing trend of BOD (9-20 %) at 2 locations, FC (20-85.91 %) at 11 locations and FC (20-85.91 %) at 11 locations were observed. "No' variation in BOD at 9 locations were observed.

6.5 Overall Observations on Water Quality of River Cauvery (covering Karnataka, Tamil Nadu)

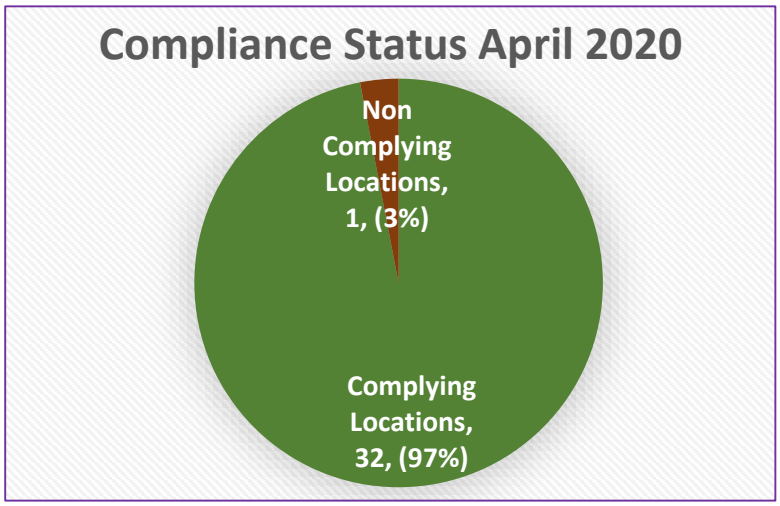


Figure 6.5. Overall Compliance Status to the Primary Water Quality Criteria for Outdoor Bathing Observed during Lockdown on River Cauvery

The analysis results revealed that

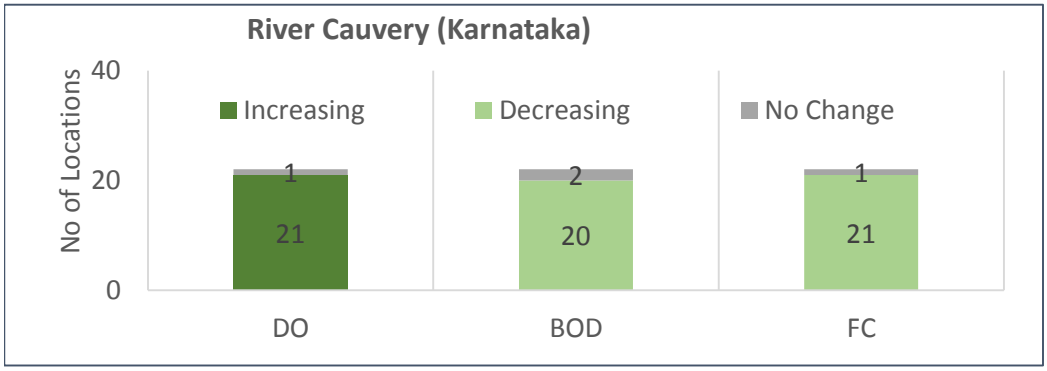
- During the pre-lockdown, pH at 38 locations, DO & FC at 42 locations, BOD at 41 monitored locations were complying with the desirable limits prescribed under the primary water quality criteria for outdoor bathing.

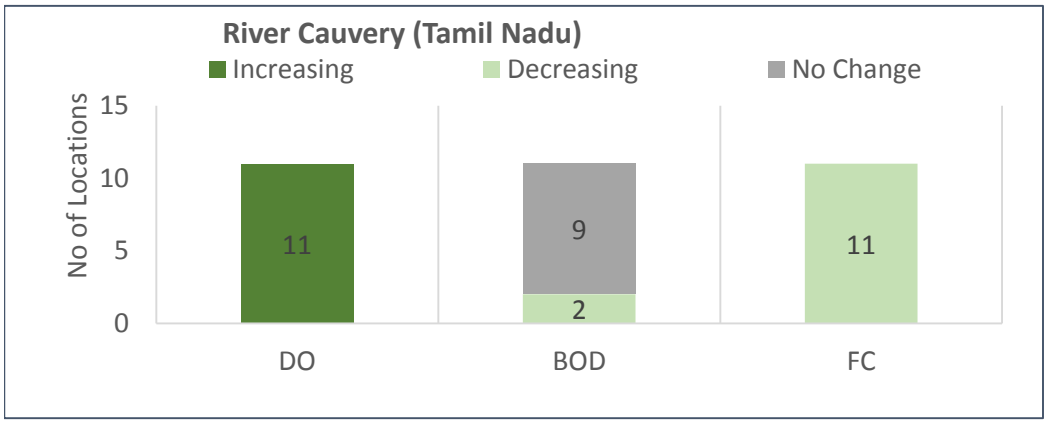
- During the lockdown, pH at 32 locations, DO, BOD and FC were found to be complying at 33 monitored locations to the primary water quality criteria limits for outdoor bathing. Status of compliance to the Primary Water Quality Criteria for Outdoor Bathing is given at **Figure 6.5.**

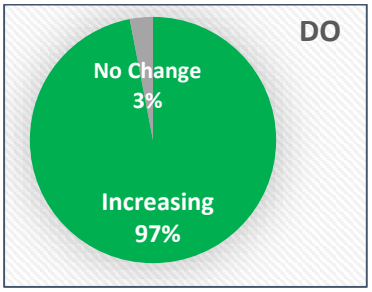
- Increasing trend of DO (1.54% -15.87%) at 32 locations and decreasing trend of BOD (9.09 % -50%) at 22 monitored locations and FC (15.78% -85.91%) at 32 locations were observed. **(Figure 6.6)**

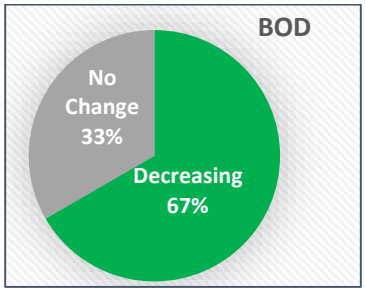
- 'No' variation in values of parameters i.e., DO (01 location), BOD (at 11 locations) and FC (at 1 location) were observed **(Figure 6.6)**

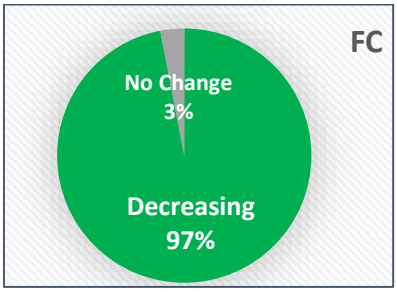
Figure 6.6 River Cauvery- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











6.6 Conclusion

- *38 out of 42 monitored locations (90.5 %) during pre-lockdown, 32 out of 33 locations (96.96 %) during lockdown were observed to be complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, overall marginal improvement in water quality of river Cauvery was observed with respect to the parameters viz., DO, BOD and FC.*

7 Impact of lockdown on Water Quality of River Chambal

7.1. About River Chambal

The River Chambal, is 960-kilometre-long and one of the cleanest perennial river and originates in the Vindhya Range in Madhya Pradesh State. The river flows north-northeast through Madhya Pradesh, running for a time through Rajasthan (Figure 7.1) then forming the boundary between Rajasthan and Madhya Pradesh before turning southeast to join the river Yamuna in Uttar Pradesh.

Facts at a Glance

Kota, Nagda, Sawai Madhopur, Karauli, Dholpur are the major cities on the banks of Chambal river.

Major left bank tributaries of river Chambal are Banas, Mej and right bank tributaries are Parbati, Kali Sindh and Shipra.

Kota is one of the industrial hubs in Northern India where chemical, cement and power plants are located.

Source: https://en.wikipedia.org/wiki/Chambal_River#/media/File:Chambal_River_near_Kota,_Rajasthan.jpg

Figure 7.1. Chambal River (Near Kota, Rajasthan)

7.2. Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

Water quality of river Chambal is assessed at 18 locations by Central Pollution Control Board (CPCB) in association with M.P. Pollution Control Board (MPPCB), Rajasthan State Pollution Control Board (RSPCB) and U.P. Pollution Control Board (UPPCB) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Chambal is depicted in **Figure 7.2**.

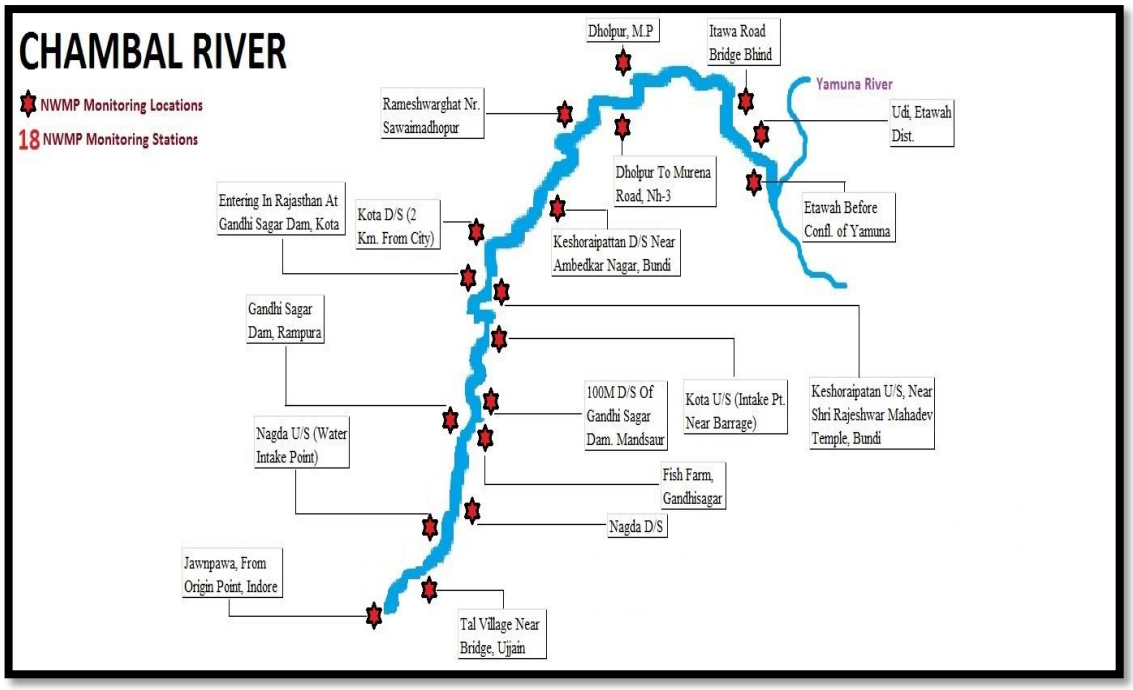


Figure 7.2: State-wise Distribution of Water Quality Monitoring Locations Under NWMP on River Chambal

7.3 Analytical Results

Monitoring of river Chambal was carried out at 8 locations [MP (07) and Rajasthan (01)] during Pre-Lockdown (March 2020) and 13 locations [MP (06) and Rajasthan (07)] during Lockdown period (April 2020) to assess the impact of lockdown on water quality of river Chambal. (**Figure 7.3**)

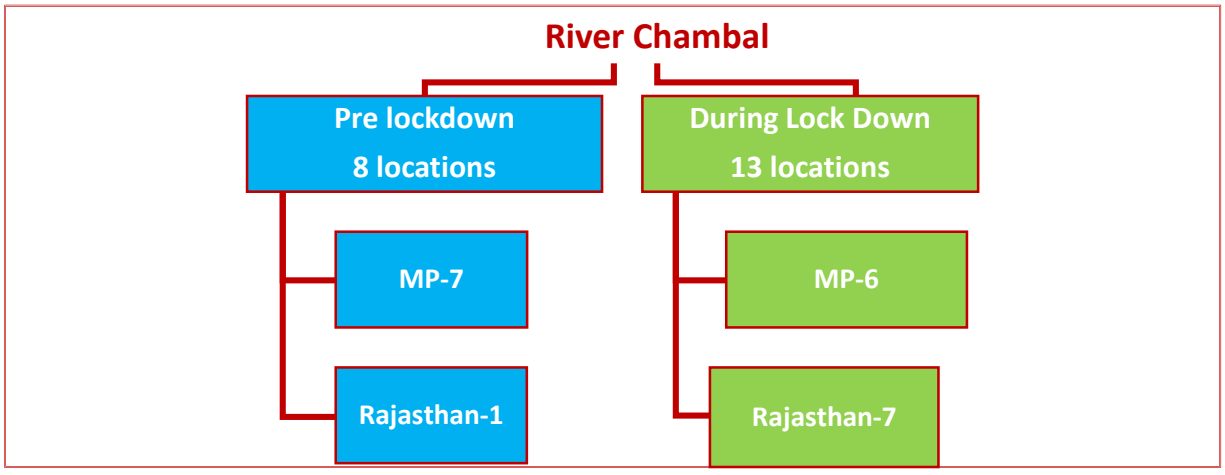


Figure 7.3 Water Quality Monitored locations carried out on river Chambal during pre- lockdown and lockdown

7.4. Observations

Based on the analytical results of the collected semples from river Chambal, following findings/observations are made:

Madhya Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

Four critical parameters were in the order of pH (7 - 8), DO (BDL-7.9 mg/L), BOD (2 -30 mg/L) and FC (2-14000 MPN/100 mL) at the 07 monitored locations.

5 out of 7 monitored locations were complying to the outdoor bathing limits.

BOD at 2 monitored locations and FC at 1 monitored location (D/s Nagda) were not complying to the Primary Water Quality Criteria for Outdoor Bathing whereas pH was complying at all the 07 monitored locations.

Minimum DO as 'Nil', maximum BOD as 30 mg/L and maximum FC (14000 MPN/100 mL) were observed at D/s Nagda, which could be due to discharge of untreated municipal sewage or industrial discharge from Nagda.

During the lock down period (April 2020)

The analysis results for four critical parameters indicate

pH (7.1-7.9), DO (2 - 8 mg/L), BOD (1.5 –28 mg/L) and FC (2 - 14000 MPN/100 mL) at the 06 monitored locations.

4 out of 6 monitored locations were found to be complying to the Primary Water Quality Criteria for Outdoor Bathing.

pH at 06 locations, DO & FC at 05 locations each and BOD at 04 locations were within the desirable limits for Outdoor Bathing.

Minimum DO as '2 mg/L', maximum BOD as 28 mg/L and maximum FC (14000 MPN/100 mL) were observed at D/s Nagda, which could be due to discharge of untreated municipal sewage discharge from Nagda city in.

Overall observations

Decreasing trend for DO (3-14 %) at 3 locations, BOD (6.7 -29 %) at 5 locations and FC (16 -33 %) at 3 locations whereas increasing trend for DO (2.8 - 27 %) at 3 locations was observed. 'No' variation in BOD at 1 location and FC at 3 locations were observed.

Rajasthan- Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

The analysis results of one monitored location indicate

pH (8.1), DO (6.1 mg/L), BOD (1.8 mg/L) and FC (64 MPN/ 100 mL) and complied to the four critical parameters (i.e. pH, DO, BOD and FC) limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Minimum DO as '6.1 mg/L', maximum BOD as 1.8 mg/L and maximum FC (64 MPN/100 mL) at Gandhi Sagar Dam were observed and complying to bathing criteria limits.

During the lock down period (April 2020)

The analysis results revealed that

The analysis results of seven monitored locations for four critical parameters were found in the ranges of pH (8.2-8.6), DO (2.5 - 6.3 mg/L), BOD (1.5 – 4.3 mg/L) and FC (20 - 150 MPN/100 mL).

02 monitored locations were observed to be complying with the analysed critical parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Also, pH at 03 locations, DO at 02 locations, BOD at 04 locations and FC at all the 07 monitored locations were observed to be within the desirable limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Minimum DO as '2.5 mg/L', maximum BOD as 4.3 mg/L and maximum FC (150 MPN/100 mL) were observed at Keshoripattan.

During the lockdown, there was marginal reduction in BOD at Nagada (6.67 %) and no redution w.r.t FC was observed at Nagda D/s.

Overall observations

Decreasing trend of DO (7 %) at one location, BOD (17 %) at one location and FC (39 %) at one monitored location.

7.5 Overall Observations on River Chambal (covering Madhya Pradesh and Rajasthan)

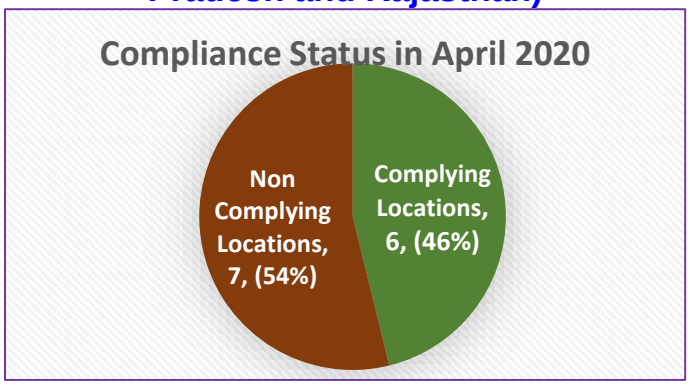


Figure 7.4 Compliance status of monitored locations during lockdown on river Chambal

Over observations on river Chambal revealed that

- Minimum DO ('BDL') was at Nagda D/s and maximum DO (7.9 mg/L) at Tal Village, Near Bridge, Ujjain during pre-lockdown whereas, minimum DO (2 mg/L) was at Nagda D/s and maximum DO (8.0 mg/L) at Dholpur during lockdown.

- Minimum BOD (1.8 mg/L) was at Gandhi Sagar Dam and maximum BOD (30 mg/L) at Nagda D/s during pre-lockdown whereas, minimum BOD (1.5 mg/L) was observed at Dholpur, Gandhi Sagar Dam and at Kota U/s and maximum BOD (28 mg/L) at Nagda D/s during lockdown.

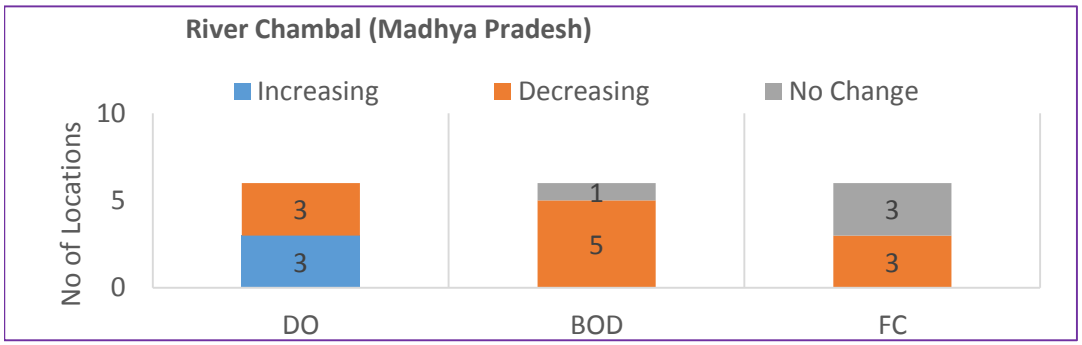
- FC (2 MPN/100 mL) was at Dholpur and Itawa Road Bridge and maximum at Nagda D/s (14000 MPN/100 ml) during pre-lockdown whereas, minimum FC was observed at Dholpur (2 MPN/100 ml) and maximum at Nagda D/s (14000 MPN/100 ml) during lockdown period.

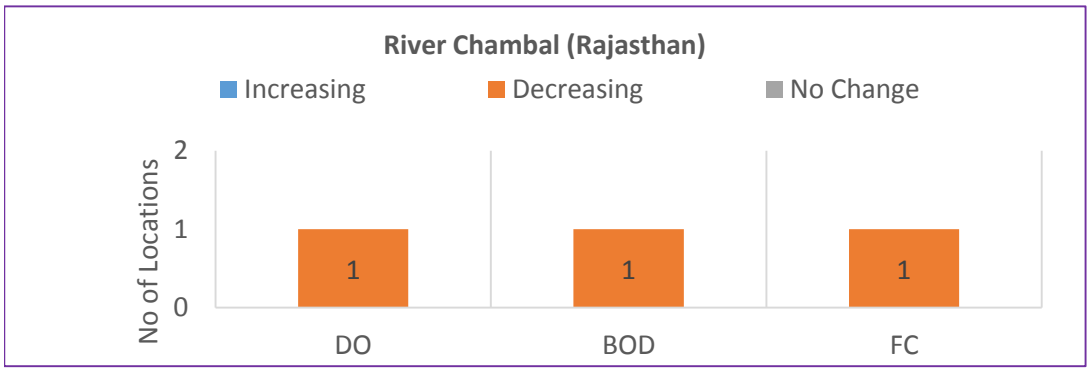
- High values of BOD and FC at Nagda D/s may be attributed to high industrial activity or domestic waste water discharge in the region. However, during lockdown, only marginal reduction in BOD (from 30 to 28 mg/L) was observed at Nagda D/s.

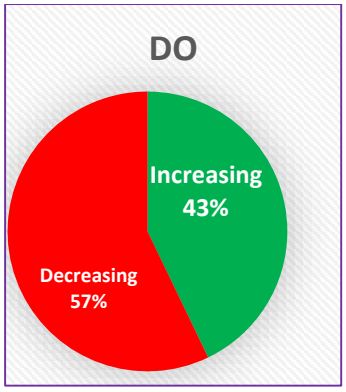
- Decreasing trend of DO (3 -14 %) at 4 locations, BOD (6.7 - 29 %) at 6 locations and FC (16 -39 %) at 4 locations whereas increasing trend of DO (2.8 - 27 %) at 3 locations while 'no' variation in BOD at 1 location and FC at 3 monitored locations were observed.

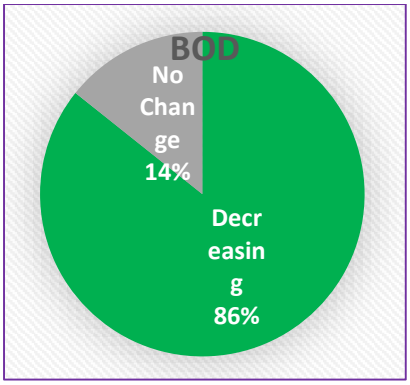
Compliance status of monitored locations on river Chambal during lockdown is given in **Figure 7.4** and River Chambal- Water Quality Trend during Pre (March 2020) and lockdown (April 2020) is given in **Figure 7.5**

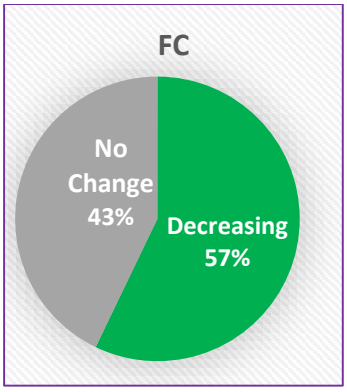
Figure 7.5 River Chambal- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











7.6 Conclusion

- *During Pre-lockdown (March 2020), 6 out of 8 monitored locations and 6 out of 13 monitored locations during lockdown (April 2020) were complying with the Primary Water Quality Criteria for Outdoor Bathing. Although, marginal improvement in water quality of river Chambal was observed with respect to DO, BOD and FC parameters, the water quality of river Chambal was deteriorated in terms of % compliance of monitored locations for the Outdoor Bathing criteria.*

8 Impact of Lockdown on Water Quality of River Ganga

8.1. About Ganga River

The Ganga river rises in the northern most part of Uttarakhand, flows through Uttar Pradesh, Bihar, Jharkhand and West Bengal and finally falls into the Bay of Bengal. Total length of River Ganga (within India) **(Figure 8.1)** is 2,525 kilometres before it discharges into the Bay of Bengal

Facts at a Glance

Tributaries of River Ganga, significant among them are river Yamuna, Gandak, Ghaghra, Gomti, Ramganga, Kosi and Sone.

Large clusters of industrial cities established on its banks like Haridwar in Uttarakhand State; Kannauj, Farukhabad, Kanpur, Allahabad and Varanasi in Uttar Pradesh; Patna, Bhagalpur and Munger in Bihar; Beharampur and Kolkata in West Bengal State.

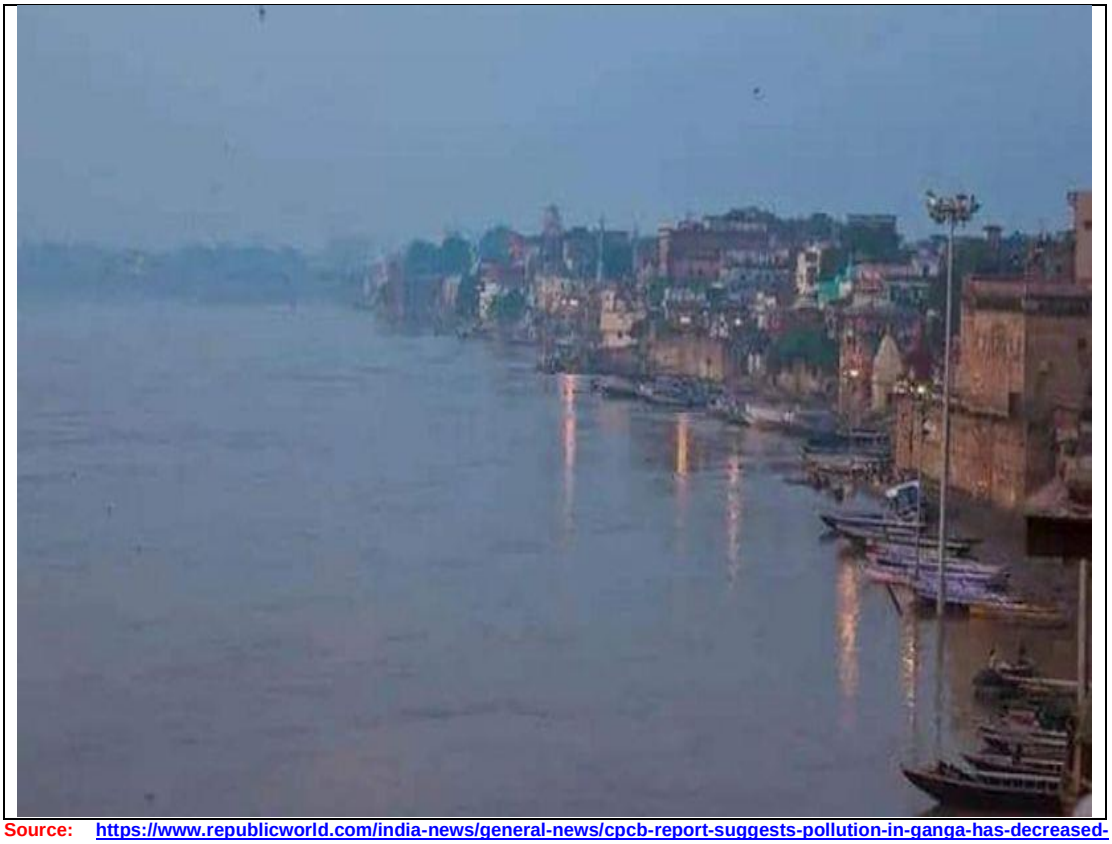
Various categories of industries discharging wastewater into Ganga river includes Sugar, Distilleries, Pulp & Paper, Textiles, Tanneries, Chemicals, Pharmaceuticals, Thermal Power Plants and Food & Dairy Industries etc.

Some of the major hotspots which are responsible for pollution in River Ganga, are in the State of Uttar Pradesh and West Bengal.

Large clusters of industrial cities established on its banks like Haridwar in Uttarakhand State; Kannauj, Farukhabad, Kanpur, Allahabad and Varanasi in Uttar Pradesh; Patna, Bhagalpur and Munger in Bihar; Beharampur and Kolkata in West Bengal State.

In Uttar Pradesh stretch, 16 out of 56 major drain out fall are from Kanpur itself and discharging 2213 (Million Litres per day) of sewage (BOD load of 107 Tonnes per day) into River Ganga. Similarly, there are 58 major drains in West Bengal stretch from which 7375 MLD of sewage (BOD load of 241 TPD) is discharged into River Ganga, and this is the root cause for high BOD in entire West Bengal stretch of river Ganga.

There are 1072 Grossly Polluting Industries (GPIs) in 5 main Ganga States which discharge their industrial effluents in River Ganga.



Source: https://www.republicworld.com/india-news/general-news/cpcb-report-suggests-pollution-in-ganga-has-decreased-since-natinal-lo.html

Figure 8.1. River Ganga at Varanasi

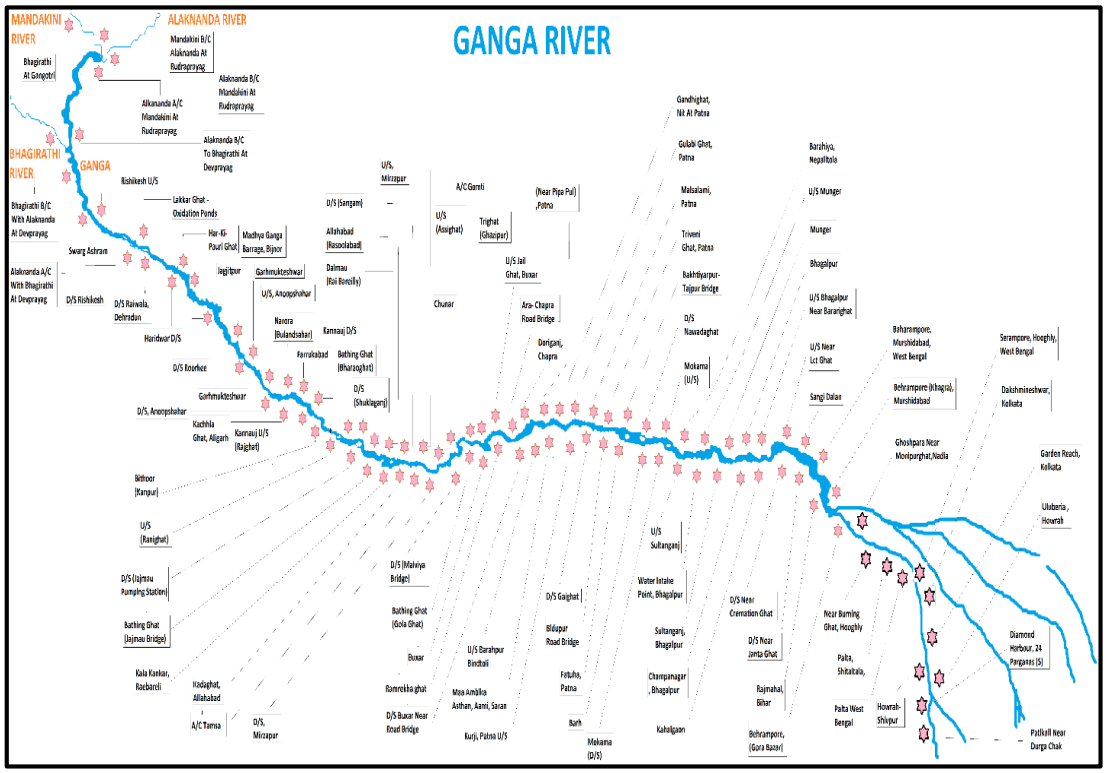


Figure 8.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Ganga

8.2 Water Quality Monitoring Locations on river Ganga under National Water Quality Monitoring Programme (NWMP)

Water Quality of River Ganga is monitored at 97 locations by Central Pollution Control Board in association with the State Pollution Control Boards of Uttarakhand (16), Uttar Pradesh (30), Bihar (33), Jharkhand (04) and West Bengal (14) under National Water Monitoring Programme (NWMP) apart from 36 Real Time Water Quality Monitoring Stations (RTWQMS). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Ganga is depicted in **Figure 8.2**.

8.3. Analytical Results

Water quality of river Ganga was examined at 65 locations [UK (6), UP (27), Bihar (17), Jharkhand (04), WB (11)] during Pre-lockdown (March 2020) and 54 locations [UK (5), UP (14), Bihar (17), Jharkhand (04), WB (14)] during lockdown period (April 2020) to assess the impact of lock-down **(Figure 8.3)**

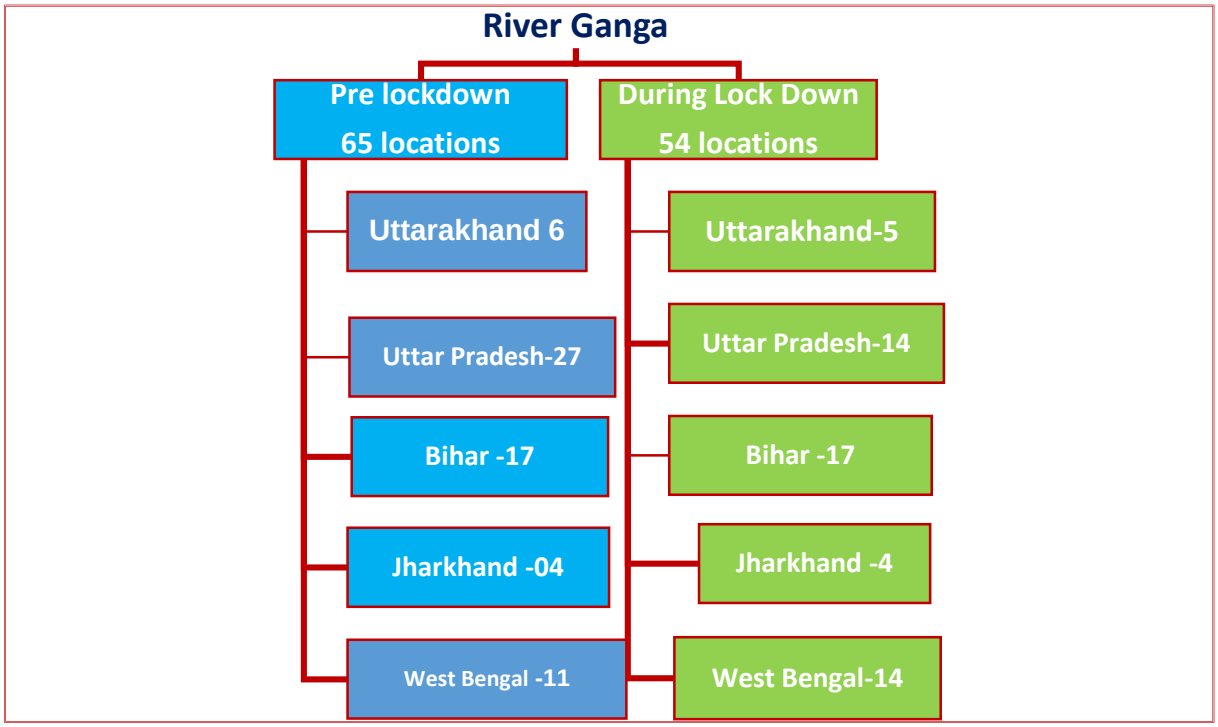


Figure 8.3. Water Quality Monitoring Carried out during Pre and Lockdown on River Ganga

8.4. Observations

Based on the analytical results of the collected samples from river Ganga, the following findings/observations are made

Uttarakhand-Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

The analysis results for four critical parameters were observed in the order of pH (6.6 - 7.9), DO (9.6 - 11.6 mg/L), BOD (1.0 - 1.2 mg/L) and FC (17 - 60 MPN/100mL) for 06 monitored locations.

All 06 monitored locations were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results revealed that

The analysis results for four critical parameters were noticed in the ranges of pH (7.5 - 8.2), DO (9.8 - 10.6 mgL), BOD (0.6 - 1.2 mg/L) and FC (12 – 60 MPN/100mL) at the 05 monitored locations.

All 05 monitored locations were observed to be within the desirable limits for Primary Water Quality Criteria for Outdoor Bathing

Overall Observations

Increasing trend of DO (4 %) at 2 locations and decreasing trend of DO (2 to 9 %) at 3 locations whereas decreasing trend of BOD (17 - 40 %) at 4 locations, 'no' variation in BOD was observed at 1 location. Increasing trend of FC (33 %) at 1 location and decreasing trend of FC (29-35 %) at 2 locations and 'no' variation at 2 monitored locations were observed.

Uttar Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results designates

Four critical parameters in the order of pH (3.3 - 8.6), DO (8.0 - 10.6 mg/L), BOD (1.0 - 4.6 mg/L) and FC (170 -31000 MPN/100mL) at the 27 monitored locations.

14 out of 27 monitored locations were found complying with the Primary Water Quality Criteria for Outdoor Bathing.

Also, pH at 25 locations, DO at 27 locations, BOD at 14 locations and FC at 15monitored locations were complying with the criteria limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results designates

The analysis results for outdoor bathing criteria were observed in the ranges of pH (7.4 - 8.7), DO (8.1 - 10.7 mg/L), BOD (0.9 - 4.0 mg/L) and FC (130-9400 MPN/100mL) at the 14 monitored locations.

pH at 11 locations, DO at all 14 monitored locations, BOD at 09 locations and FC at 08 monitored locations were complying with the criteria limits for outdoor bathing.

Also, 8 out of 14 monitored locations were found to be within the desirable limits for Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1 -13 %) at 8 locations and decreasing trend of DO (2 - 9 %) at 6 locations, increasing trend of BOD (7 - 33 %) at 4 locations and decreasing trend of BOD (3 - 20 %) at 9 locations. 'No' variation was observed at 1 location. Also, decrease in variation of FC (33 - 67 %) at 10 monitored locations were observed..

Bihar-Observations

During the pre-lock down period (March 2020)

The analysis results showed that

The analysis results for four critical parameters were found to be in the order of pH (7.8 - 8.9), DO (6.3 - 10 mg/L), BOD (1.4 - 2.6 mg/L) and FC (2600-160000 MPN/100mL) at the 17 monitored locations.

All 17 monitored locations were found complying with the criteria limits outdoor bathing parameters.

During the lock down period (April 2020)

The analysis results showed that

The analysis results for four criteria parameter were noticed in the order of pH (8.0 - 8.4), DO (7.6 - 9.7 mg/L), BOD (1.4 -2.1 mg/L) and FC (680-14000 MPN/100mL) at the 17 monitored locations.

6 out of 17 monitored locations were observed within the desirable limits for Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

The analysis results revealed increasing trend for DO (1 -38 %) at 8 locations whereas decreasing trend for DO (1 - 15 %) at 7 locations.

Increasing trend were shown for BOD (5 -36 %) at 9 locations and FC (27 %) at 1 monitored location. Decreasing trend for BOD (6-27 %) at 4 locations and 'no' variation was observed at 2 monitored locations whereas decreasing trend for FC (18 -94 %) at 14 monitored locations were observed.

Jharkhand-Observations

During the pre-lock down period (March 2020)

The analysis results indicate that

The analysis results for four critical parameters were found to be in the order of pH (8.2 - 8.4), DO (consistent as 8.6 mg/L) and BOD constant as 2.6 mg/L at the 04 monitored locations.

04 monitored locations complying with the Primary Water Quality Criteria for Outdoor Bathing. However, FC was not been analysed and reported by the Jharkhand SPCB.

During the lock down period (April 2020)

The analysis results indicate that

The analysis results for the analyzed parameters were observed to be in the order of pH (7.1 - 7.2), DO (9.2 - 9.6 mg/L), BOD (1.5 -1.8 mg/L) at the 04 monitored locations

All the 04 monitored locations were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing

Overall Observations

Increasing trend for DO (7 -12 %) and decreasing trend for BOD (31 -42 %) at all the 4 monitored locations. ..

West Bengal-Observations

During the pre-lock down period (March 2020)

The analysis results showed that

The analyzed parameters are in the order of pH (6.8 - 8.6), DO (5.0 - 9.1 mg/L), BOD (1.75- 4.5 mg/L) and FC (900 -140000 MPN/100mL) at the 11 monitored locations.

All pH at 10 locations, DO at 11 locations, BOD at 05 locations whereas FC at 01 location were found to be complying with the criteria limits. Only 1 out of 11 monitored locations were found to be within the desirable limits for Primary Water Quality Criteria for Outdoor Bathing.

.

During the lock down period (April 2020)

The analysis results showed that

During the lockdown period (April, 2020), the analysis results of four critical parameters were found to be in the order of pH (6.8 - 8.5), DO (3.9 - 9.6 mg/L), BOD (1.05 - 5.5 mg/L) and FC (790 - 140000 MPN/100mL) at the 14 monitored locations.

Also, pH at all 14 locations, DO at 11 locations, BOD at 06 locations and FC at 02 monitored locations were observed to be within the desirable limits as per Primary Water Quality Criteria for Outdoor Bathing.

Only 2 out of 14 monitored locations were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend were showed for DO (7-22 %) at 4 locations, BOD (4 -67 %) at 6 locations and FC (75 -325 %) at 2 monitored locations whereas decreasing trend were shown for DO (7-40 %) at 7 locations, BOD (7 -71 %) at 5 locations and FC (15 - 95%) at 8 monitored locations.

8.5. Overall Observations on river Ganga (covering 5 States- Uttarakhand, U.P, Bihar, Jharkhand and West Bengal)

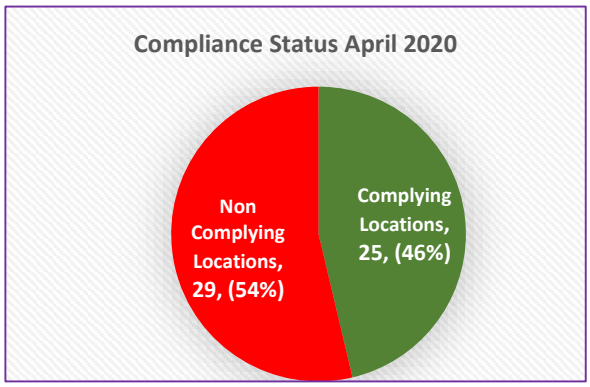


Figure 8.4. Overall Compliance Status of Monitoring Locations on River Ganga During Lockdown (April 2020)

The analysis results reveaedl that

- During pre-lockdown period (March, 2020), in Uttarakhand (6 out of 6 monitored locations), in UP (14 out of 27 monitored locations), in Bihar (17 out of 17 monitored locations), in Jharkhand (04 out 4 monitored locations) and in WB (1 out of 11 monitored locations) and overall, 42 out of 65 monitored locations were complying with the Outdoor Bathing criteria.

- During lockdown period (April 2020), in Uttarakhand (5 out of 5 monitored locations), in UP (8 out of 14 monitored locations), in Bihar (6 out of 17 monitored locations), in Jharkhand (all 4 monitored locations) and in WB (2 out of 14 monitored locations) and overall, 25 out of 54 monitored locations were found to be within the desirable limits for Outdoor Bathing criteria

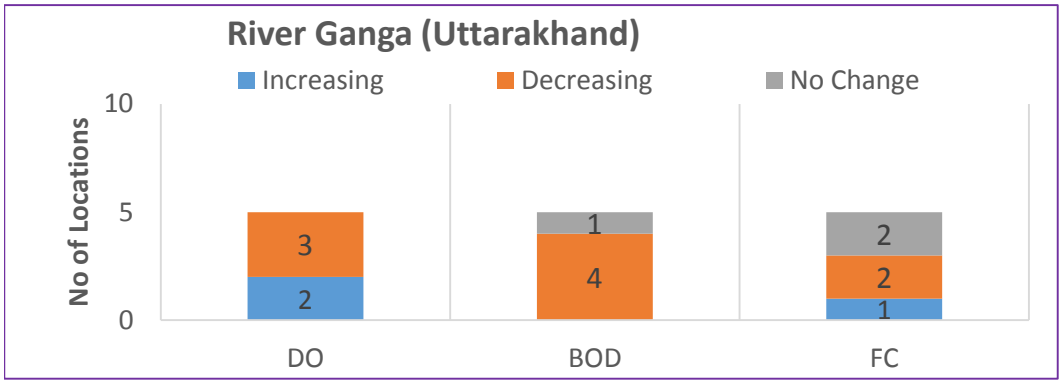
- During lockdown, maximum DO was at Kachhla Ghat, Aligarh (10.7mg/L) and minimum at Howrah-Shivpur, WB (3.9 mg/L). Maximum BOD was observed at Khagra as (5.5 mg/L) and minimum as 'BDL' at 04 locations viz., Kachhla Ghat, Aligarh, Rishikesh U/s, D/s Rishikesh and Har-ki-Pauri Ghat while maximum FC count was observed at Garden Reach, West Bengal and Palta Shitalatala (140000MPN/100 mL) and minimum at Rishikesh U/s (12 MPN/100 mL).

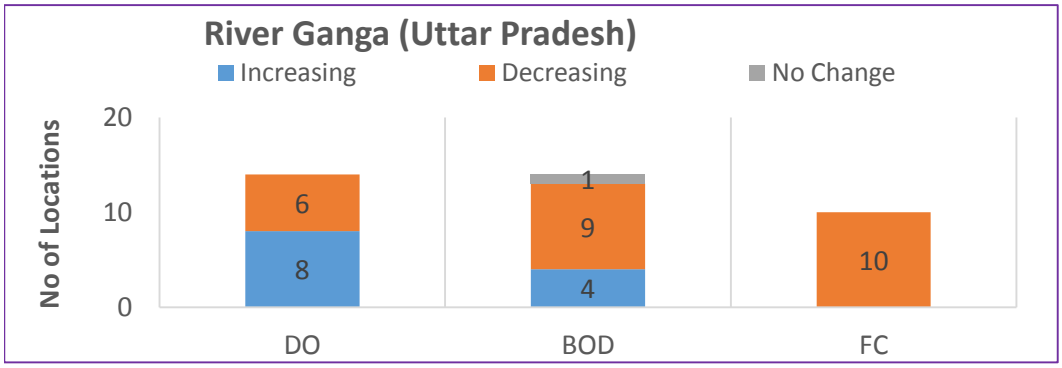
- Increasing trend were observed for DO (1% - 38%) at 26 locations, BOD (4-67 %) at 19 locations and 'no' variation at 4 monitored locations while FC (27 - 325 %) at 4 monitored locations.

- Decreasing trend w.r.t DO (1% - 40%) at 23 locations, BOD (3-71 %) at 26 locations and FC (15 - 95 %) at 34 locations were observed. No' variation in FC was observed at 2 monitored locations.

Overall compliance status during lockdown is given in **Figure 8.4** and Trend analysis on river Ganga during pre and lockdown is given at **Figure 8.5 to Figure 8.6**

Figure 8.5 River Ganga- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





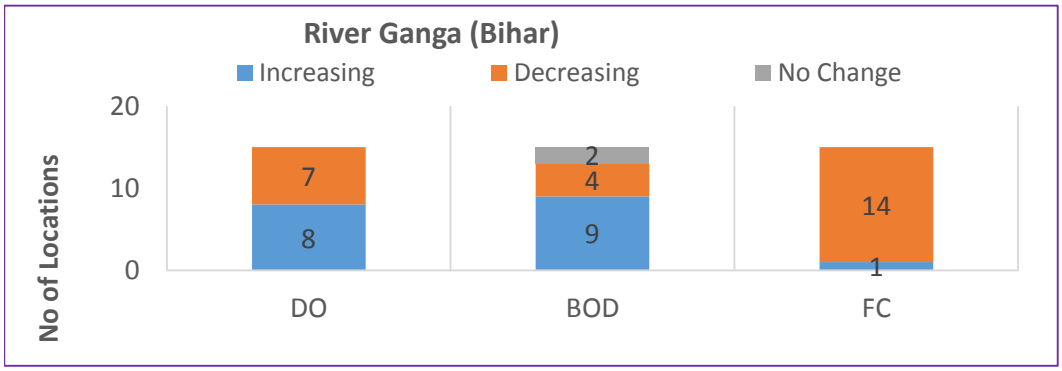
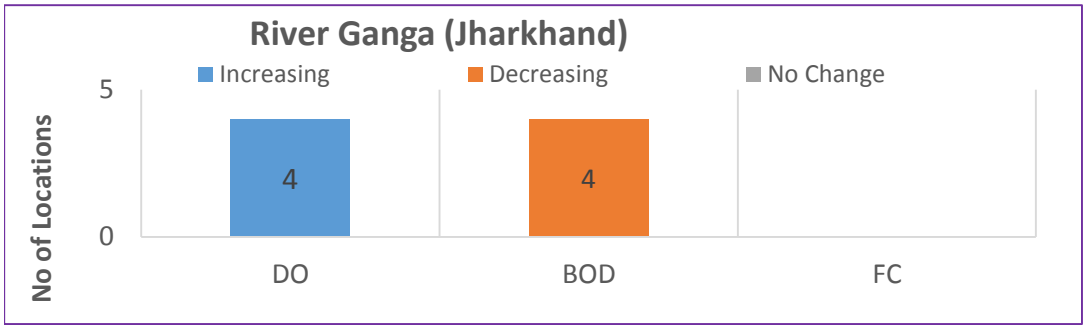
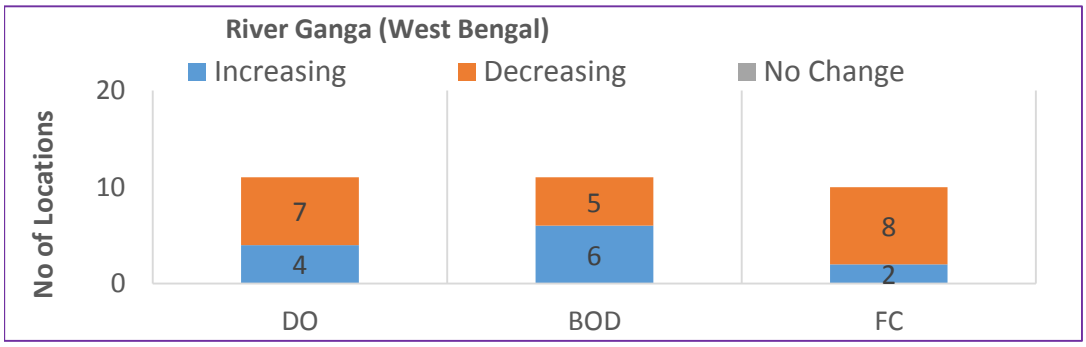
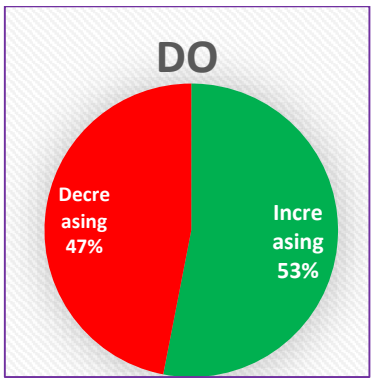
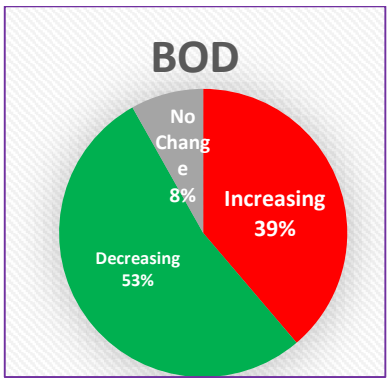


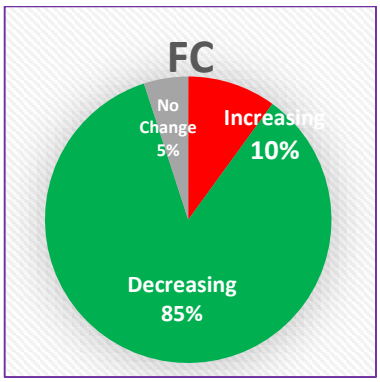
Figure 8.6 River Ganga- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











8.6. Conclusion

- *During pre-lockdown, 42 out of 65 monitored locations (64.6 %) and during lockdown, 25 out of 54 monitored locations (46.3 %) were found to be within the desirable limits of Primary Water Quality Criteria for Outdoor Bathing. Also, overall moderate improvement in water quality of River Ganga was observed with respect to the parameters i.e., DO, BOD and FC.*

9 Impact of Lockdown on Water Quality of River Ghaggar

9.1 About Ghaggar River

The Ghaggar river is an intermittent river that originates in the Shivalik Hills of Himachal Pradesh and flows about 320 kilometre length through Punjab, Haryana and Rajasthan States. The river is known as 'Ghaggar' before the Ottu barrage and as the 'Hakra' downstream of the Ottu barrage. Main sources of pollution identified contributing to pollution in river Ghaggar (Figure 9.1) from Haryana includes main drains such as Sukhna Nallah, Jatton Wala Nallah, MDC Drain, Ambala Drain, Ghail drain, Sagarpara (Saraswati) Drain, Kaithal Drain and Ratia Drain where as from Punjab State main drain such as Sukhna Choe, Derabessi drain, Thermal Choe, Petick drain, Kaithal drain, Sirhin Choe etc. Non-availability of adequate infrastructure facilities in the catchment area of river Ghaggar for treatment of generated sewage and solid waste apart from other factors including discharge of treated or partially treated/untreated sewage and industrial discharges.

Facts at a Glance

Major Towns: *Major towns on the banks of river Ghaggar within the jurisdiction of Haryana include Kurukshetra, Ambala, Karnal, Sirsa, Hissar and Jind whereas in Punjab State major towns are Khanaur, Moonak, Mohali, Derabassi, Rajpura, Sardulgarh, Sirhind, Zirakpur, Patiala, Sangrur, Ghanaur.*

Major Tributaries *on the left bank of river Ghaggar are River Markhanda, Tangri and Chautang.*

Major industrial establishments *on the banks of river Ghaggar comprises sugar, distillery, pulp and paper industries.*

Figure 9.1 River Ghaggar at Chanderpur Syphon

9.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP) on River Ghaggar

The Water Quality of river Ghaggar is monitored at 19 locations by Central Pollution Control Board (CPCB) in association with the Punjab Pollution

Control Board (PPCB) and Haryana State Pollution Control Board (HSPCB) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Ghaggar is depicted in **Figure 9.2**

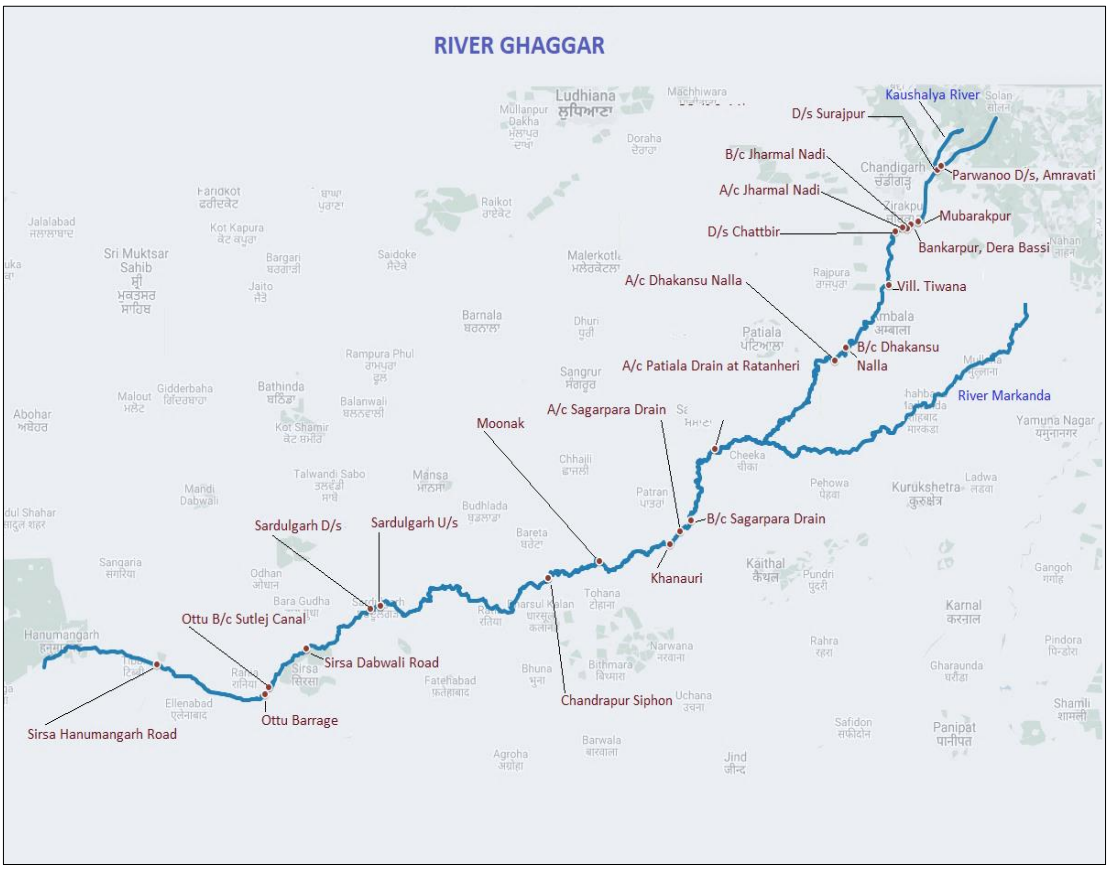


Figure 9.2 State-wise Distribution Water Quality Monitoring Locations under NWMP on River Ghaggar

9.3 Analytical Results

Water quality of river Ghaggar was carried out at 19 locations (i.e., 5 locations in Haryana and 14 locations in Punjab) during Pre-Lockdown and Lockdown period to assess the impact on water quality of river Ghaggar (**Figure 9.3**).

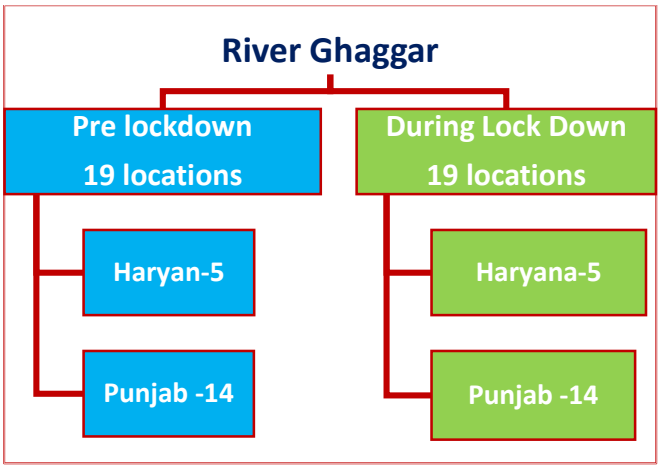


Figure 9.3 Water Quality Monitoring Locations carried out during Pre-lockdown and Lockdown

9.4 Observations

Based on the analytical results of the samples collected from river Ghaggar, following findings/observations are made:

Haryana-Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

Four critical parameters were in the ranges of pH (7 - 9.1), DO (0.9 - 9.2 mg/L), BOD (4 – 64 mg/L) and FC (33000 – 35000 MPN/100 mL) at the 5 monitored locations.

Also, pH at 4 locations, DO at 2 locations while BOD & FC were not complying to the limits prescribed under primary water quality criteria for outdoor bathing, at any of the monitored locations.

Maximum DO (9.2 mg/L) was at D/s of Surajpur and minimum DO (0.9 mg/L) at before Ottu Weir. Maximum BOD (64 mg/L) was at Before Ottu Weir and minimum BOD ('4 mg/l') at D/s of Surajpur. Maximum FC observed at Before Ottu Weir (35000 MPN/100 mL) and minimum at D/s Markanda (33000 MPN/100 mL).

All 4 monitored locations are not complying to the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results revealed that

Four critical parameters were in the order of pH (7.3 - 8.4), DO (6.4 – 8 mg/L), BOD (16 – 22 mg/L) and FC (17000 – 64000 MPN/100 mL) at the 5 monitored locations

Maximum DO (8 mg/L) was at D/s of Surajpur and minimum DO (6.4 mg/L) at Before Ottu Weir.

Maximum BOD (64 mg/L) was at Before Ottu Weir and minimum BOD ('16 mg/l') at Sirsa-Dabwali road. Maximum FC at (64000 MPN/100 mL) was at Chanderpur Syphen and minimum (17000 MPN/100 mL) at D/s of Surajpur.

Reduction in BOD from 64 mg/L to 22 mg/L (67.19 %) whereas FC reduced from 35000 to 21000 MPN/100 mL (

All 5 monitored locations are non-complying to the Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

During the lockdown and pre-lockdown period, increasing trend of DO (9.7 - 611.1 %) at 3 locations and BOD (140 %) at 1 location were observed. Also, the analysis results indicate decreasing trend of DO (13 %) at 1 location, BOD (65.6 -70.4 %) at 2 locations and FC (36.4 -50 %) at 3 monitored locations were observed. All 5 monitored locations not complying to the Bathing Water Quality Criteria limits.

Punjab-Observations

During the pre-lock down period (March 2020)

The analysis results revealed that

Four critical parameters were in the order of pH (6.8 - 8), DO (1.9 – 6.9 mg/L), BOD (11 – 43 mg/L) and FC (2700 – 4700 MPN/100 mL) at the 14 monitored locations.

Maximum DO (6.9 mg/L) was at Mubarakpur and minimum DO (1.9 mg/L) at Moonak. Maximum BOD (43 mg/L) was observed at D/s Chatbir and minimum BOD as '11 mg/l' at Mubarakpur.

Maximum FC count (4700 MPN/100 mL) was observed at D/s after mixing with Sagarpara Drain and minimum (2700 MPN/100 mL)at U/s Dhakansu Nallah.

All 14 monitored locations were not complying with the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results revealed that

Four critical parameters were in the order of pH (7.3 – 7.8), DO (3.1 – 7.3 mg/L), BOD (5 – 20 mg/L) and FC (1400 – 2700 MPN/100 mL) at the 14 monitored locations

Maximum DO was observed at Mubarakpur (7.3 mg/L)) and minimum at D/s after mixing with Sagarpara Drain (3.1 mg/L).

Maximum BOD was at D/s after mixing with Sagarpara Drain (20 mg/L). Minimum BOD (5 mg/L) was at Mubarakpur Rest House (Patiala) and U/s Dhakansu Nallah.

Maximum Fecal Coliform (FC) observed at D/s after mixing with Sagarpara Drain (2700 MPN/100 mL) and minimum at Mubarakpur Rest House (Patiala) (1400 MPN/100 mL).

All 14 monitored locations are not complying to the Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (5.8 -131.8 %) at 14 locations, decreasing trend of BOD (21.7-81.4 %) at 14 locations and FC (31.6-63 %) at 14 monitored locations were observed. All the 14 monitored locations failed to comply with the Bathing Water Quality Criteria Limits.

9.5 Overall Observations on Water Quality of River Ghaggar (covering Haryana & Punjab)

The analysis results revealed that

- During the pre-lockdown, pH at 19 locations and DO at 4 locations were within the desirable limits prescribed under the primary water quality criteria for outdoor bathing whereas BOD & FC were not complied to the criteria limits at all 19 monitored locations.

- During the lockdown, pH at 19 locations, DO at 9 locations and FC at 12 monitored locations were found to be complying to the primary water quality criteria for outdoor bathing.

- Increasing trend of DO (5.8 to 611.1 %) at 17 locations, BOD (140%) at 1 location and decreasing trend of DO (13 %) at 1 location, BOD (21.7 to 81.4 %) at 16 locations and FC (31.6 % to 63 %) at 17 monitored locations were observed.

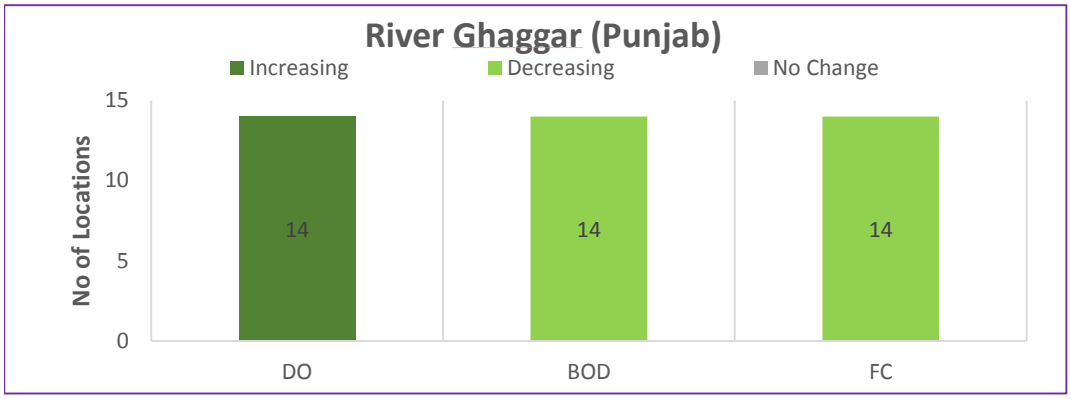
- Reduction in BOD was observed from 64 mg/L to 22 mg/L at Before Ottu Weir (65.63 %) and from 54 to 16 mg/L at Sirsa (70.37 %). Decrease in FC was observed from 35000 to 21000 MPN/100 ml at Before Ottu Weir.

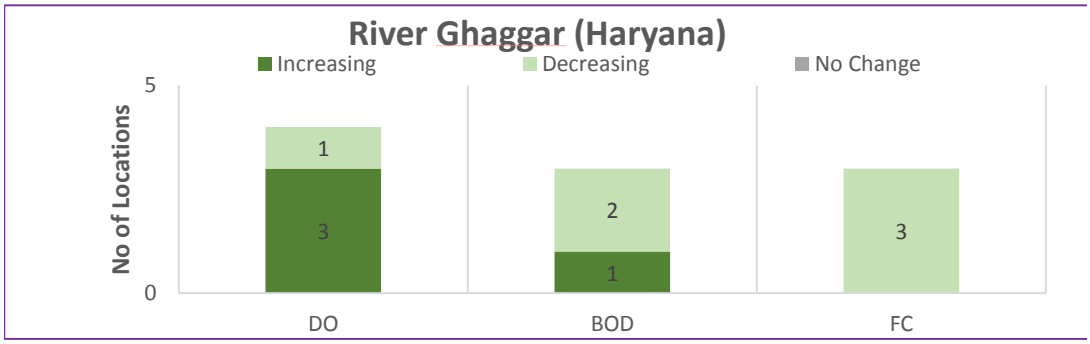
- *All the 19 monitored locations failed to comply with the Primary Water Quality Criteria for Outdoor Bathing.*

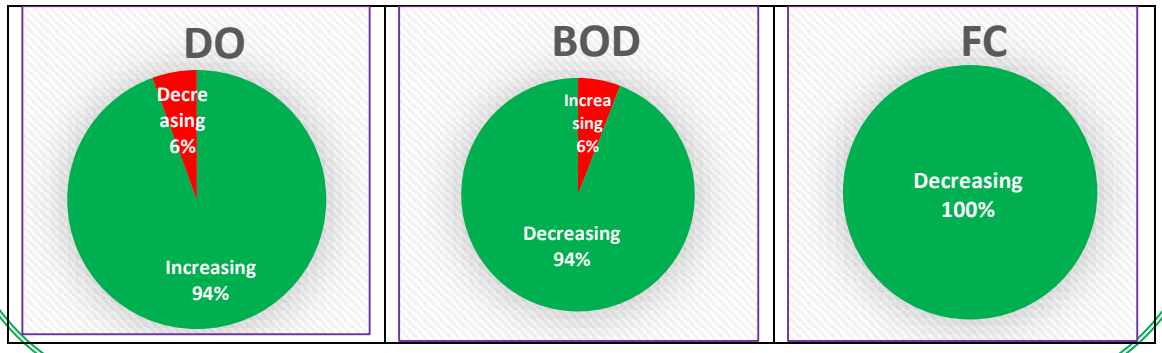
9.6 Water Quality Trend of River Ghaggar

Water Quality trend of river Ghaggar as observed during pre-lockdown and lockdown are given in **Figure 9.4**

Figure 9.4 River Ghaggar- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)







9.7. Conclusion

- *None of the monitored locations on river Ghaggar during pre and lockdown period were complying with the Primary Water Quality Criteria for Outdoor Bathing. However, decreasing trend of BOD & FC values during lockdown period indicate marginal improvement in water quality of river Ghaggar.*

10 Impact of Lockdown on Water Quality of River Godavari

10.1 About Godavari River

The River Godavari **(Figure 10.1)** is 1,465 km long and ranks as India's second longest river after river Ganga and it flows from western to southern India. It is also referred to as Dakshin Gangotri. It originates at Triambakeshwar, Western Ghats (Brahmagiri hills), Nashik district, Maharashtra. Main stream of Godavari flows through Maharashtra, Telangana & Andhra Pradesh and ultimately emptying into the Bay of Bengal at Narasapuram in West Godavari District, Andhra Pradesh (AP).

Facts at a Glance

Major Towns or Cities on the banks of River Godavari: *Triambakeshwar, Nashik, Nanded, Gangakhed, Gevrai, Sironcha in Maharashtra. In Telangana State, main towns or cities are Nirmal, Basara, Adilabad, Battapur, Tadpakala, Dharmapuri, Goodem Gutta, Manthani, Kaleshwaram, Godavarikhani, Mancherial, Bhadrachalam and in AP, main towns or cities located on the banks of river Godavari are Yanam, Rajahmundry, Tallapudi, Kovvur, Antarvedi, Narsapur and Tadipudi.*

Major Tributaries of the Godavari River*:*
Left tributaries of Godavari are river Purna, Indravati, Banganga, Kadva, Shivana, Sabari, Pranhita, Kadam and Taliperu. Right tributaries of Godavari are river Darna, Maner, Nasardi, Manjeera, Sindphana, Pravara and Kinnerasani.

Major industrial activities *are centred mainly at Aurangabad, Nashik, Rajahmundry. Sugar and distillery units are large in number in Maharashtra followed by pharmaceuticals, leather, pulp and paper as well as pesticide units. In Andhra Pradesh, sugar and distillery units are large in number followed by Pulp & Paper and fertilizer industries on the catchment of river Godavari.*

Figure 10.1 River Godavari at Basara

10.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP) on River Godavari

Water Quality of river Godavari is monitored at 43 locations by CPCB in association with Maharashtra Pollution Control Board (MPCB), Telangana State Pollution Control Board (TSPCB) and Andhra Pradesh Pollution Control Board (APPCB) as well as CPCB (Vadodara & Bengaluru) under NWMP. State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Godavari is depicted in **Figure 10.2.**

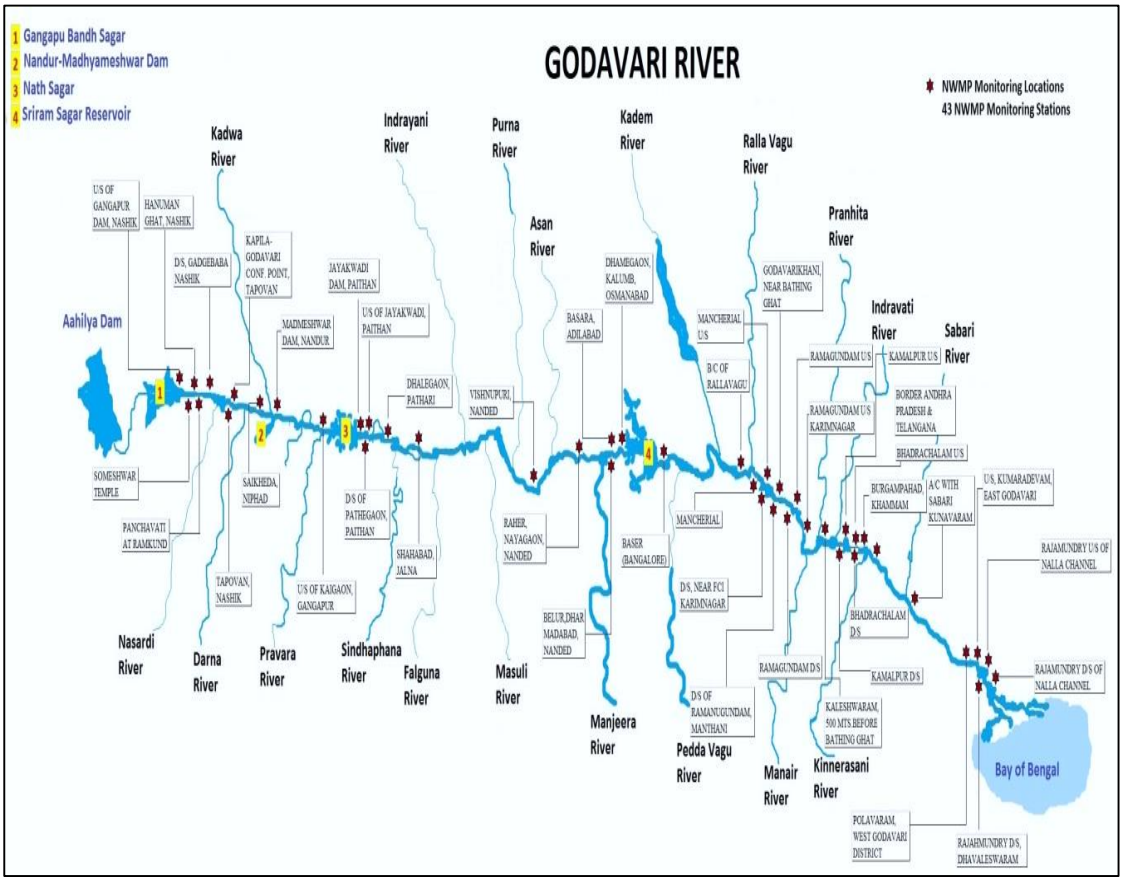


Figure 10.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Godavari

10.3 Analytical Results

Water quality of river Godavari was carried out at 38 locations during Pre-Lockdown (March 2020) [Maharashtra (14), Telangana (17) and AP (7)] and at 37 locations during Lockdown period (April 2020) [Maharashtra (14), Telangana (16) and AP (7)] to assess the impact on water quality of river Godavari (**Figure 10.3**)

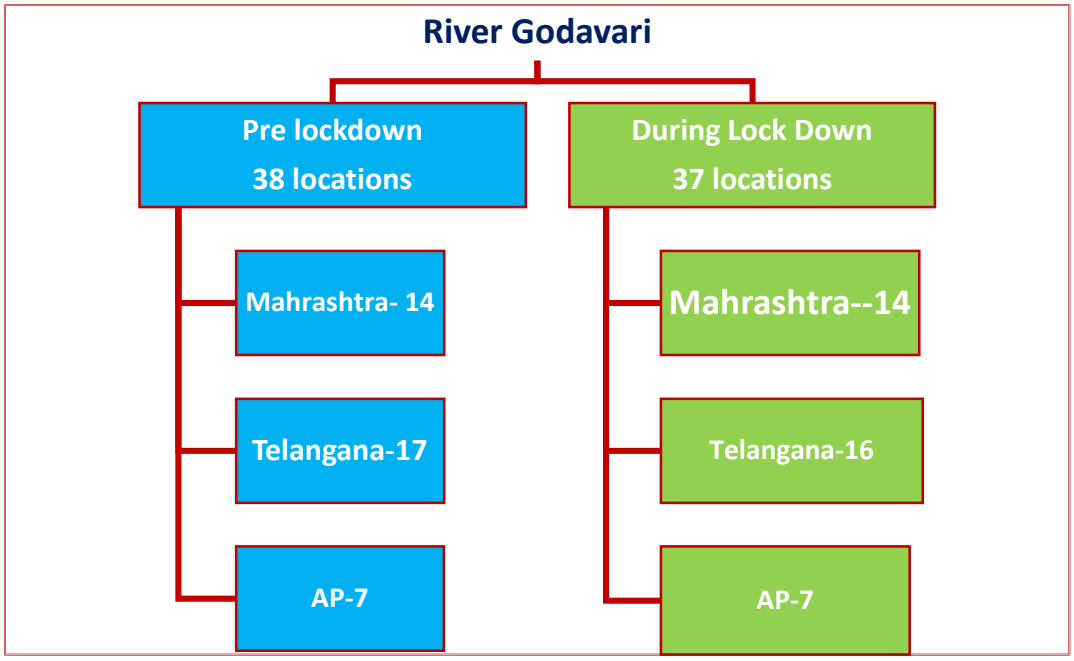


Figure 10.3 Water Quality Monitoring Locations carried out during Pre-lockdown and Lockdown on River Godavari

10.4 Observations

Based on the analytical results of the samples collected from river Godavari, following findings/observations are made:

Maharashtra-Observations

During the pre-lock down period (March 2020)

The analysis results of 14 monitored locations revealed that

The parameters were in the order of pH (7.1 - 8.1), DO (3.1 - 6.9 mg/L), BOD (2.2 - 8.8 mg/L) and FC (2 – 70 MPN/100 mL) at all the 14 monitored location

Maximum DO (6.9 mg/L) was observed at Dhlegaon, Parbhani and minimum DO (3.1 mg/L) at Tapovan whereas maximum BOD (8.8 mg/L) was observed at Tapovan and minimum BOD (2.2 mg/L) at Dhalegaon, Parbhani.

Maximum FC (70 MPN/100 mL) was at Tapovan (could be due to wastewater discharge from Tapovan) and minimum FC (2 MPN/100 mL) was at 8 locations.

5 out of 14 monitored locations were found to be within the desirable limits of Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 14 monitored locations revealed that

The four critical parameters were in the range of pH (7 - 8.1), DO (5 - 6.8 mg/L), BOD (2.4 - 6.2 mg/L) and FC (2 – 47 MPN/100 mL) at the 14 monitored locations.

Maximum DO (6.8 mg/L) was at U/s Intake Pump House, Jayakwadi and minimum DO (5 mg/L) at Tapovan whereas maximum BOD (6.2 mg/L) was observed at Tapovan and minimum BOD (2.4 mg/L) at U/s Intake Pump House, Jayakwadi.

Maximum FC count (47 MPN/100 mL) was observed at Tapovan (due to wastewater discharge from Tapovan) and minimum FC (2 MPN/100 mL) was observed at 8 locations.

8 out of 14 monitored locations were found to be complying with the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.5% - 61.3 %) at 9 locations, BOD (7.7-27.3 %) at 3 locations, FC (28.6 %) at 1 location, and decreasing trend of DO (1.5 -3.1%) at 3 locations, BOD (5.9 -29.5 %) at 10 locations, FC (15 -45.5 %) at 4 locations. 'No' variation in DO (at 2 locations), BOD (at 01 location) and FC (at 09 locations) were observed.

Telangana-Observations

During the pre-lock down period (March 2020)

The analysis results of 17 monitored locations revealed that

The analysis results for the four critical parameters were observed to be in the order of pH (7.2 - 10.7), DO (4.1 - 7.3 mg/L), BOD (2.1 – 4 mg/L) and FC (2 – 20 MPN/100 mL).

Maximum DO (7.3 mg/L) was observed at Pochara Water Fall, Adilabad and minimum DO (4.1 mg/L) at D/s Ramagundam.

Maximum BOD (4 mg/L) was observed at Ramagundam and minimum was at (2.1 mg/L) at 1 location

Maximum FC count (20 MPN/100 mL) was observed at D/s Ramagundam (due to wastewater discharge from Ramagundam) and minimum FC (2 MPN/100 mL) was at 8 locations.

14 out of 17 monitored locations were within the desirable limits Primary Water Quality Criteria for Outdoor Bathing.

Also, pH and BOD at 16 locations, DO at 14 locations, FC at 17 locations were complying with the bathing criteria limits.

During the lock down period (April 2020)

The analysis results of 16 monitored locatios revealed that

The analysis results for the four critical parameters observed to be in the order of pH (7.3 - 11.3), DO (4 - 7.6 mg/L), BOD (2.1 – 4 mg/L) and FC (2 – 22 MPN/100 mL).

Maximum DO (7.6 mg/L) was observed at Basara and minimum DO (4 mg/L) at Burgampahad whereas maximum BOD (4 mg/L) was observed at Ramagundam and minimum was observed at (2.1 mg/L) at 10 locations. Maximum FC count (22 MPN/100 mL) was observed at D/s Ramagundam (due to wastewater discharge from Ramagundam) and minimum FC (2 MPN/100 mL) was observed at 4 locations.

14 out of 16 monitored locations were found to be complying to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Also, pH & BOD at 15 locations, DO at 14 locations, BOD and FC at all the 16 monitored locations were complying to the bathing water quality criteria limits

Overall Observations

Increasing trend of DO (4.2- 46.3 %) at 9 locations, BOD (14.3 -33.3 %) at 2 locations, FC (46.7-100 %) at 3 locations and decreasing trend of DO (1.4 -28.6%) at 3 locations, BOD (3.3-30 %) at 5 locations. No' variation in DO (at 4 locations), BOD (at 09 locations) and FC (at 13 locations) were observed.

Andhra Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 7 monitored locations revealed that

The analysis results for the four critical parameters were found in the order of pH (7.4 - 8.7), DO (6.5 - 8.5 mg/L), BOD (1.4 - 2.3 mg/L) and FC (3 – 15 MPN/100 mL) at the 7 monitored locations.

Maximum DO (8.5 mg/L) was observed at Rajahmundry U/s Nallah Channel and minimum DO (6.5 mg/L) at 2 locations.

Maximum BOD (2.3 mg/L) was observed at Polavaram and minimum (1.4 mg/L) was at 2 locations (U/s Rajahmundry at Kumaradevam and U/s Rajahmundry at Dhawaleswaram).

Maximum FC count (15 MPN/100 mL) was observed at 2 locations (D/s Rajahmundry, Dhawaleswaram and at Rajahmundry D/s Nallah Channel) and minimum FC (3 MPN/100 mL) was observed after confluence of Sabari at Kunavaram.

6 out of 7 monitored locations were shown compliance to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 7 monitored locations revealed that

The analysis results indicates pH (7.5 - 8.2), DO (6.2 - 6.8 mg/L), BOD (1.2 - 2.2 mg/L) and FC (4 – 11 MPN/100 mL).

Maximum DO (6.8 mg/L) was observed at 3 locations and minimum DO (6.2 mg/L) at D/s Rajahmundry, Dhawaleswaram.

Maximum BOD (2.2 mg/L) was observed at D/s Rajahmundry, Dhawaleswaram and minimum (1.2 mg/L) was at U/s Rajahmundry at Kumaradevam.

Maximum FC count (11 MPN/100 mL) was observed at Rajahmundry D/s Nalla Channel) and minimum FC (4 MPN/100 mL) was observed at 4 locations.

All the 7 monitored locations were within the desirable limits of the Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.5 %) at 1 location, BOD (5.6-57.1 %) at 3 locations, FC (33.3 %) at 1 location and decreasing trend of DO (1.5-26.2 %) at 5 locations, BOD (13.3-40.9 %) at 4 locations and FC (26.7-63.6 %) at 5 locations were observed. 'No' variation was observed in DO (at 1 location) and FC (at 1 location).

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10.5. Overall Observations on Water River Godavari (covering Maharashtra, Telangana & AP)

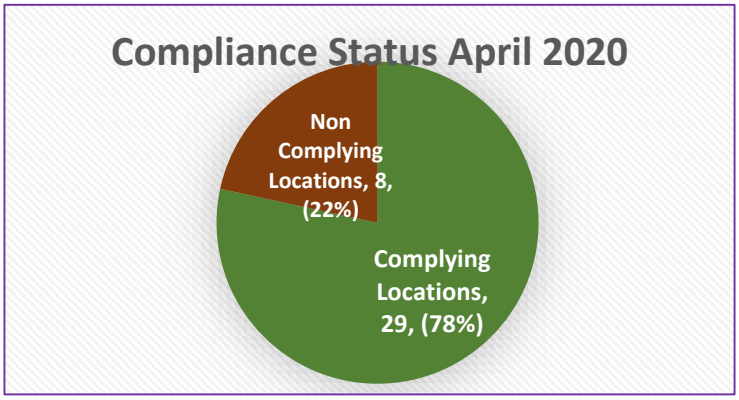


Figure 10.4 Compliance Status of River Godavari During Lockdown

Over all observations on river Godavari revealed that

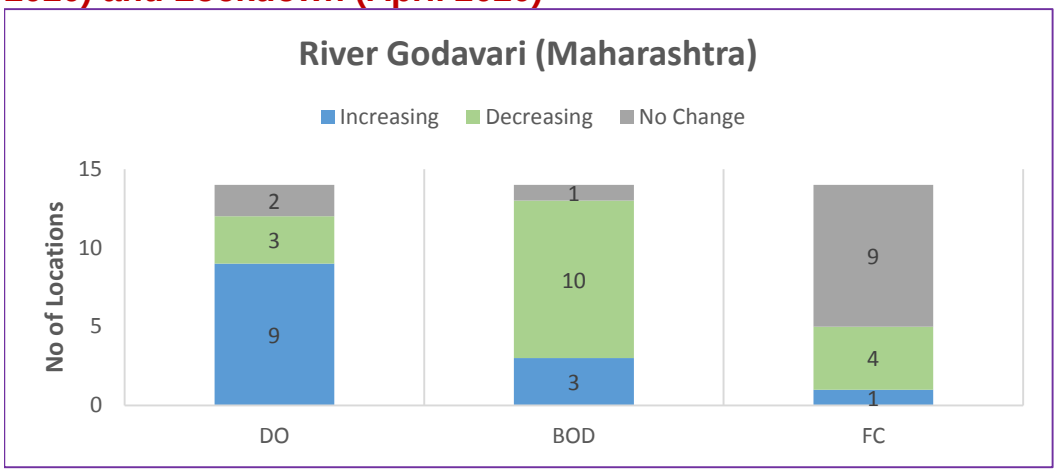
- During pre-lockdown (March 2020), 25 out of 38 monitored locations were complying with the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.
- During lockdown (April 2020), 29 out of 37 monitored locations were complying with the Primary Water Quality Criteria for Outdoor Bathing.
- DO level U/s of Ramagundam drops suddenly as the River Godavari passes through Mancherial. Also, DO level at Burgampahad drops suddenly as the River receives wastewater from Bhadrachalam town. Maximum BOD was observed at Tapovan (6.2 mg/L) which could be due to confluence of River Nasardi (which receives wastewater from Nashik city) with river Godavari.
- At Tapovan, max BOD reduced from 6.8 to 6.2 mg/L (reduction 29.5 %) and FC reduced from 70 to 47 MPN/100 mL (reduction 32.9 %).
- Increasing trend of DO (1.5 - 61.3 %) at 19 monitored locations, BOD (5.6-57.1%) at 8 locations, FC (28.6 -100 %) were observed at 5 monitored locations.
- Decreasing trend of DO (1.4 - 28.6 %) at 11 monitored locations, BOD (3.3- 40.9 %) at 19 locations, FC (15 - 63.6 %) at 9 monitored locations were observed. 'No' variation in DO at 7 locations, BOD at 19 locations and FC at 23 monitored locations were observed

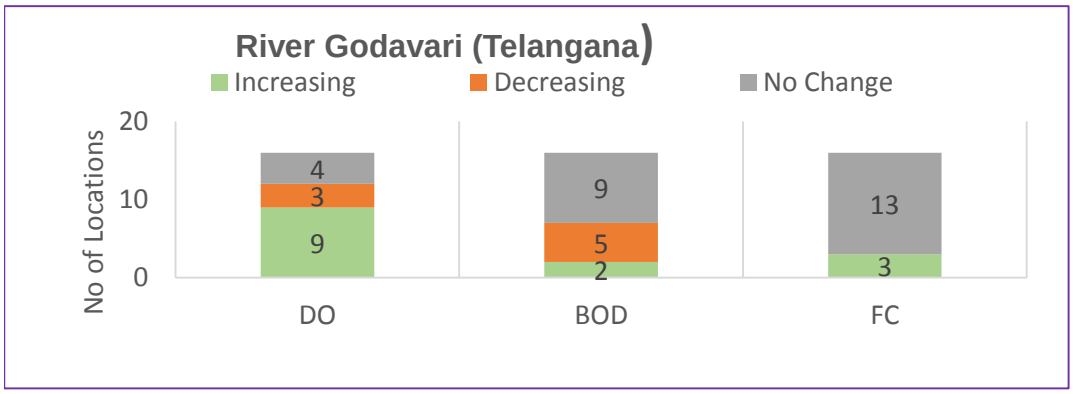
Compliance status of monitored locations for Primary Water Quality Criteria for Outdoor Bathing during lockdown is given in **Figure 10.4**.

10.6 Water Quality Trend of River Godavari

Water Quality trend of river Godavari as observed during pre-lockdown and lockdown are given in **Figure 10.5 to Figure 10.6**

Figure 10.5 River Godavari- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





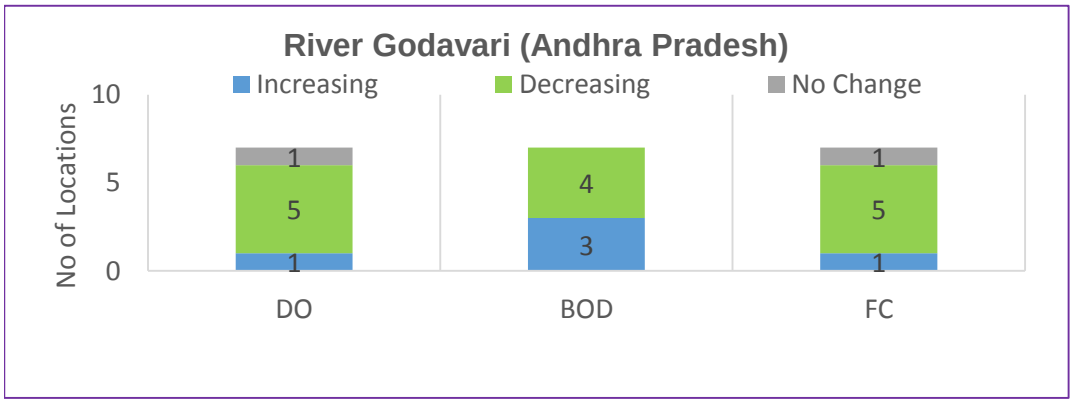
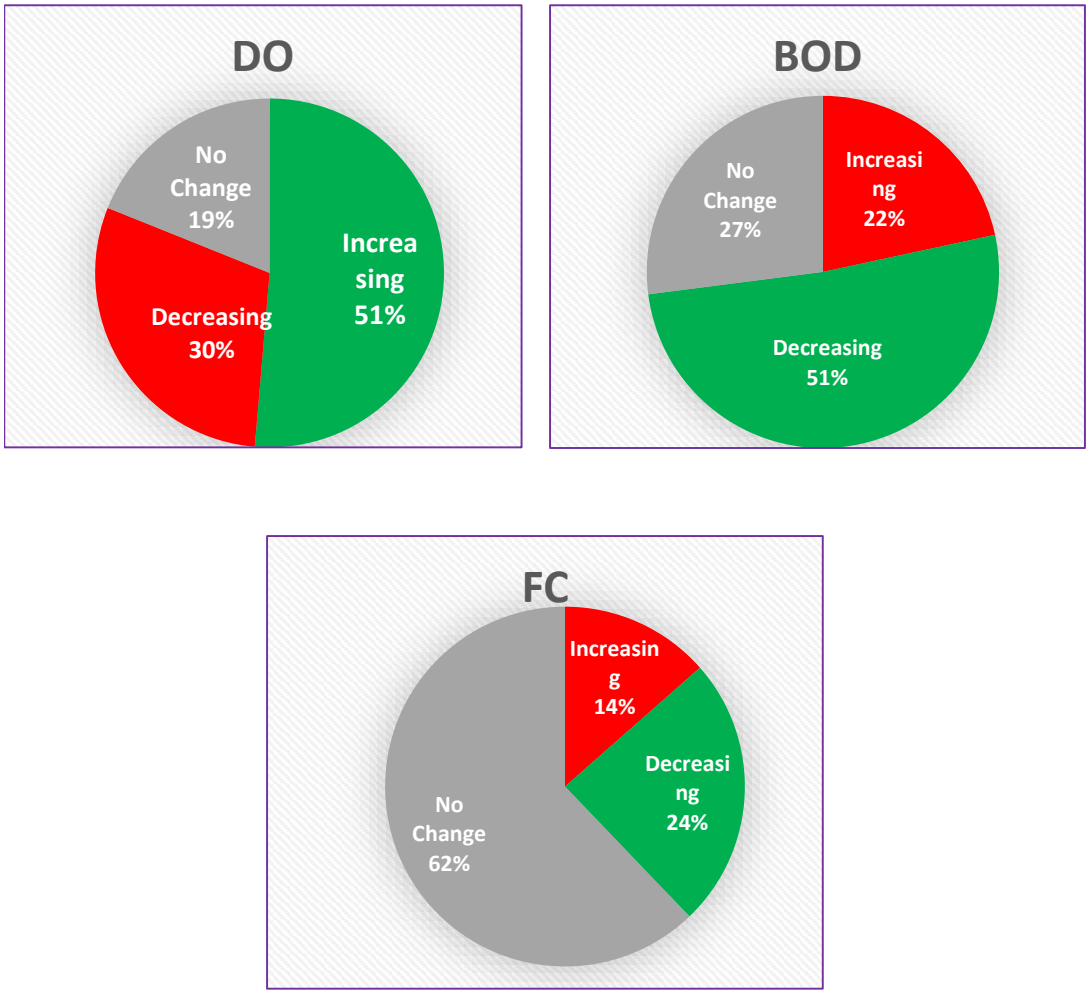


Figure 10.6 River Godavari- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)



10.7 Conclusion

- *25 out of 38 monitored locations (65.79 %) during pre-lockdown (March 2020), 29 out of 37 monitored locations (78.38 %) during lockdown (April 2020) were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing.*

- *Also, marginal improvement in water quality of river Godavari was observed during the lockdown period specially w.r.t the parameters viz., DO, BOD and FC as well as in terms of percent compliance of monitored locations.*

11 Impact of Lockdown on Water Quality of River Krishna

11.1 About Krishna River

The Krishna river originates in the Western Ghats near Mahabaleshwar in the State of Maharashtra and is one of the longest rivers in India. The Krishna river **(Figure 11.1)** is 1288 km long and flows through Maharashtra, Karnataka before entering Telangana State and finally empties into the Bay of Bengal at Hamasala Deevi (near Koduru) in Andhra Pradesh, on the east coast.

Facts at a Glance

Major Towns: *Vijayawada is the largest city on the bank of River Krishna. The industrialized urban cities are Satara, Kolhapur, Solapur, Pune, and Sangli in Maharashtra State, Raichur, Hubli-Dharwad, Bijapur, Gulbarga, Bhadravati, Davangere, Belgaum, Chitradurga, Bagalkot are in Karnataka, Nalgonda and Suryapet in Telangana and Kurnool, Guntur, Vijayawada in Andhra Pradesh State*

Major Tributaries: *On the left bank of river Krishna are river Bhima, Dindi, Peddavagu, Musi, Paleru, Munneru and right bank tributaries are river Kundali, Venna, Konya, Panchganga, Dudhaganga, Ghataprabha, Malaprabha and Tungabhadra.*

Major Industrial Establishments *on the banks of river Krishna mainly comprises leather & fertilizer units, Chemicals, Thermal Power plants, etc. Krishna river basin is endowed with rich mineral deposits such as oil & gas, coal, iron, limestone, dolomite, gold, granite, laterite, uranium, diamonds, etc.*

Pollution Causes: *High alkalinity water is discharged from the ash dump areas of many coal fired power stations into the river Krishna which further increases the alkalinity of the river water whose water is naturally of high alkalinity since the river basin is draining vast area of basalt rock formations.*

Source:https://www.britannica.com/place/Krishna-River

Figure 11.1 River Krishna - Prakasham Barrage, Vijayawada

11.2 Water Quality Monitoring Locations under National Water Monitoring Programme (NWMP) on river Krishna

Water quality of river Krishna is monitored at 30 locations by Central Pollution Control Board (CPCB) in association with the State Pollution Control Boards of Maharashtra, Karnataka, Telangana and Andhra Pradesh under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Krishna is depicted in **Figure -11.2.**

Figure 11.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Krishna

11.3 Analytical Results

Water quality of river Krishna was carried out at 26 locations [Maharashtra (09), Karnataka (05), Telangana (04) and AP (08)] during Pre-Lockdown (March 2020) and at 18 locations [Maharashtra (04), Karnataka (06), and AP (08)] during Lockdown period (April 2020) to assess the impact on water quality of river Krishna (**Figure 11.3)**

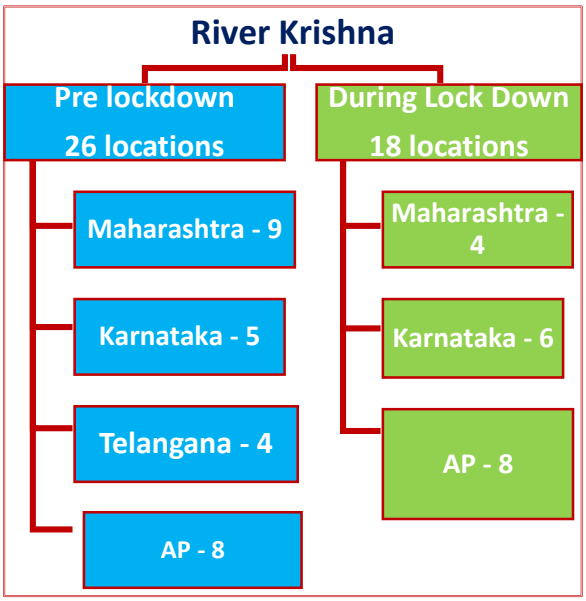


Figure 11.3. Water Quality Monitoring Locations carried out during Pre and Lockdown on river Krishna

11.4. Observations

Based on the analytical results of the samples collected from river Krishna, following findings/observations are made:

Maharashtra - Observations

During the pre-lock down period (March 2020)

The analysis results of the 9 monitored locations for the four critical parameters of outdoor bathing showed pH (7 -8.3), DO (6 -6.7 mg/L), BOD (1.8 -6.3 mg/L) and FC (7 -200 MPN/100mL).

Minimum DO (6 mg/L) at Kurundwad whereas maximum BOD (6.3 mg/L) was observed at Venna Sangam.

Maximum FC (200 MPN/100 mL) was observed at Kshetra Mahuli.

08 out of 09 monitored locations were found complying with the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters of outdoor bathing observed to be in the order of pH (7.8 -8.2), DO (6.6 -6.7 mg/L), BOD (1.5 -1.6 mg/L) and FC (7 -17 MPN/100mL) at 04 monitored locations.

Minimum DO (6.6 mg/L) at 3 out of 4 monitored locations whereas maximum BOD (1.6 mg/L) was observed at Kurundwad. Maximum FC (17 MPN/100 mL) was observed at Rajapur Weir, Vilage Rajapur.

All the 04 monitored locations were within the desirable limits of Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.5 -10 %) at 3 locations, FC (16.7-84.8 %) at 3 locations and decreasing trend of BOD (17-20 %) at 4 locations were observed. 'No' variation in DO (at 1 location) and FC (at 1 location) were observed.

Karnataka - Observations

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters were observed to be in the order of pH (8.0 -8.5), DO (6.0 -7.8 mg/L), BOD (1.0-2.5 mg/L) and FC (350 -900 MPN/100mL) at 05 monitored locations.

Minimum DO (6 mg/L) at Ankali Bridge whereas maximum BOD (2.5 mg/L) was observed at Devasagar Bridge. Maximum FC (900 MPN/100 mL) was observed at 2 locations.

All 05 monitored locations were complying with the Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters were found to be in the order of pH (8.1 - 8.7), DO (6.5 -7.7 mg/L), BOD (1.0 -2.9 mg/L) and FC (170 -900 MPN/100mL) at 06 monitored locations.

Minimum DO (6.5 mg/L) at Ankali Bridge whereas maximum BOD (BDL mg/L) was observed at U/s of Ugarkhurd Barrage.

Maximum FC (900 MPN/100 mL) was observed at D/s Almatti Dam.

5 out of 6 monitored locations were observed to be within the criteria limits prescribed under Primary Water Quality Criteria for Outdoor Bathing (except pH non complying at one location)

Overall Observations

Increasing trend of DO (1.5 -8.3 %) at 3 locations, BOD (10-32%) at 3 locations, FC (80 %) at 1 location. Decreasing trend of DO (2.8-7.7 %) at 2 locations, BOD (10-20 %) at 2 locations, FC (20-44.4 %) were observed. 'No' variation in FC (at 1 location) was observed.

Telangana -Observations

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters were observed to be in the order of pH (7 -8.7), DO (5.7 - 6.6 mg/L), BOD (2.1 -4 mg/L) and FC (2 -19 MPN/100mL) at 04 monitored locations.

3 out of 4 monitored locations were found to be complying with the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

No sampling carried out

Andhra Pradesh - Observations

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters were observed to be in the order of pH (6.9 -7.9), DO (4.6-7.4 mg/L), BOD (1.0 -2.6 mg/L) and FC (3-100 MPN/100mL) at 08 monitored locations.

6 out of 8 monitored locations are complying to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters were found to be in the order of pH (7.2-7.9), DO (4.8-7.2 mg/L), BOD (01-2.2 mg/L) and FC (3 - 300 MPN/100mL) at 8 monitored locations.

7 out of 8 monitored locations were observed to be complying with the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.4 -30.6 %) at 4 locations, BOD (20 %) at 1 location, FC (200-666.7 %) at 2 locations and decreasing trend of DO (1.4-2.7 %) at 3 locations, BOD (13-44 %) at 4 locations were observed. No' variation in DO at 1 location, BOD at 3 locations and FC at 6 locations were observed.

11.4 Overall observations on water quality of river Krishna (covering Maharashtra, Karnataka, Telangana & AP)

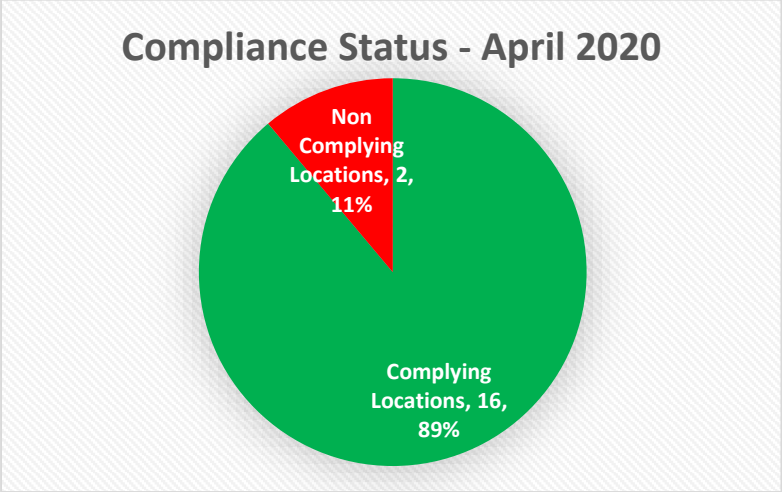


Figure 11.4. Compliance Status of Monitored Locations during Lockdown on River Krishna

Overall analysis results revealed that

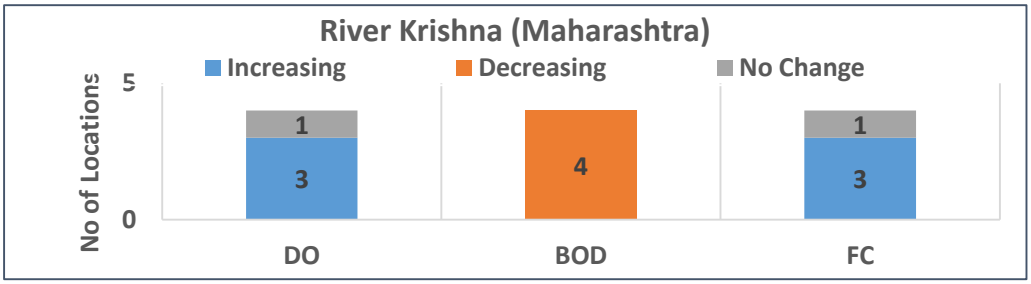
- During pre-lockdown, 22 out of 26 monitored locations were found to be complying to the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

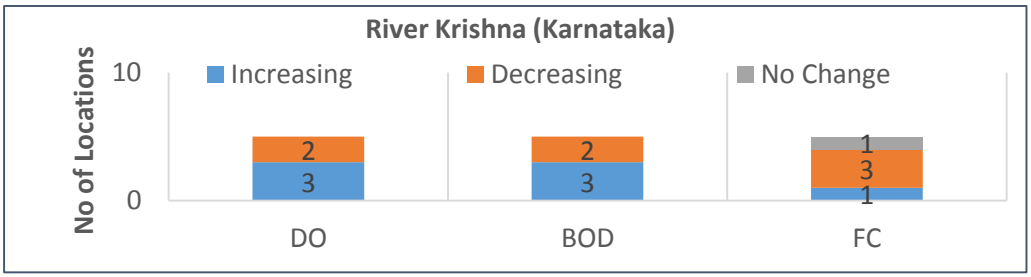
- During lockdown (April 2020), 16 out of 18 monitored locations were found to be within the desirable limits prescribed under Primary Water Quality Criteria for Outdoor Bathing (**Figure 11.4)**. Maximum DO at U/s Ugarkhurd Barrage (7.7 mg/L)) and minimum at Hamsala Deevi, Puligadda Aqueduct (4.8 mg/L). Maximum BOD was observed at D/S Almatti Dam (2.9 mg/L) and minimum as 'BDL' at 06 locations viz U/S Ugarkhurd Barrage, at A/C Confluence with River Musi, D/S Srisailam Kurnool, Amravati, Guntur, Pavitra Sangam A/C & at Vijyawada. Maximum FC was observed at 2 locations viz Ankali Bridge & D/S Almatti Dam (900 MPN/100 mL) and minimum at 05 locations viz. Confluence with River Musi, Vedradri Kurnool, Amravati Guntur , Pavitra Sangam A/C & Hamsala Devi Puligada Aqueduct (03 MPN/100 mL).

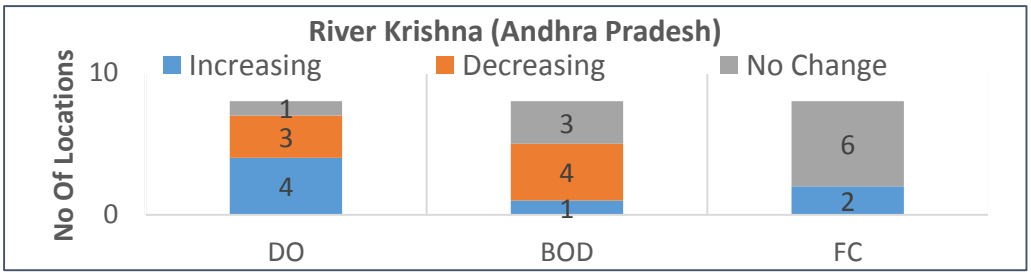
- Overall, decreasing trend of DO (1.4 -7.7 %) at 05 locations, BOD (10 - 44%) at 10 locations, FC (20-44.4%) at 3 locations were observed.

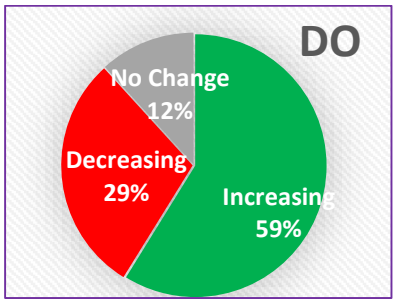
- Overall increasing trend of DO (1.4% -30.6%) at 10 locations, BOD (10 - 32 %) at 4 locations and FC (16.7-666.7 %) at 6 locations were observed. 'No' variation was observed w.r.t DO (at 2 locations), BOD (at 3 locations) and FC (at 8 locations). (**Figure 11.5)**

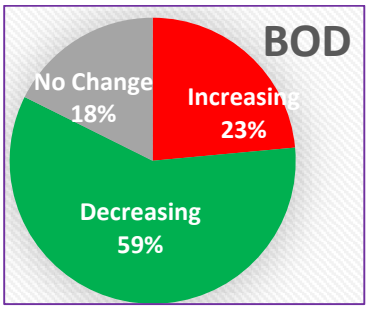
Figure 11.5 River Krishna- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)

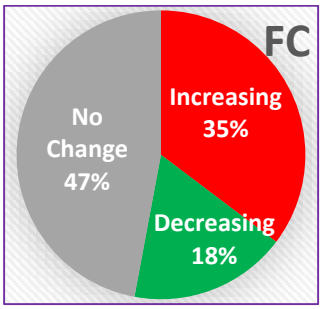












11.6 Conclusion

- *During pre-lockdown, 22 out of 26 monitored locations, 16 out of 18 monitored locations during lockdown were complied with the Primary Water Quality Criteria for Outdoor Bathing. Also, marginal improvement in water quality of river Krishna was observed with respect to parameters viz., DO & BOD.*

12 Impact of Lockdown on Water Quality of River Mahanadi

12.1 About Mahanadi River

The Mahanadi River **(Figure 12.1)** is a major river in East Central India which rises in Dhamtari district of Chhattisgarh. It is 858 kilometers long river flows through Chhattisgarh and Odisha States. The Mahanadi river empties into Bay of Bengal via several channels near Paradeep at False Point, Jagat Singhpur in Odisha. Total length of the river Mahanadi from origin to its outfall into Bay of Bengal is 851 km of which 357 km lies in Chattisgarh and 494 km in Odisha. Hirakud Dam across the river Mahanadi is longest major earthen dam in India.

Facts at a Glance

The major towns ***on the River Mahanadi are Narmada are Dindori, Jabalpur, Harda, Hoshangabad, Barwani, Omkareshwar, Maheshwar, Narnada Nagar, Dewas, Mandla and Bharuch & Rajpipla in Gujarat State.***

Principal Tributaries of the Mahanadi river: ***On left bank of river Mahanadi are Shivnath, Mand, Ib, Hasdeo and right bank tributaries are Ong, Parry, Jonk, Telen. Hirakud Dam across the river Mahanadi is longest major earthen dam in India.***

The Industrialized Towns on the bank of Mahanadi River are ***Jagatpur, Paradeep, Sambalpur, Nayagarh and Cuttack consisting of major industries such as paper, textiles, thermal power plants, fertilizers, breweries, Sugar industries, Cement, coal mining, and aluminium smelter etc.***

Source:https://www.deccanchronicle.com/nation/current-affairs/ 171016/water-row-between-chhattisgarh-odisha-a-shot-in-the-arm-for-congress-party.html

Figure 12.1. River Mahanadi

12.2. Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP) on River Mahanadi

The Water Quality of River Mahanadi is monitored at 27 locations by Central Pollution Control Board (CPCB) in association with State Pollution Control Boards of Chhattisgarh (09) and Odisha (18) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Mahanadi is depicted in **Figure 12.2**

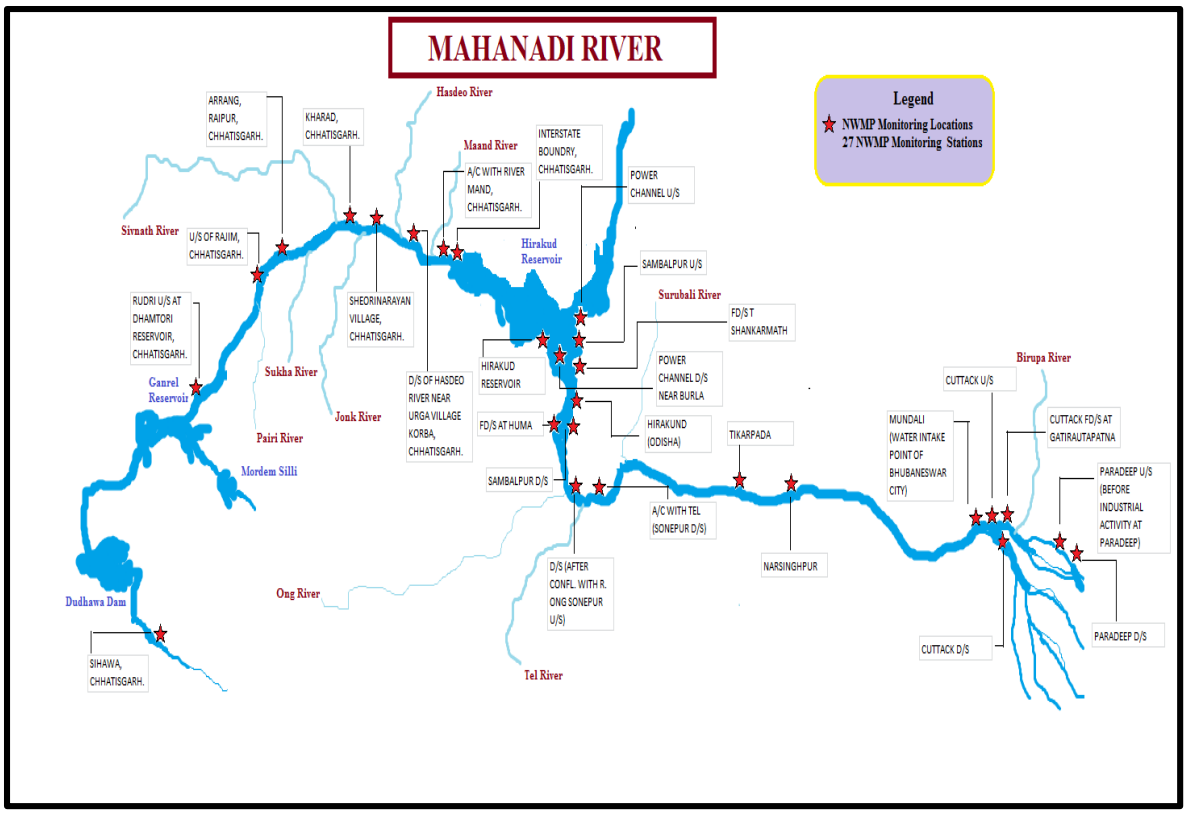


Figure 12.2. State-wise Distribution of Water Quality Monitoring Locations Under NWMP on River Mahanadi

12.3. Analytical Results

Water quality of river Mahanadi was carried out at 13 locations [Chhattisgarh State (5) and Odisha State (8)] during Pre-lockdown (March 2020) and at 22 locations [Chhattisgarh State (5) and Odisha State (17)] during lockdown period (April 2020) to assess the impact on water quality of river Mahanadi **(Figure 12.3)**

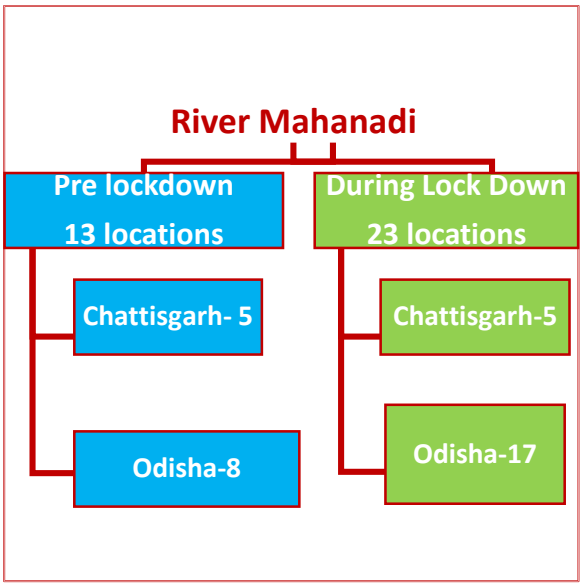


Figure 12.3. Water Quality Monitoring Locations carried out during Pre and Lockdown on River Mahanadi.

12.4. Observations

Based on the analytical results of the samples collected from river Mahanadi, the following findings/observations are made

Chhattisgarh-Observations

During the pre-lock down period (March 2020)

The analysis results of the 05 monitored locations for the four critical parameters observed to be in the order of pH (7.1 - 8.5), DO (6.5 - 7.6 mg/L), BOD (1.2 - 1.5 mg/L) and FC (20 – 30 MPN/100 mL).

Minimum DO (6.5 mg/L) was observed at 3 locations which include after confluence of river Mahanadi with River Mand, maximum DO (7.6 mg/L) was observed at Kharad while maximum BOD (1.5 mg/L) was observed at interstate boundary and minimum BOD (1.2 mg/L) observed at Near Urga village. Maximum FC (30 MPN/100mL) was observed at Heornarayan village and after confluence with river Mand.

All 05 monitored locations were complying with the parameters (i.e. pH, DO, BOD) prescribed under Primary Water Quality Criteria for Outdoor Bathing. FC is complying at all 03 monitored locations (2 locations not reported for FC).

During the lock down period (April 2020)

The analysis results of 05 monitored locations for the four critical parameters observed to be in the range of pH (7.1 - 8.2), DO (6.3 - 7.3 mg/L), BOD (BDL(0.9) - 1.6 mg/L) and FC (BDL1.8 - 8.0 MPN/100 mL). 04 out of 05 monitored locations complying with the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Minimum DO (6.3 mg/L) was observed at Heornarayan village, maximum DO (7.3 mg/L) was observed at Kharad while maximum BOD (1.6 mg/L) was observed at interstate boundary and minimum BOD (0.9 mg/l) was observed at Near Urga village. Maximum FC (8 MPN/100mL) was observed at Heornarayan village.

Maximum reduction in BOD (25 %) was obsereved at D/s Hasdeo Nr. Urga Village, during lockdown.

Overall Observations

Decreasing trend of BOD (7 % -25 %) at 03 locations, DO (3% -4%) at 2 locations and FC (90% - 94%) at 03 monitored locations whereas increasing trend of DO (3% to 8%) at 3 locations and BOD (7% to 8%) at 02 monitored locations.

Odisha-Observations

During the pre-lock down period (March 2020)

The analysis results of 08 monitored locations for the four critical parameters observed to be in the order of pH (7.2 - 8.4), DO (6.6 - 8.6 mg/L), BOD (0.3 - 2.4 mg/L) and FC (1.8- 1700 MPN/100mL).

Minimum DO (6.6 mg/L) was observed at Tikarpada, maximum DO (8.6 mg/L) was observed at Paradeep D/s while maximum BOD (2.4 mg/L) was observed at Paradeep D/s and minimum BOD (BDL mg/l) was observed at 6 out of 8 monitored locations. Maximum FC (1700 MPN/100mL) was observed at Cuttack D/s at Gatirautapatna and minimum FC (BDL MPN/100 mL) was observed at Paradeep D/s.

All the 08 monitored locations were complying with the Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of the 17 monitored locations for the four critical parameters were observed to be in the order of pH (7.12 - 8.2), DO (6.6 - 8.8 mg/L), BOD (0.2 -1.4 mg/L) and FC (1.8 – 220 MPN/100mL).

Minimum DO (6.6 mg/L) was observed at Tikarpada, maximum DO (8.8 mg/L) was observed at Sonepur D/s while maximum BOD (1.4 mg/L) was observed at Samabalpur D/s and minimum BOD (BDL mg/l) was observed at 16 out of 17 monitored locations. Maximum FC (220 MPN/100mL) was observed at Cuttack D/s and minimum FC (BDL MPN/100 mL) was observed at Paradeep D/s.

Maximum reduction in BOD (85 %) was obsereved at U/s Paradeep and also maximum reduction (99.60 %) in FC (from 390 to 1.8 MPN/100 mL) at D/s Hasdeo Nr.Urga Village,was noticed during lockdown.

All 17 monitored locations complying with the Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

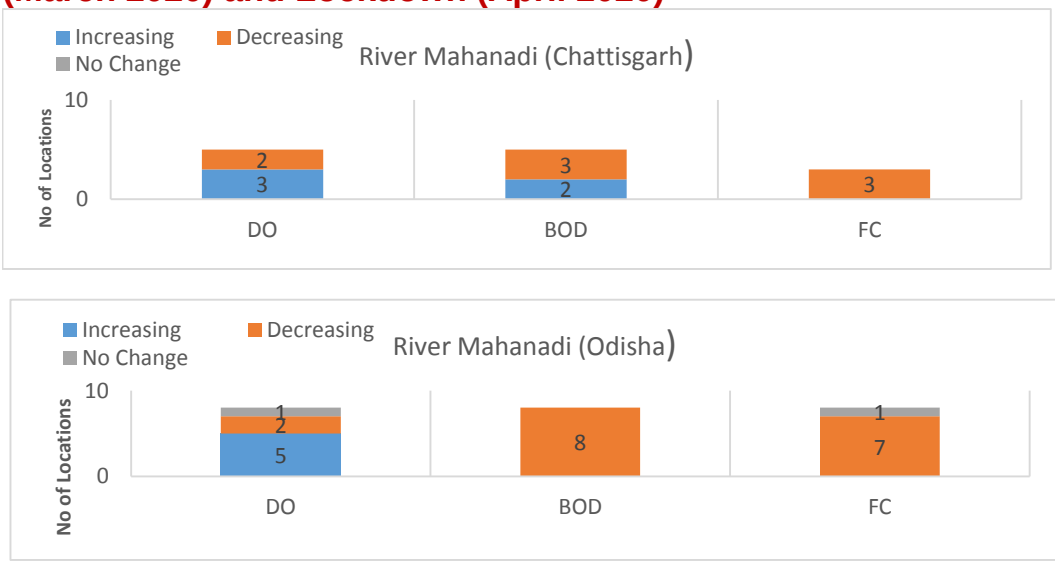
Decreasing trend of DO (2% -6%) at 02 locations, BOD (33%-85 %) at 08 monitored locations and FC (42 -99.6%) at 07 locations whereas increasing trend of DO (5% - 19%) at 05 locations were observed

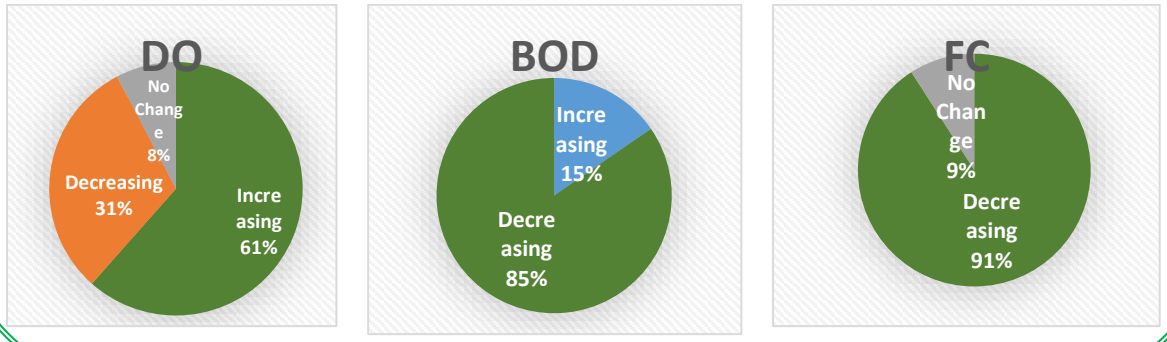
12.5 Overall Observations on river Mahanadi (Chhattisgarh and Odisha)

The analysis results reveal that

Increasing trend of DO (3-19%) at 8 locations, BOD (7-8 %) at 2 locations while decreasing trend of DO (2-6 %) at 4 locations, BOD (7-8.5 %) at 11 locations and FC (42% -99.6 %) at 10 locations and 'no' variation in DO & FC was observed at 1 monitored location. (Overall water quality trend in river Mahanadi during pre and lockdown is given at **Figure 12.4**.

Figure 12.4 River Mahanadi - Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





12.6 Conclusion

- *13 monitored locations on River Mahanadi during pre-lockdown (ie 05 in Chhattisgarh and 8 locations in Odisha) and 22 monitored locations on River Mahanadi (ie 05 in Chhattisgarh and 17 locations in Odisha) during lockdown were observed to be complying (100 %) with the Primary Water Quality Criteria for Outdoor Bathing. Also, overall improvement in water quality of River Mahanadi was observed with respect to BOD and FC parameters.*

13 Impact of Lockdown on Water Quality of River Mahi

13.1 About River Mahi

The river Mahi is 583 km long, originating in Madhya Pradesh State and passing through Rajasthan and Gujarat States and finally draining into Gulf of Khambhat in Gujarat.

Facts at a Glance

Major Tributaries of river Mahi are River Som, Jakham, Moran and Bhadar.

Important Urban Centres in the watershed of Mahi river are Ratlam, Jaora in Madhya Pradesh, Godhra, Vadodara, Dohad and Dabhoi in Gujarat and Banswara in Rajasthan.

Vadodara is the major centre for industrial activity and majority of industrial units are pharmaceutical, petrochemicals, distillery, fertilizer, dyes & dye intermediates and pesticides.

Pollution Causes: **The wastewater discharged by the industries such as fertilizer, oil refinery and caustic soda and Dyes & Dye Intermediate units located in Vadodara industrial estate are possible sources of discharges into the Gulf of Khambhat through the Vadodara effluent channel.**

13.2. Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Mahi is evaluated at 17 locations by Central Pollution Control Board (CPCB) in association with M.P. Pollution Control Board (MPPCB), Gujarat Pollution Control Board (GPCB) & Rajasthan State Pollution Control Board (RSPCB) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Mahi is depicted in **Figure 13.1**

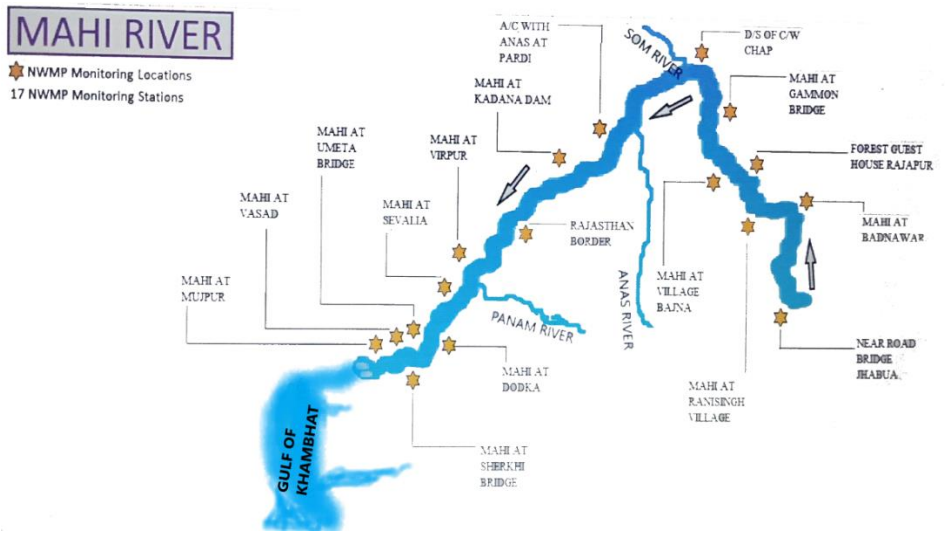


Figure 13.1: State-wise Distribution of Water Quality Monitoring Locations Under NWMP

13.3. Analytical Results

Water quality of river Mahi was carried out at 14 locations during pre-lockdown [MP (04), Rajasthan (01) and Gujarat (9)] and lockdown period [MP (04), Rajasthan (01) and Gujarat (9)] to assess the impact on water quality of river Mahi **(Figure 13.2).**

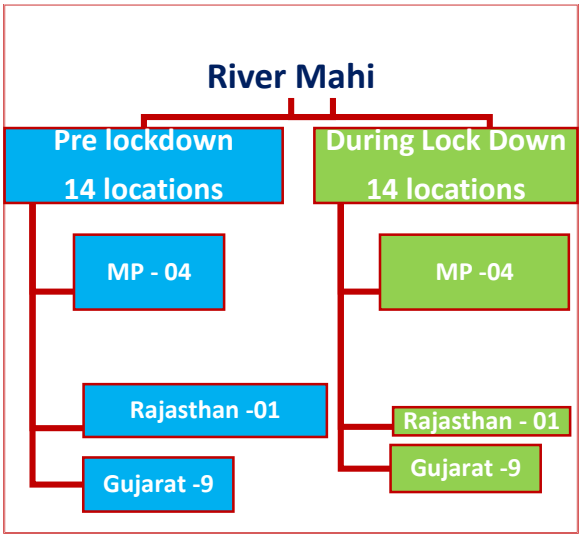


Figure 13.2. Monitoring Locations carried out during Pre and Lockdown on River Mahi

13.4. Observations

Based on the analytical results of the samples collected from river Mahi, following findings/observations are made:

Madhya Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 04 monitored locations were observed to be in the order of pH (7.6 - 7.8), DO (6.9 -7.9 mg/L), BOD (1.3 -2.0 mg/L) and FC (BDL-8.0 MPN/100mL) at 04 monitored locations.

All the 4 monitored locations (04) were found to be complying with the monitored criteria parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 04 monitored locations indicate pH (7.7- 8.3), DO (7.4 -8.0 mg/L), BOD (BDL -1.8 mg/L) and FC (BDL -3.0 MPN/100mL).

All the monitored locations (04) were found to be within the desirable limits for the critical parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (5.7 -15.9 %) at 3 locations, and decreasing trend of DO (3.8 %) at 1 location, BOD (10-43 %) at 4 locations, FC (50-62.5 %) at 2 locations and 'no' variation in FC was observed at 2 locations.

Rajasthan-Observations

During the pre-lock down period (March 2020)

The analysis result of one monitored location shown pH (8.3), DO (4.4 mg/L), BOD (1.3 mg/L) and FC (75 MPN/100mL) at 01 location. pH, BOD and FC were observed to be complying with the bathing criteria limits whereas DO was not complying with the limit prescribed under Primary Water Quality Criteria for Bathing.

During the lock down period (April 2020)

The analysis result of one monitored location indicate pH (8.4), DO (4.9 mg/L), BOD (1 mg/L) and FC (64 MPN/100mL). One monitored location complying to the bathing criteria limits for the parameters (i.e. pH, BOD and FC) and DO was non-complying to the limit prescribed under Primary Water Quality Criteria for Bathing.

Overall Observations

The analysis results of one monitored location revealed increasing trend of DO (11.4 %), decreasing trend of BOD (23 %) and FC (14.7 %) was observed.

Gujarat

During the pre-lock down period (March 2020)

The analysis results of 9 monitored locations for four critical parameters were observed to be in the range of pH (7.9 -8.4), DO (7.0 -8.3 mg/L), BOD (0.4 -0.6 mg/L) and FC (2.0 -46 MPN/100mL).

All the monitored locations (09) were found to be complying with the limits for criteria parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 9 monitored locations for four critical parameters were observed to be in the order of pH (7.8-8.3), DO (6.5 -8.4 mg/L), BOD (0.3 -0.6 mg/L) and FC (2 -12 MPN/100mL).

All the 9 monitored locations were complying within the limits for the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.2 to 12.3 %) at 5 locations while decreasing trend of DO (7.1 %) at 1 location, BOD (17 -25 %) at 5 locations, FC (14.3-81.8 %) at 7 locations and 'no' variation was observed w.r.t DO at 3 locations, BOD at 4 locations and FC at 2 locations.

13.5 Overall Observations on River Mahi (covering Madhya Pradesh, Rajasthan and Gujarat)

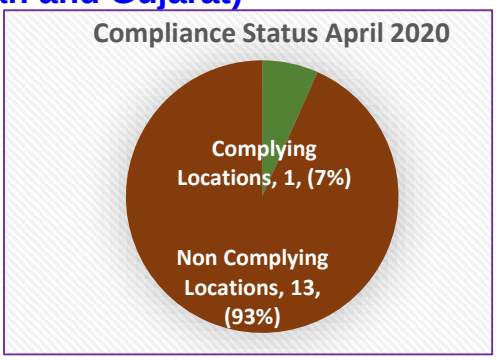


Figure 13.3. Compliance Status of Monitoring Locations carried out during Lockdown on River Mahi

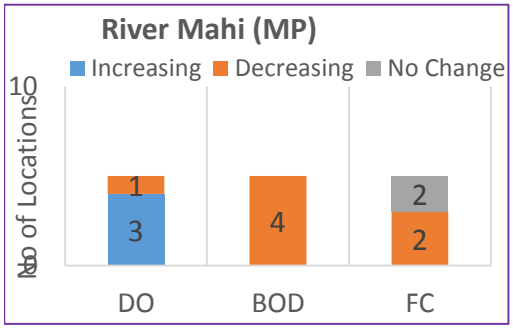
The analysis results revealed that

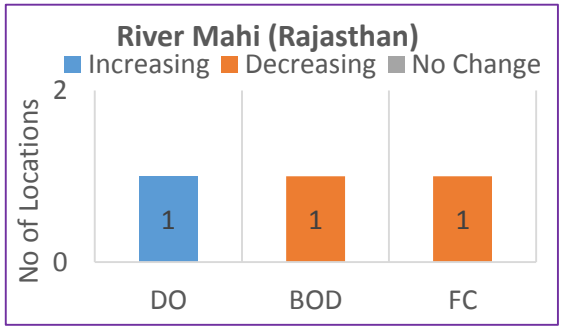
- During lockdown, maximum DO was observed at Rajasthan Border at Katana Dam (8.4 mg/L)) and minimum at D/s Confluence with River Chap (4.9 mg/L). Maximum BOD (1.8 mg/L) was observed at 02 locations- Ranisingh Village, Ratlam and Forest Guest house, Ratlam and minimum BOD (0.3 mg/L) was observed at Sevalia whereas maximum FO count was observed at D/s Confluence with River Chap (64 MPN/100 mL) and minimum as 'BDL' at 02 locations- Road Bridge, Jhabua and Badnawar. Compliance status of monitoring locations during Lockdown on River Mahi is given at **Figure 13.3.**

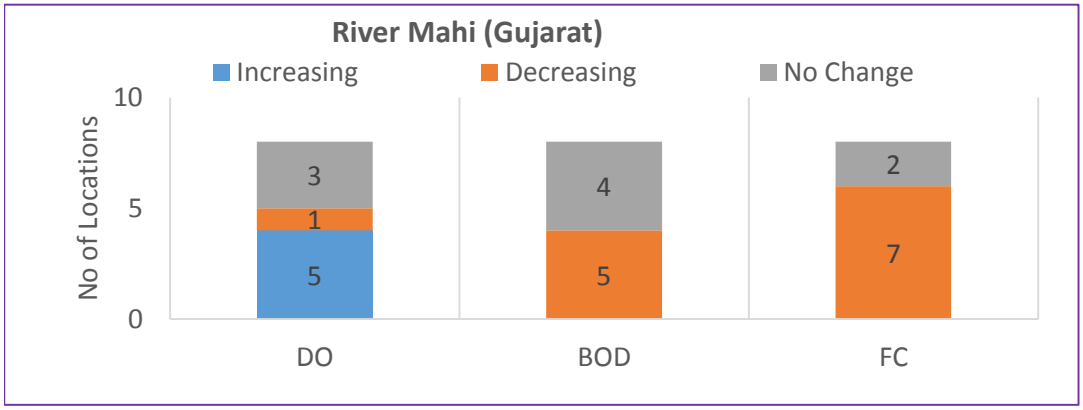
- Overall, decreasing trend of DO (3.8 -7.1%) at 2 locations, BOD (10% to 43%) at 10 locations, FC (14.3%-81.8%) at 10 locations and increasing trend for DO (1.2% -15.9%) at 09 locations and 'nil' variation in DO at 03 locations, BOD & FC at 04 locations were observed. (**Figure 13.4**)

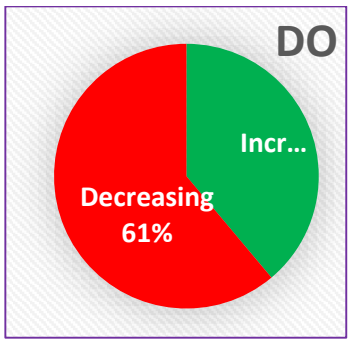
- 13 out of 14 locations on river Mahi within MP and Gujarat states were observed to be complying with the limit for parameters viz., pH, DO, BOD and FC prescribed under Primary Water Quality Criteria for Outdoor Bathing and one location in Rajasthan was found to be non-complying with the DO parameter for outdoor bathing criteria limit.

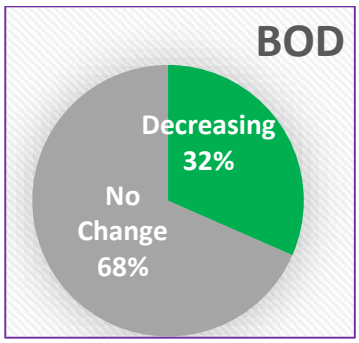
Figure 13.4 River Mahi Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)

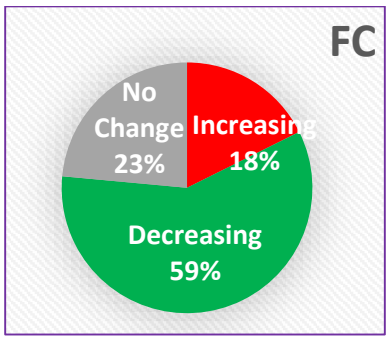












13.6 Conclusion

- *13 out of 14 monitored locations on river Mahi during pre-lockdown (March 2020), lockdown (April 2020) were observed to be complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, an improvement in water quality of river Mahi was observed with respect to DO, BOD and FC. However, overall improvement was observed with respect to the parameters viz., DO and BOD.*

14 Impact of Lockdown on Water Quality of River Narmada

14.1 About Narmada River

The Narmada River **(Figure 14.1)** rises from Amarkantak Hill in Anuppur District of East Madhya Pradesh forming the traditional boundary between North India and South India. It is one of only three major rivers in peninsular India that run from east to west (longest west flowing river). It flows over a length of 1,312 km through Deccan trap in between Vindhya and Satpura ranges of hills before draining through the Gulf of Khambhat into the Arabian Sea, in west of Bharuch city of Gujarat. It runs through the states of Madhya Pradesh, Maharashtra and Gujarat.

Facts at a Glance

The major towns *on the River Narmada are Dindori, Jabalpur, Harda, Hoshangabad, Barwani, Omkareshwar, Maheshwar, Narnada Nagar, Dewas, Mandla and Bharuch & Rajpipla in Gujarat State.*

The major tributaries *of the Narmada River are river Burhner, Banjar, Sher, Shakkar, Dudhi, Tawa (longest tributary), Ganjal, Kundi, Goi, Karjan & right bank tributaries are river Barna, Hiran, Tendoni, Choral, Man, Uri, Hatni & Orsang.*

Major industrial districts *on the banks of river Narmada are Dhar, Jabalpur and Bharuch consisting of cluster of pharmaceuticals, pesticides, dyes & distilleries, leather & fertilizer units whereas in Jabalpur, Khandwa and Hoshangabad, the main industrial activities are the paper mills.*

Figure 14.1 River Narmada (Bargi, Jabalpur)

14.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Narmada is assessed at 54 locations by Central Pollution Control Board (CPCB) under National Water Quality Monitoring Programme (NWMP) in association with MPPCB (48), GPCB (05) and one location monitored by CPCB RD-Vadodara. State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Narmada is depicted in **Figure 14.2**.

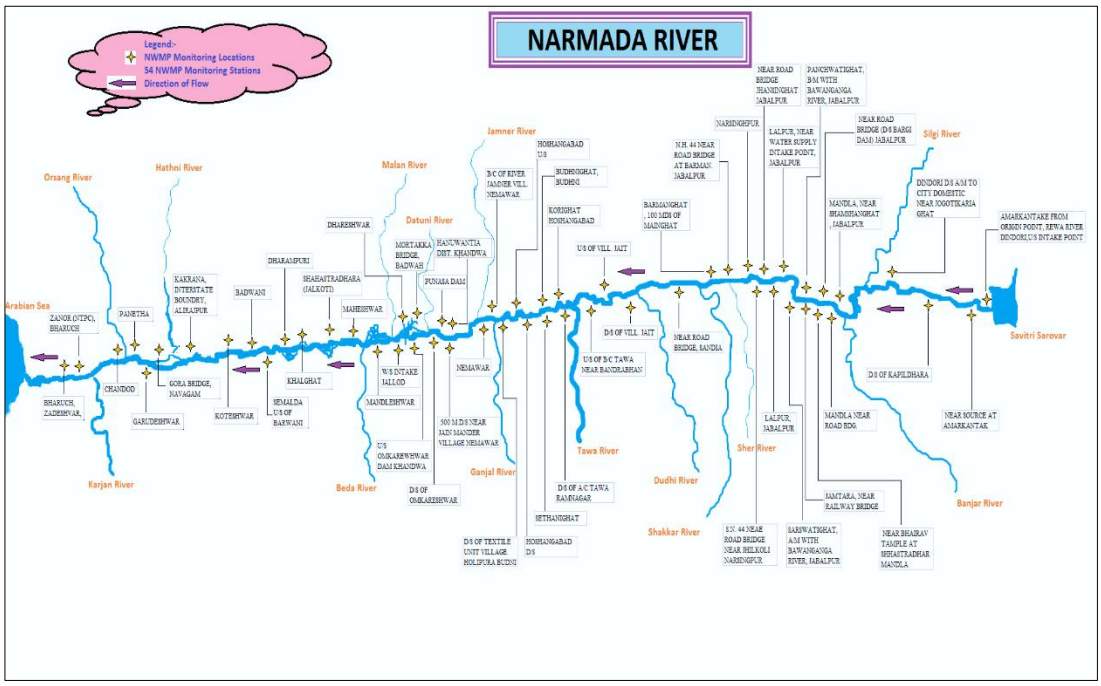


Figure 14.2 State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Narmada

14.3 Analytical Results

Water quality of river Narmada was carried out at 32 locations during Pre-Lockdown (March 2020) and Lockdown period (April 2020) to assess the impact on water quality of river Narmada. **(Figure 14.3)**.

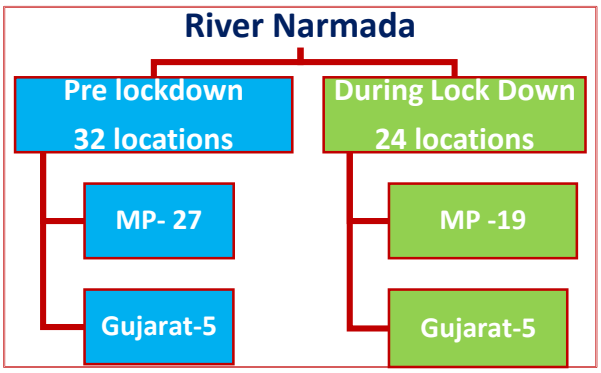


Figure 14.3 Water Quality Monitoring Locations Carried out during Pre-lockdown and Lockdown on River Narmada

14.4 Observations

Based on the analytical results of the samples collected from river Narmada, following findings/observations are made:

Madhya Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 27 monitored locations revealed that

The analysis results for the criteria parameters were observed to be in the order of pH (7.3 - 8.3), DO (6.9 - 8.7 mg/L), BOD (BDL (0.3)-1.9 mg/L) and FC (BDL(1) - 37 MPN/100 mL) at 27 monitored locations.

During pre-lockdown period (March 2020), the analysis results revealed that maximum DO was observed as 8.7 mg/L at 02 locations (Viz., at Hoshangabad U/s and D/s) and minimum observed as 6.9 mg/L at Amarkantak. Maximum BOD (1.9 mg/L) was observed at Mandla, Near Shamshanghat, Jabalpur and minimum observed as 0.3 mg/L at Amarkantak whereas maximum FC count (37 MPN/100 mL) was observed at Dindori which could be due to discharge of city sewage and minimum FC as BDL (1 MPN/100 mL) at 9 locations (Viz., at Punasa Dam, Punasa, at D/s of Omkareshwar, at Nr Mortakka Bridge, Badwah, at Maheshwar, at Dharampuri, at Semalda, at Barwani, at Koteshwar and at Kakrana, Interstate Boundry, Alirajpur).

All 27 monitored locations complying with the desirable limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 19 monitored locations revealed that

The analysis results for the critical parameters were observed to be in the range of pH (7.0 - 8.3), DO (7.0 - 8.0 mg/L), BOD (BDL(0.4) - 1.2 mg/L) and FC (BDL(1.0)- 2.0 MPN/100mL) at 19 monitored locations.

During lockdown period (April 2020), the analysis results revealed that maximum DO was observed as 8 mg/L at 02 locations (Viz., at Mandaleshwar & Semalda U/S Barwani) and minimum observed as 7 mg/L at 02 locations (Viz., Nr. Road Bridge (D/S Bargi Dam, Jabalpur) & Narsinghpur, MP). Maximum BOD was observed at Dharampuri as (1.2 mg/L) and minimum observed as 0.4 mg/L at Near Road Bridge (D/S Bargi Dam) Jabalpur whereas maximum FC count (2 MPN/100 mL) at 9 locations and minimum FC as BDL (1 MPN/100 mL) at 10 locations (Viz., at Punasa Dam, Punasa, at Near Mortakka Bridge, Badwah, D/s of Omkareshwar, at Mandleshwar, at Maheshwar, at Dharampuri, at Semalda U/s of Barwani, at Barwani, at Koteshwar and at Kakrana, Interstate Boundry, Alirajpur).

All 19 monitored locations complying with the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.27% - 6.85%) at 8 locations, and decreasing trend of DO (1.27 -10.26 %) at 8 locations, BOD (11.1 -76.47 %) at 18 locations and 'No' variation for DO at 2 locations and FC at 18 monitored locations were observed

Gujarat -Observations

During the pre-lock down period (March 2020)

The analysis results of 5 monitored locations revealed that

The analysis results for the critical parameters were observed to be in the order of pH (7.5 - 8.2), DO (7.3 -7.7 mg/L), BOD (BDL(0.6) - 0.8 mg/L) and FC (12 -110 MPN/100 mL) at the 5 monitored locations

Minimum DO (7.3 mg/L) at Bharuch, Zadeshvar and maxicum DO (7.8 mg/L) was observed at Chandod. Maximum BOD (0.8 mg/L) was observed at 2 locations (viz., Zanor (NTPC), Bharuch and Bharch, Zadeshvar) and minimum BOD (BDL (0.6 mg/L) was observed at Chandod and Garudeshwar. Maximum FC (110 MPN/100 mL) was observed at Zadeshvar, Bharuch.

All 5 monitored locations were found to be within the desirable limits for the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 5 monitored locatios revealed that

The analysis results for the critical parameters were found to be in the order of pH (7.1 - 7.8), DO (7.4 - 7.9 mg/L), BOD (0.4 - 0.8 mg/L) and FC (11- 94 MPN/100 mL) at the 5 monitored locations. Minimum DO (7.4 mg/L) was observed at Bharuch, Zadeshvar and maxicum DO (7.8 mg/L) was observed at Chandod. Maximum BOD (0.8 mg/L) was observed at 2 locations (viz., Zanor (NTPC), Bharuch and Bharch, Zadeshvar) and minimum BOD (BDL (0.4 mg/L) at Chandod. Maximum FC (94 MPN/100 mL) was observed at Zadeshvar, Bharuch.

All 5 monitored locations were complying with the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of DO (1.28% - 1.37 %) at 3 locations, FC (4.5 - 48.48 %) at 2 locations and decreasing trend of DO (2.6 - 3.9 %) at 2 locations, BOD (14.29 - 33.3 %) at 2 locations, FC (4.55 - 14.55 %) at 3 locations and 'No' variation in BOD was observed at 3 locations.

14.5 Overall Observations on Water River Narmada (covering Madhya Pradesh & Gujarat)

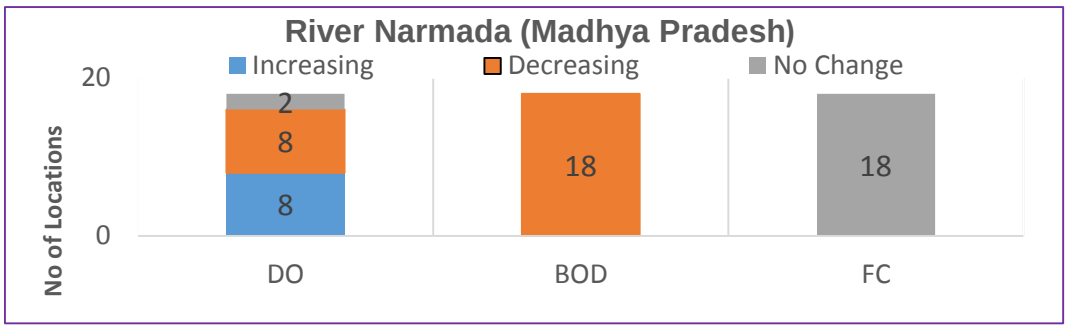
Over all observations on river Narmada revealed that

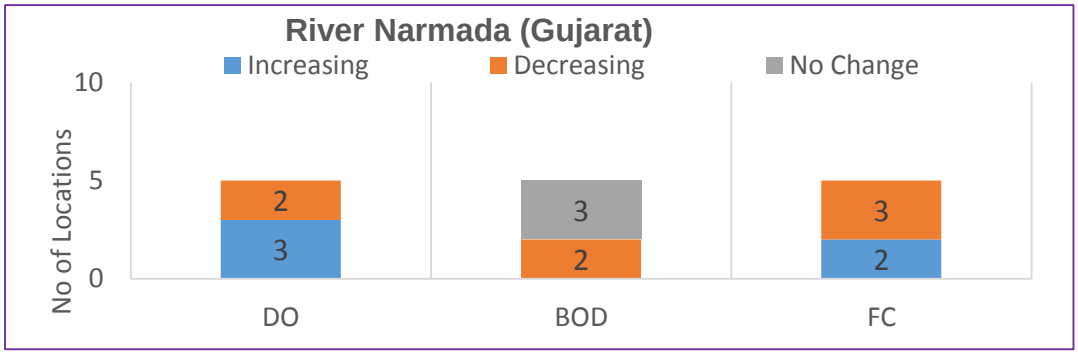
- During pre-lockdown period (March 2020), the analysis results shows pH (7.3 - 8.3), DO (6.9 - 8.7 mg/L), BOD (BDL (0.3)- 1.9mg/L) and FC (1 -110 MPN/100 mL) at the 32 monitored locations
- All 32 monitored locations during pre-lockdown on river Narmada were observed to be complying with the parameters of Primary Water Quality Criteria for Outdoor Bathing.
- During lockdown period (April 2020), the analysis results reveal pH (7 - 8.3), DO (7 - 8 mg/L), BOD (BDL (0.4) - 1.2 mg/L) and FC (1 - 94 MPN/100 mL) at the 24 monitored locations.
- 24 out of 24 monitored locations during lockdown on river Narmada were found to be within the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.
- Increasing trend of DO (1.27% -6.85%) at 11 locations and FC (4.5 % - 48.48%) at 2 locations whereas decreasing trend of DO (1.27 % -10.26%) at 10 locations, BOD (11.1% - 76.47%) at 20 locations and FC (4.55 -14.55%) at 03 locations were observed. (**Figure 14.4**)
- 'No' variation was observed w.r.t DO at 2 locations, BOD at 3 locations and FC at 18 monitored locations.

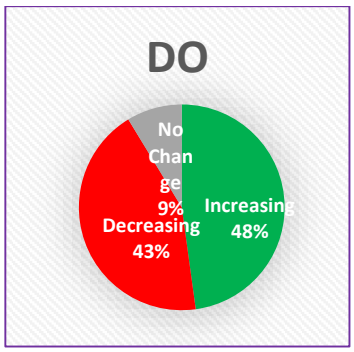
14.6 Water Quality Trend of River Narmada:-

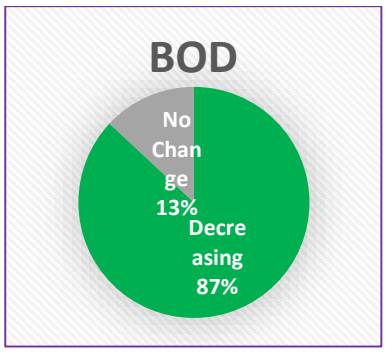
Water Quality trend of river Narmada as observed during pre-lockdown and lockdown are given in **Figure 14.4**

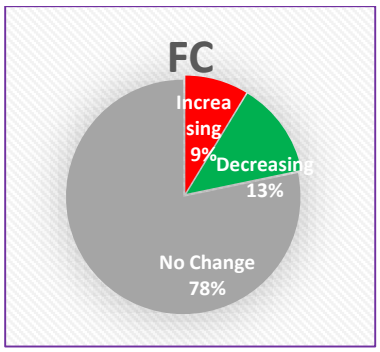
Figure 14.4 River Narmada- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











14.7 Conclusion

- *During pre-lockdown (March 2020), 32 out of 32 monitored locations, 24 out of 24 monitored locations during lockdown (April 2020) and overall river Narmada shown 100 % compliance to the Primary Water Quality Criteria for Outdoor Bathing during pre-lockdown and lockdown.*

15 Impact of Lockdown on Water Quality of River Pennar

15.1 About Pennar River

The Pennar (Penneru or Uttara Pinakini) river **(Figure15.1)** is a seasonal river which rises in the Nandi Hills in Chikkaballapur District of Karnataka and flows north and east through Karnataka & Andhra Pradesh (AP) covering a distance of 597 kilometres and finally drains into the Bay of Bengal in Nellore District of AP.

Fact at a Glance

Major Towns: Chikkaballapur & Gauribidanur in Karnataka, Hindupur, Anantapur, Proddutur, Kadapa & Nellore in AP

Major Tributaries on the left bank of river Pennar are Jayamangali, Kunderu and Sagileru and major right bank tributaries are river Chitravathi, Papagni and Cheyyeru.

Major Industrial Establishments on the banks of river Pennar comprises in Anantapur District are mainly agro based such as cotton mills, sugar mills, rice mills and in Kadapa District mainly agro based, cotton, textile & mineral based whereas in Nellore district mainly food & agro based, textile, mineral & forest based industries.

Source: https://commons.wikimedia.org/

Figure 15.1 River Pennar

15.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP) on River Pennar

The Water Quality of river Pennar is monitored at 04 locations by the CPCB in association with Andhra Pradesh Pollution Control Board (APPCB) under National Water Quality Monitoring Programme (NWMP) during the period March 2020 (Pre-lockdown) and April 2020 (Lockdown). Distribution of Monitoring Locations on River Pennar within Andhra Pradesh State is depicted in **Figure 15.2.**

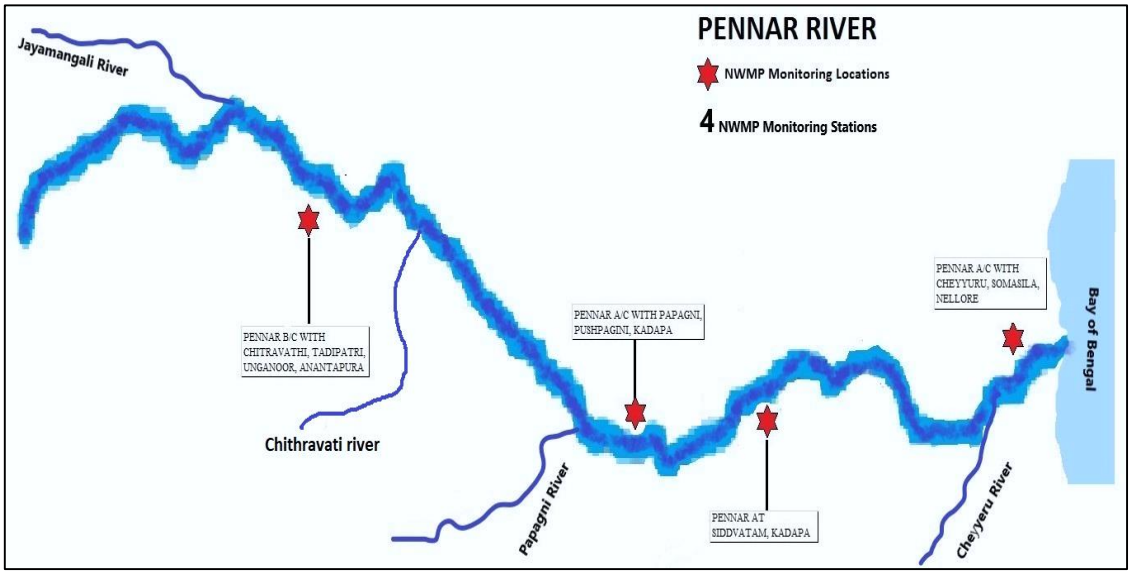


Figure 15.2 Distribution of Water Quality Monitoring Locations under NWMP on River Pennar (Andhra Pradesh)

15.3 Analytical Results

During pre-lockdown and lockdown period, there was no flow at River Pennar before confluence with Chitravathi at Unganoor, Anantapur District in A.P. Water quality of river Pennar was carried out at 03 locations during Pre-Lockdown (March 2020) and at 03 locations during Lockdown period (April 2020) to assess the impact on water quality of river Pennar. (**Figure 15.3**)

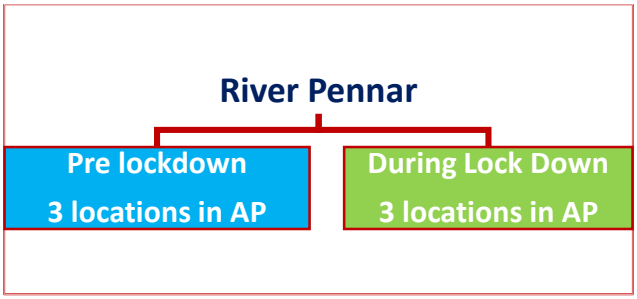


Figure 15.3 Water Quality Monitoring Locations carried out during Lockdown and Pre-lockdown on River Pennar.

15.4. Observations

Based on the analytical results of the samples collected from river Pennar, following findings/observations are made:

Andhra Pradesh

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters were observed to be in the order of pH (7.7 -7.9), DO (6.2 - 7.4 mg/L), BOD (1.4 -1.7 mg/L) and FC (3 -200 MPN/100 mL) at all the 03 monitored locations.

All the 03 monitored locations were found to be complying with the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters were found to be in the order of pH (6.7 -7.43), DO (5.7 -6.9 mg/L), BOD (1-2.8 mg/L) and FC (3 -200 MPN/100 mL) at the 03 monitored locations.

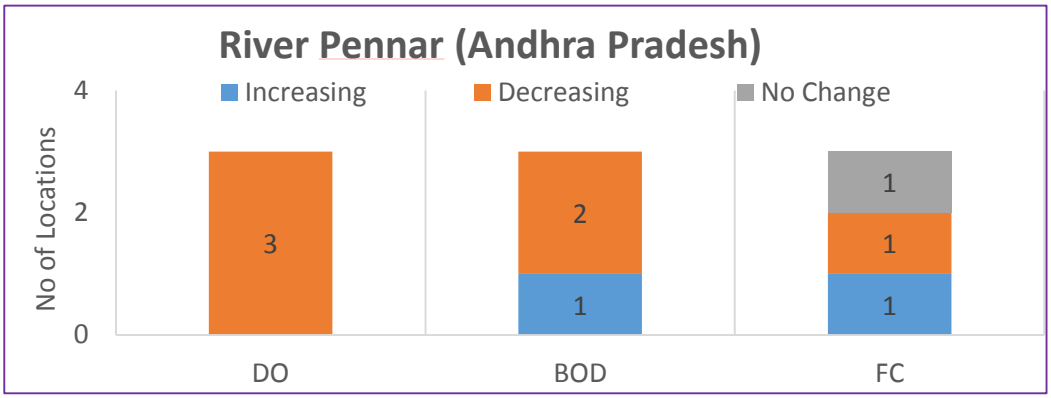
Maximum DO was observed at A/C Cheyyuru Somasila (6.9 mg/L)) and minimum at after confluence with Papagni, at Pushpagini (5.7 mg/L). Maximum BOD was observed at Siddhavatm, Kadapa (2.8 mg/L) and minimum at A/C with Papagni , Pushpagini (01 mg/L) whereas maximum FC count observed at Siddhavatm, Kadapa (200 MPN/100 mL) and minimum at A/C Cheyyuru Somasila (03 MPN/100 mL).

All the 03 monitored locations were found to be within the desirable limits for the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

All the 03 monitored locations (during pre-lockdown and lockdown) were complying with the primary water quality criteria for outdoor bathing parameters. Also, increasing trend of BOD (87%) at 1 location and FC (100%) at 1 location whereas decreasing trend of DO (3.2% to 10.9%) at 3 locations, BOD (14 % -41%) at 2 locations and FC (50%) at 1 location were observed. 'No' variation was observed w.r.t parameter FC at 1 monitored location. Water Quality Trend During Pre (March 2020) and Lockdown (April 2020) in River Pennar is given at **Figure 15.4**.

Figure 15.4 River Pennar- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)



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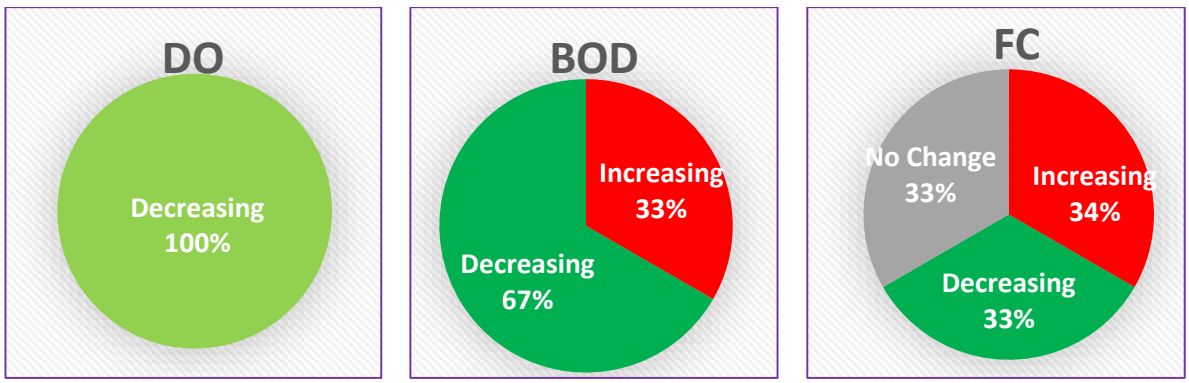


15.5 Conclusion

- *03 out of 03 monitored locations on river Pennar during pre and lockdown period were observed to be complying (100 % compliance) with the Primary Water Quality Criteria for Outdoor Bathing limits notified under Environment (Protection) Rules, 1986. Also, considerable improvement in water quality of river Pennar was observed with respect to the parameters viz., DO, BOD and*

16 Impact of Lockdown on Water Quality of River Sabarmati

16.1 About Sabarmati River

The Sabarmati river **(Figure 16.1)** is one of the major west-flowing rivers in India. It originates in the Aravalli Range, Udaipur District of Rajasthan and meets the Gulf of Cambay of Arabian Sea after traversing 371 km in a south-westerly direction across Rajasthan and Gujarat States. 48 km of the river length is in Rajasthan, while 323 km is in Gujarat.

Facts at a Glance

Ahmedabad city is located on the banks of the Sabarmati River. It has emerged as an important economic and industrial hub in the state of Gujarat having large, medium and small scale industries of various types.

The Right bank tributaries of river Sabarmati are river Sei, Siri and Dhamni, while left bank tributaries are Wakal, Harnav, Hathmati, Khari, Watrak etc.

A large number of industries such as textiles, leather and leather goods, dyes & dye intermediates, chemicals, thermal power plant, pulp and paper, machinery, metal products, engineering, news print, automobile, plastic, rubber goods, drugs and pharmaceutical, etc. are located in the Ahmedabad city. There are 04 major industrial estates, and two major textile industrial clusters in Ahmedabad city.

Source: https://guruprasad.net/

Figure 16.1 River Sabarmati

16.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP) on River Sabarmati

Water quality of river Sabarmati is evaluated at 11 locations by Central Pollution Control Board in association with Gujrat Pollution Control Board, under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Sabarmati is depicted in **Figure 16.2.**

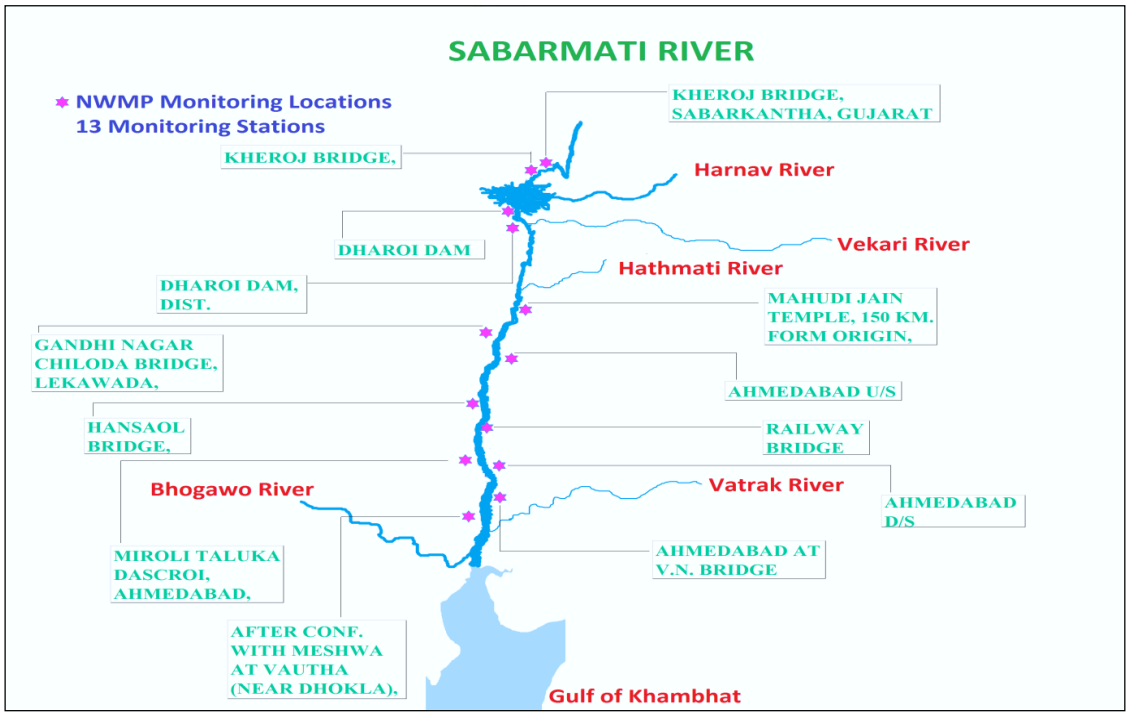


Figure 16.2 Water Quality Monitoring Locations Under NWMP on River Sabarmati

16.3 Analytical Results:-

Water quality of river Sabarmati was carried out at 9 locations in Gujarat during Pre-lockdown (March 2020) and during lockdown period (April 2020) to assess the impact on water quality of river Sabarmati. (**Figure 16.3**)

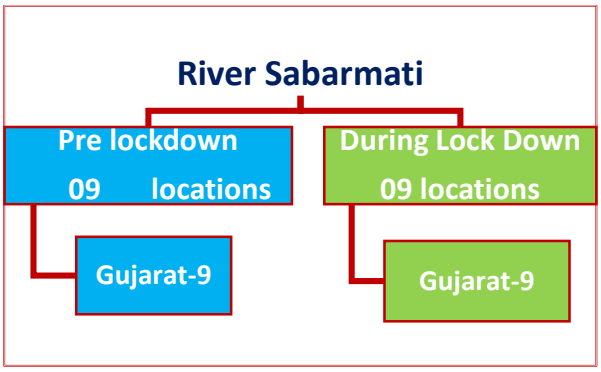


Figure 16.3 Water Quality Monitoring Location carried out during Pre-lockdown and Lockdown on River Sabarmati.

16.4 Observations

Based on the analytical results of the samples collected from river Sabarmati, following findings/observations are made:

Gujarat-Observations

During the pre-lock down period (March 2020)

The analysis results of 09 monitored locations indicate pH (7.9 -8.5), DO (0.1 (BDL) -7.7 mg/L), BOD (BDL (0.7) -87 mg/L) and FC (2 -1100 MPN/100mL). DO and BOD (at 5 locations), pH and FC (9 monitored locations) were found to be within the desirable limits for primary water quality criteria for outdoor bathing.

Also, the water quality of river Sabarmati at Dharoi Dam after confluence with Meshwa at Vautha (Near Dhokla) was observed that DO (deteriorated from 7.7- BDL mg/L), BOD (increased from 0.8-34 mg/L) whereas FC (increased from 2 -220 MPN/100 mL)

During the lock down period (April 2020)

The analysis results of 09 monitored locations indicate pH (7.0 to 8.2), DO (0.1 (BDL) -8.2 mg/L), BOD ((BDL) 0.5 -57 mg/L) and FC (2 - 170 MPN/100mL) . pH and FC were found to be complying at all 09 monitored locations whereas DO and BOD were observed to be complying only at 05 locations.

The water quality of river Sabarmati at Dharoi Dam after confluence with Meshwa at Vautha (Near Dhokla) observed that DO (deteriorated from 6.7 -4.3 mg/L), BOD (increased from 0.6 -12 mg/L), FC (increased from 2 -110 MPN/100 mL

Overall Observations

During lockdown, maximum DO was observed at Railway Bridge, Ahmedabad (8.2 mg/L)) and minimum observed as 'BDL' at V.N. Bridge, Ahmedabad. Maximum BOD was observed at V.N Bridge, Ahmedabad (57 mg/L) and minimum at Dharoi Dam, Dt. Mehsana (0.5 mg/L) whereas maximum FC count (170 MPN/100 mL) was observed at 02 locations viz., Vill. Maroli, Taluka Dascrol and Ahemdabad D/s and minimum of 02 MPN/100 mL at 02 locations i.e., at Dharoi Dam and Dharoi Dam, Dt Mehsana.

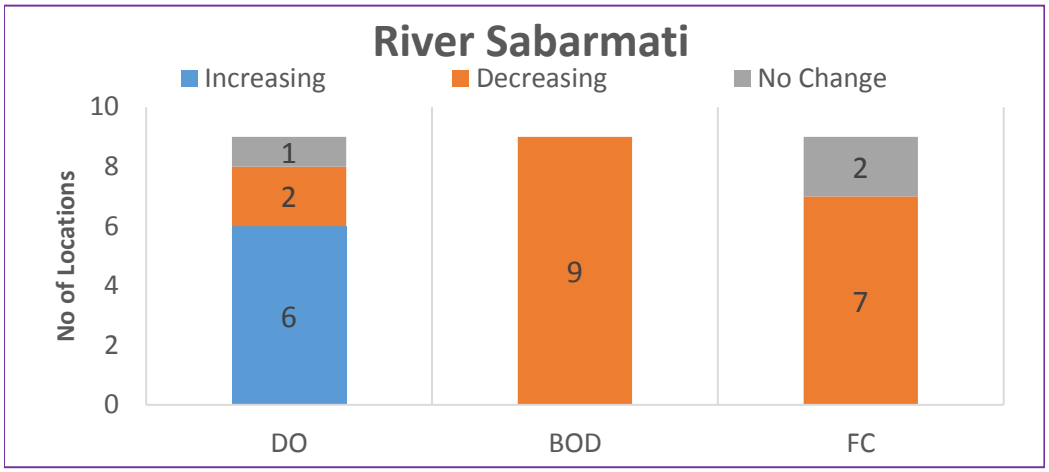
Overall decreasing trend of DO (13% - 14%) at 02 locations, BOD (18% -65%) at 09 monitored locations and FC (5% -96%) at 07 locations whereas increasing trend of DO (9.0% - 4200%) at 06 locations and 'No' percent variation in DO at 01 location and FC at 02 locations were observed.

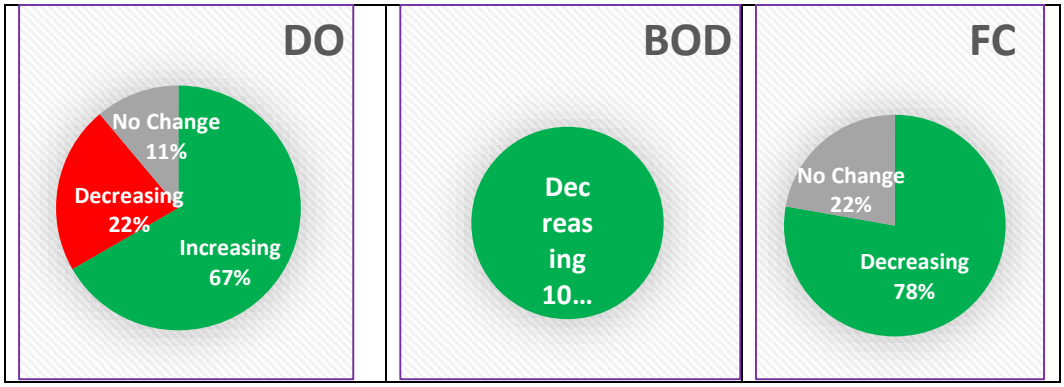
5 out of 9 monitored locations were complying with the Outdoor Bathing Criteria.

16.5 Water Quality Trend of River Sabarmati

Water Quality trend of river Sabarmati as observed during pre-lockdown and lockdown is given in **Figure 16.4**

Figure 16.4 River Sabarmati - Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)





16.6 Conclusion

- *05 out of 09 monitored locations on river Sabarmati during pre and lockdown were observed to be complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, an improvement in water quality of river Sabarmati was observed with respect to the criteria parameters viz., DO, BOD & FC at the monitored locations and consistent % compliance of monitored locations on river Sabarmati to Primary Water Quality Criteria for Outdoor Bathing was observed during pre-lockdown and lockdown period.*

17 Impact of Lockdown on Water Quality of River Swarnarekha

17.1 About River Swarnarekha

The river Swarnarekha originates south of Ranchi. Before falling in the Bay of Bengal near Talsari, the river flows through Ranchi and Singhbhum Districts of Jharkhand State, Thereafter, it flows for shorter distances through Paschim Midnapore district in West Bengal and Balasore district of Odisha. Swarnarekha river **(Figure 17.1)** flows for a total length of 395 kilometres. Out of this, 269 km lies in Bihar, 64 km in West Bengal, and 62 km in Odisha

Facts at a Glance

Jamshedpur is the largest Industrial city of Jharkhand, situated in the middle of the Swarnarekha river valley. Between Mayurbhanj and Singhbhum districts .

Prominent Tributaries of Swarnarekha *are river Kharkai, Roro, Kanchi, Harmu Nadi, Damra, Karru, Chinguru, Karakari, Gurma, Garra, Singaduba, Kodia, Dulunga and river Khaijori.*

On the right banks of the Subarnarekha, *are the country's richest copper deposits. Mining activities are taking place near Jaduguda areas of Singhbhum district.*

Source: Shutterstock

Figure 17.1 River Swarnarekha

17.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Swarnarekha is monitored at 24 locations by Central Pollution Control (CPCB) Board in association with State Pollution Control Boards of Jharkhand (20 locations), West Bengal (02 locations) and Odisha (02 locations) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Swarnarekha is depicted in **Figure 17.2.**

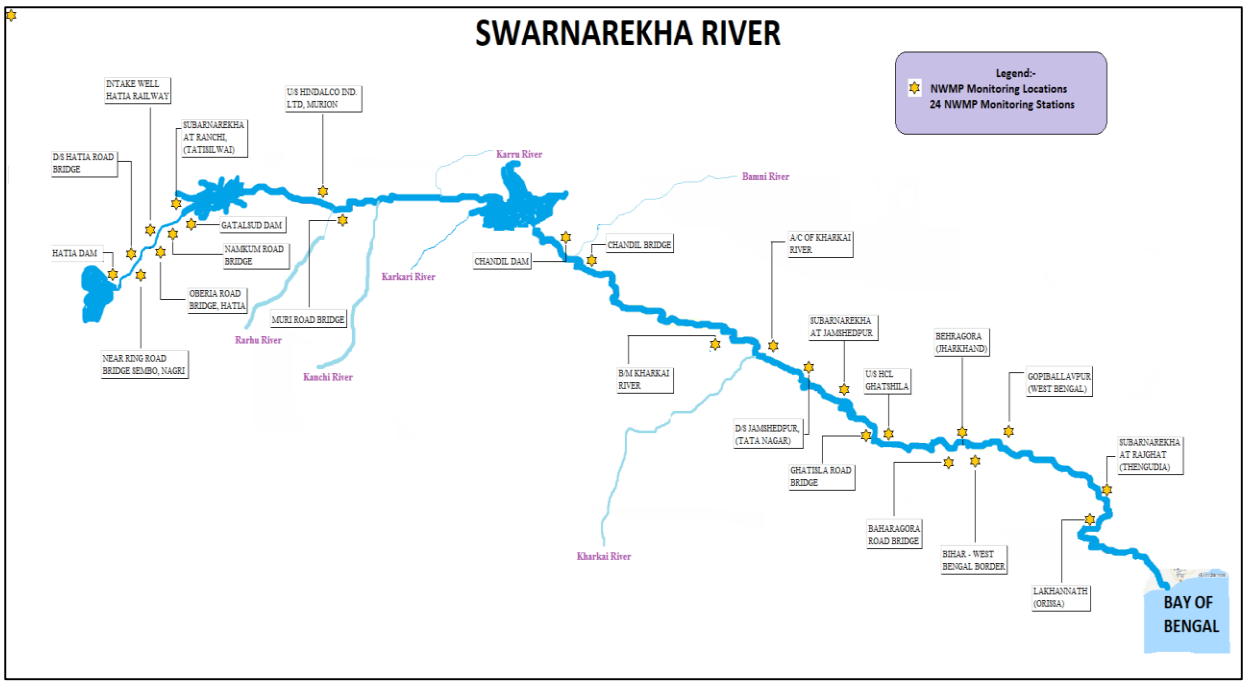


Figure 17.2 State-wise Distribution of Water Quality Monitoring Locations Under NWMP on River Swarnarekha

17.3. Analytical Results

Water quality of river Swarnarekha was carried out at 05 locations (Jharkhand-04 and Odisha-01) during Pre-Lockdown (March 2020) and 15 locations (Jharkhand-14 and Odisha-01) during Lockdown period (April 2020) to assess the impact on water quality of river Swarnarekha **(Figure 17.3).**

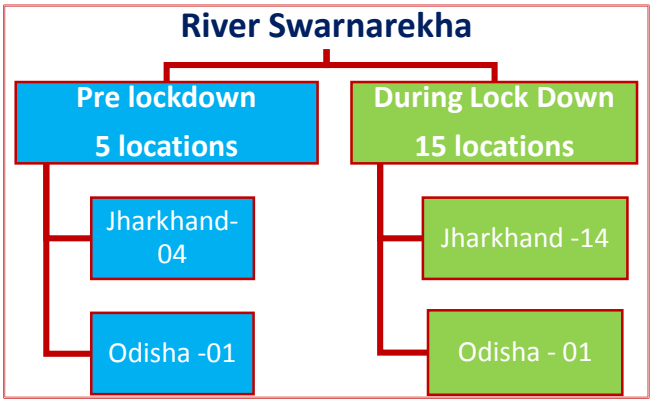


Figure 17.3 Water Quality Monitoring Locations carried out during pre and lockdown on River Swarnarekha

17.4. Observations

Based on the analytical results of the samples collected from river Swarnarekha, following findings/observations are made:

Jharkhand- Observations

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters observed to be in the order of pH (6.5-7.4), DO (3.6 -7.9 mg/L), BOD (2.7 - 2.9 mg/L) and FC (140 - 150 MPN/ 100 mL) at the 04 monitored locations.

Maximum DO (7.9 mg/L) was observed at Near Ring Road Bridge, Sembo and minimum DO (3.6 mg/L) at Oberia Road Bridge, Hatia whereas maximum BOD (2.9 mg/L) was observed at 3 locations and minimum BOD (2.7 mg/L) observed at Near Intake Well, Hatia Railway. Maximum FC count (150 MPN/100 mL) was observed at 3 locations and minimum BOD (140 MPN/100 mL) observed at Near Intake Well, Hatia Railway

3 out of 4 monitored locations were found to be complying to Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters observed to be in the ranges of pH (7.2-7.6), DO (3.7 - 8.2 mg/L), BOD (BDL(0.4)–6.4 mg/L) at 14 monitored locations. FC not monitored by SPCB.

Maximum DO (8.2 mg/L) was observed at Chandil Dam and minimum DO (3.7 mg/L) at Oberia Road Bridge, Hatia whereas maximum BOD (6.4 mg/L) was observed at Namkum Road Bridge and minimum BOD (BDL-0.4 mg/L) observed at Chandil Dam.

pH at 14 locations, DO at 13 locations and BOD at 07 locations were found to be complyingwith the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing

7 out of 14 monitored locations (excluding FC) were observed to be within the desirable limits (for pH, DO & BOD) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Decreasing trend of DO (8 -16 %) at 02 locations, BOD (11 %) at 01 location and increasing trend of DO (3 - 42 %) at 02 locations and BOD (17 - 100 %) at 03 monitored locations.

Odisha- Observations

During the pre-lock down period (March 2020)

The analysis results for the four critical parameters observed to be in the order of pH (8.1), DO (7.6 mg/L), BOD (1.2 mg/L) and FC (1300 MPN/ 100 mL) at the only 01 monitored location (Rajghat Thengudia, Odisha).

Data of only 01 monitored location (Rajghat Thengudia, Odisha) was available and found to be within the desirable limits for the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results for the four critical parameters observed to be in the order of pH (7.4), DO (8 mg/L), BOD (1 mg/L) and FC (220 MPN/100 mL) at the only 01 monitored location (Rajghat Thengudia, Odisha) and complying with the criteria parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall observations

The analysis results of one monitored location (Rajghat Thengudia, Odisha) shown decreasing trend of BOD (17%), FC (83.08 %) and increasing tendency of DO (5%).

17.5 Overall Observations on River Swarnarekha (covering both Jharkhand and Odisha States)

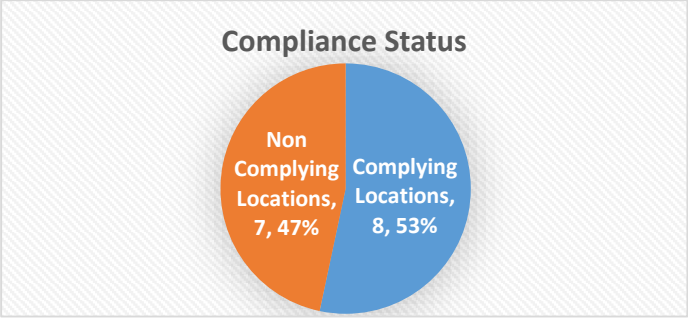
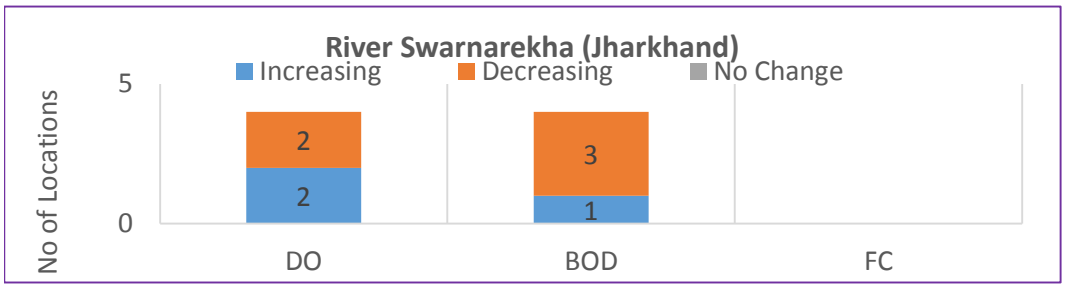


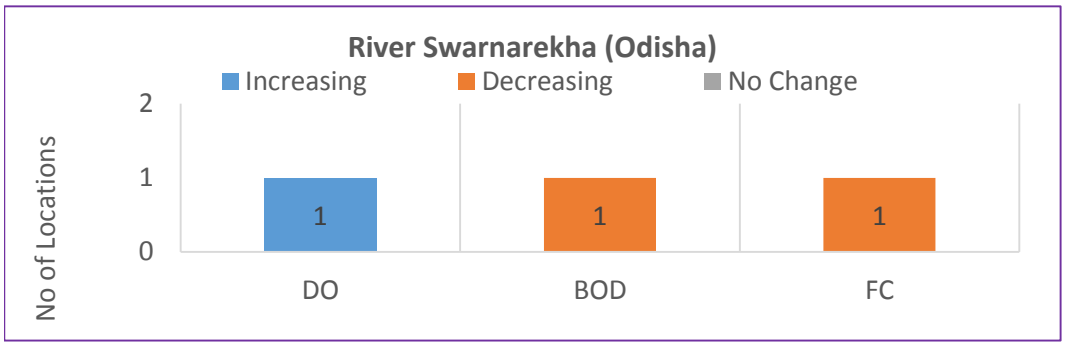
Figure 17.34 Compliance Status of Monitored Location on river Swarnarekha during Lockdown

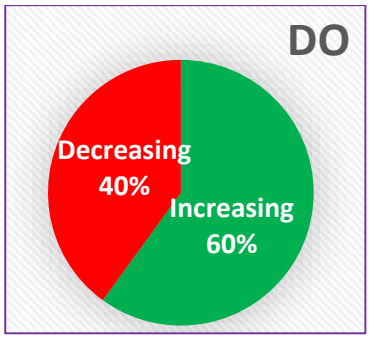
The analysis results revealed that

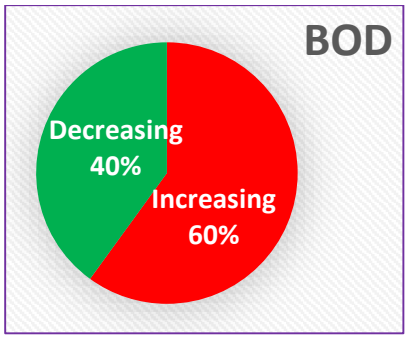
- 8 out of 15 monitoring locations complying with the Outdoor Bathing criteria during lockdown (**Figure 17.4**)
- During lockdown, maximum DO is observed at Chandil Dam (8.2 mg/L) and minimum observed at Oberia Road bridge, Hatia (3.7 mg/L) whereas maximum BOD was observed at Namkum Road Bridge (6.4 mg/L) and minimum BOD as BDL (0.4 mg/L) at Chandil dam. Maximum FC observed at Rajghat, Thenugudia (220 MPN/100 mL).
- Increasing trend of DO (3%- 42 % %) at 3 locations, BOD (17 -100%) at 3 locations and decreasing trend of DO (8 - 16 %) at 02 locations, BOD (11 -17 %) at 2 locations and FC (83.08 %) at 1 location. (**Figure 17.5**)

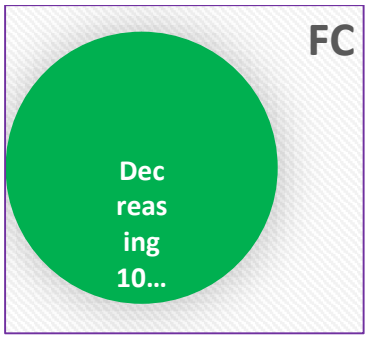
Figure 17.5 River Swarnarekha - Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











17.6 Conclusion

- *During pre-lockdown, 4 out of 5 monitored locations during lockdown, 8 out of 15 monitored locations were found to be complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, the water quality of river Swarnarekha during the lockdown period was deteriorated in terms of % compliance of monitored locations (i.e., 53.33 %) to the bathing criteria limits.*

18 Impact of Lockdown on Water Quality of River Sutlej

18.1 About Sutlej River

The River Sutlej rises from beyond Indian borders in the Kailash mountain near Mansarover lake from Rakas lake (as Longcchen Khabab river in Tibet). River Sutlej enters India near Mansarover and flows North Westwards. It enters Himachal at Shipkila and flows in the South-Westerly direction and it leaves Himachal Pradesh State to enter the plains of Punjab State at Bhakhra. About 14 km (kilometre) downstream of Bhakra Dam, Nangal, the river takes southern direction. After flowing for another about 50 km, it enters the plains near Ropar in Punjab. The river Sutlej **(Figure 18.1)** finally reaches Harike where it meets river Beas. During the monsoon period, the river leaves Punjab plains near Ferozepur and finally drains into the river Indus.

There are two major drains i.e. Buddha Nallah and East Bein, which carry domestic as well as industrial effluents of Ludhiana, Jalandhar, Phagwara, Phillaur, Nawanshahar etc. and merge with river Sutlej at village Wallipur and near village Malsian, respectively.

The Buddha Nallah is a non-perennial natural drain of about 51 km length, which traverses about 14 km across Ludhiana city from East to West and finally meets river Sutlej near village Wallipur in district Ludhiana. The total waste water of Ludhiana city discharged into river Sutlej is estimated about 700 MLD which include industrial effluent.

East Bein passes through Nawanshahar, Kapurthala and Jalandhar. It is a natural storm water drain which originates near village Bhairon Mazra, District Nawanshahar. After travelling through a length of around 40 km, it passes through Jalandhar district near village Phadrana. As East Bein traverses through Jalandhar district, number of drains out fall into it. East Bein falls into river Sutlej at Village Mundi Kalan few kilometres upstream of Harike lake.

Facts at a Glance

In Punjab, main cities and towns along the river Sutlej are Nangal, Anandpur Sahib, Kiratpur Sahib, Ropar, Kurali, Machhiwara, Ludhiana, Phillaur, Phagwara, Jalandhar, Cantonment Jalandhar, Nawanshahar, Banga and Hoshiarpur.

***Major Districts** are Mandi. Hamirpur in HP State and Kapurthala, Gurdaspur & Hoshiarpur in Punjab State.*

***The tributaries of River Sutle**j are river Baspa, Spiti, and Beas. In Himachal Pradesh, river Sutlej passes through Kinnaur, Shimla, Kullu, Solan, Mandi and Bilaspur districts. Its coarse in Himachal Pradesh is 320 km from Rakastal, with the tributaries viz. the river Spiti, Ropa, Taiti, Kashang,Mulgaon, Yula, Wanger, Throng and the Rupi as right bank tributaries, whereas the river Tirung, Gayathing, Baspa, Duling and the Soldang are left bank tributaries.*

***Major industrial establishments** on the banks of river Beas within Punjab jurisdiction mainly comprises Fertilizer, Caustic Soda, TPP, Cement Plant, Dyeing,Electroplanting, Pickling units and Leather etc.*

Figure 18.1 River Sutlej at confluence of Budha Nallah

18.2. Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Sutlej is measured at 42 locations by Central Pollution Control Board (CPCB) in association with H.P. State Pollution Control Board (HPPCB) and Punjab Pollution Control Board (PPCB) under National Water Quality Monitoring Programme (NWMP). State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Sutlej is depicted in **Figure 18.2**

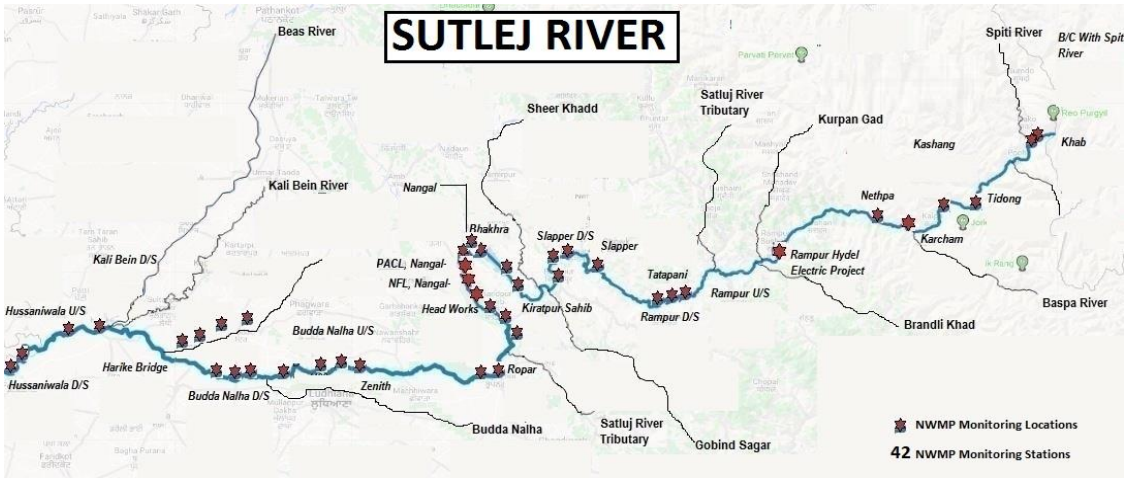


Figure 18.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Sutlej (HP & Punjab)

18.3. Analytical Results

Water quality monitoring of river Sutlej was carried out at 31 locations during pre-lockdown (March 2020) and 23 locations during lockdown period (April 2020) to assess the impact of lock-down on water quality of river Sutlej. (**Figure 18.3**)

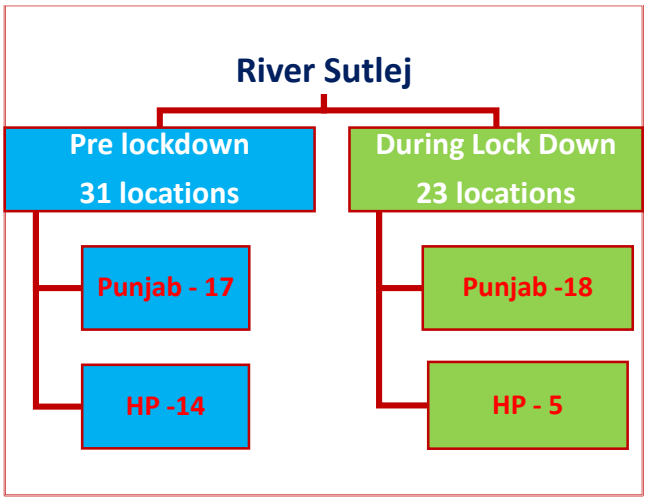


Figure 18.3 Water Quality Monitoring Locations carried out during pre-lockdown and lockdown on River Sutlej.

18.4. Observations

Based on the analytical results of the samples collected from river Sutlej, following findings/observations are made:

Himachal Pradesh - Observations

During the pre-lock down period (March 2020)

The analysis results revealed four critical parameters are in the order of pH (7.1 – 8.4), DO (7.7 – 9.7 mg/L), BOD (BDL mg/L) and FC (34 – 540 MPN/ 100mL) at the 14 monitored locations.

All the 14 monitored locations complying with desirable limits for Outdoor Bathing Criteria.

During the lock down period (April 2020)

The analysis results of four critical parameters indicates pH (7.8 – 8.2), DO (8.2 – 9.5 mg/L), BOD (BDL mg/L) and FC (31-140 MPN/ 100mL) at the 5 monitored locations.

All the 5 monitored locations complying to the Outdoor Bathing Criteria.

Overall Observations

Decreasing trend for the parameters i.e., DO (2.2 -13.40 %) at 3 locations, FC (8.8 %) at 1 location while increasing trend were shown for the parameters i.e., DO (1.1-23.40 %) at 2 locations, FC (16.7-17 %) at 3 locations. 'No' variation in FC at one location and consistent 'BOD' at all the 5 monitored locations were noticed.

Punjab - Observations

During the pre-lock down period (March 2020)

The analysis results for four critical parameters were found to be in the order of pH (7.2 – 8.5), DO (2.8 – 9.2 mg/L), BOD (BDL – 14 mg/L) and FC (68-230000 MPN/ 100mL) at the 18 monitored locations.

13 out of 18 monitored locations were complying to Outdoor Bathing criteria to the parameters (i.e. DO, BOD and FC).

During the lock down period (April 2020)

The analysis results for four critical parameters found to be in the order of pH (6.9 – 8.5), DO (2.8 – 10.6 mg/L), BOD (BDL – 16 mg/L) and FC (45 - 70000 MPN/ 100mL) at the 18 monitored locations. 13 out of 18 monitored locations were complying to the parameters (i.e. DO, BOD and FC).

Overall Observations

Decreasing trend for the parameters i.e., DO (1.7 -20.2 %) at 7 locations, BOD (15.4 - 33.33 %) at 7 locations and FC (2.2 -74.7 %) at 11 locations whereas increasing trend were shown for the parameters i.e., DO (3.4-30.78 %) at 10 locations, BOD (7.5 -14.3 %) at 4 locations, FC (13-113 %) at 7 locations. 'No' variation was observed in FC at one location and consistent 'BOD was observed at 7 locations.

18.5 Overall Observations on River Sutlej (covering Himachal Pradesh and Punjab)

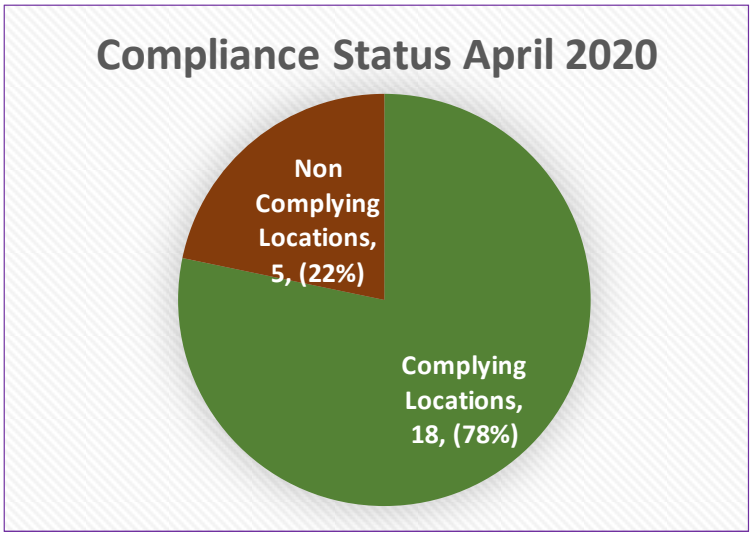


Figure 18.4 Compliance Status of Monitored Locations during Lockdown Period

The analysis results revealed that

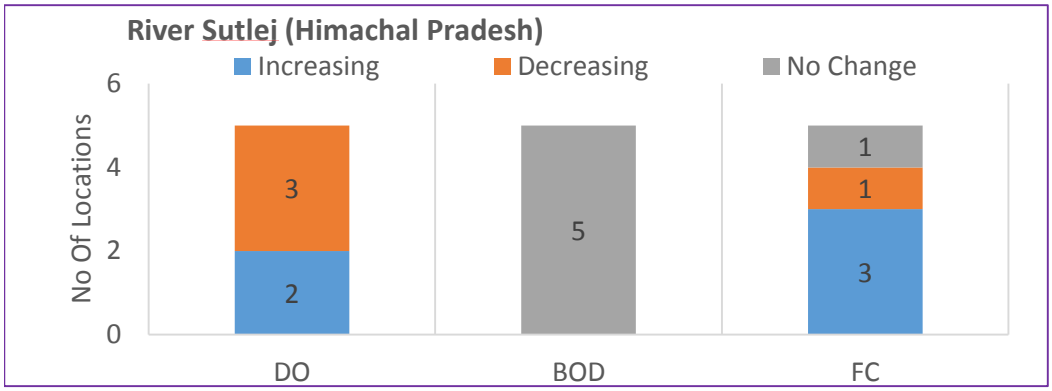
- During Pre-lockdown period (March 2020), the analysis results of four critical parameters were in the order of pH (7.1 - 8.5), DO (2.8 – 9.7 mg/L), BOD (BDL – 14 mg/L) and FC (34 - 230000 MPN/ 100mL) at the 31 monitored locations. 27 locations were found to be within the desirable limits of Outdoor Bathing Criteria.

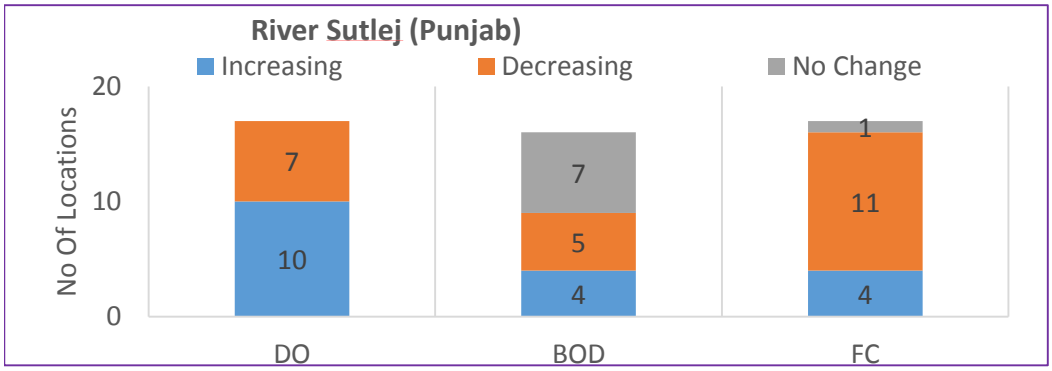
- During lockdown period (April 2020), the analysis results of four critical parameters were in the ranges of pH (6.9 - 8.5), DO (2.8 – 10.6mg/L), BOD (BDL – 16 mg/L) and FC (31-70000 MPN/ 100mL) at 23 monitored locations. 18 out of 23 monitored locations were observed to be complying with the Outdoor Bathing Criteria. (**Figure 18.4**)

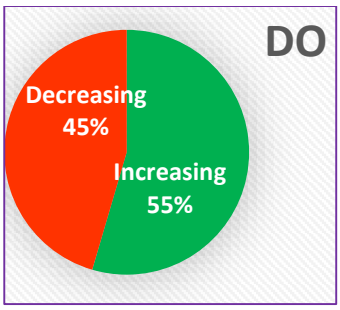
- During lockdown, maximum DO was observed at Kiratpur Sahib (10.6 mg/L)) and minimum at D/s East Bein (2.8 mg/L. Maximum BOD was observed at D/s Budha Nallah (16.0 mg/L) and minimum as 'BDL' at 16 locations while maximum FC count was observed at two (02) locations - D/S Budha Nallah and D/s East Bein (70000 MPN/100 mL) and minimum at D/s Bhakra (31 MPN/100 mL).

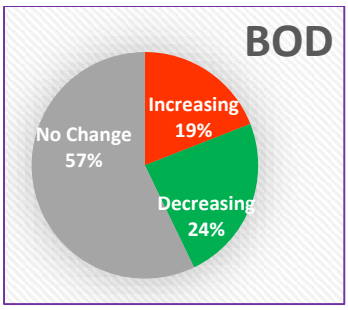
- Decreasing trend were shown for DO (1.7 - 20.2 %) at 10 monitored locations, BOD (15.4 - 50 %) at 7 locations and FC (2.2 - 74.7 %) at 12 monitored locations. Increasing trend was observed for DO (1.1 - 30.8 %) at 12 locations, BOD (7.5 - 14.3 %) at 5 locations and FC (13 - 113 %) at 10 locations. 'No' variation in FC at 2 locations and consistent 'BOD' at 12 monitored locations were observed. (**Figure 18.5**)

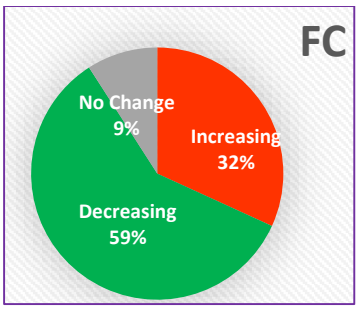
Figure 18.5 River Sutlej- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)











18.6 Conclusion

- *27 out of 32 monitored locations during pre-lockdown (March 2020) and 18 out of 23 monitored locations during lockdown (April 2020) were within desirable limits of Outdoor Bathing Criteria. Discernible improvement in river Sutlej water quality could be seen during the lockdown period which may be due to inadequate infrastructure for treatment of generated municipal sewage in the catchment of river Sutlej. However, overall improvement was observed with respect to the parameters viz., DO and BOD.*

19 Impact of Lockdown on Water Quality of River Tapi

19.1. About River Tapi

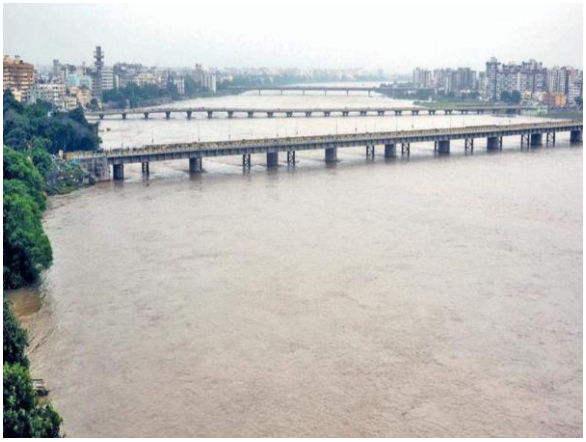
Tapi River (also known as the Tapti) is the second largest westward inter-state flowing rivers of the Peninsular India. The river Tapi originates in the Betul district from a place called Multai in the eastern Satpura Range of southern Madhya Pradesh (MP). The Tapi River **(Figure 19.1)** flows for about 724 km over the plains of Vidharbha, Khandesh and Gujarat and in the states of Maharashtra and Madhya Pradesh and finally joins Arabian sea in Gulf of Cambay after flowing past the Surat city.

Facts at a Glance

Major Towns or Cities on the banks of River Tapi *Bhusawal in Maharashtra, Betul, Multai, and Burhanpur in Madhya Pradesh, and Surat in Gujarat. Apart from Surat, other main towns or cities on the banks of river Tapti are Mandvi. Kalod, Kamrej, Kathor and Dumas.*

Major Tributaries of River Tapi: *Right bank tributaries are the river Vaki, Gomai, Arunavati and the Aner. On the left bank, important tributaries are river Nesu, Arunavati, Buray, Panjhra, Bori, Girna, Vaghur, Purna, Mona and the river Sipna.*

Major Industries: *In Madhya Pradesh, the industries are centred only in one District-East Nimar (Khandwa) while in Maharashtra, Jalgaon is the most industrialized area. Distillery units contribute the largest share in Maharashtra whereas textile occupies the predominant activity at Surat in Gujarat followed by food & beverages, paper & news print (at Nepanagar) and chemical industries.*



Source: Times of India

Figure 19.1 River Tapi at Surat, Gujarat

19.2 Water Quality Monitoring Locations under NWMP on River Tapi

Water quality of river Tapi is monitored at 17 locations by Central Pollution Control Board (CPCB) in association with Gujarat Pollution Control Board (GPCB) and Maharashtra Pollution Control Board (MPCB) under National Water Quality Monitoring Programme (NWMP). The State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Tapi is depicted in **Figure 19.2**.

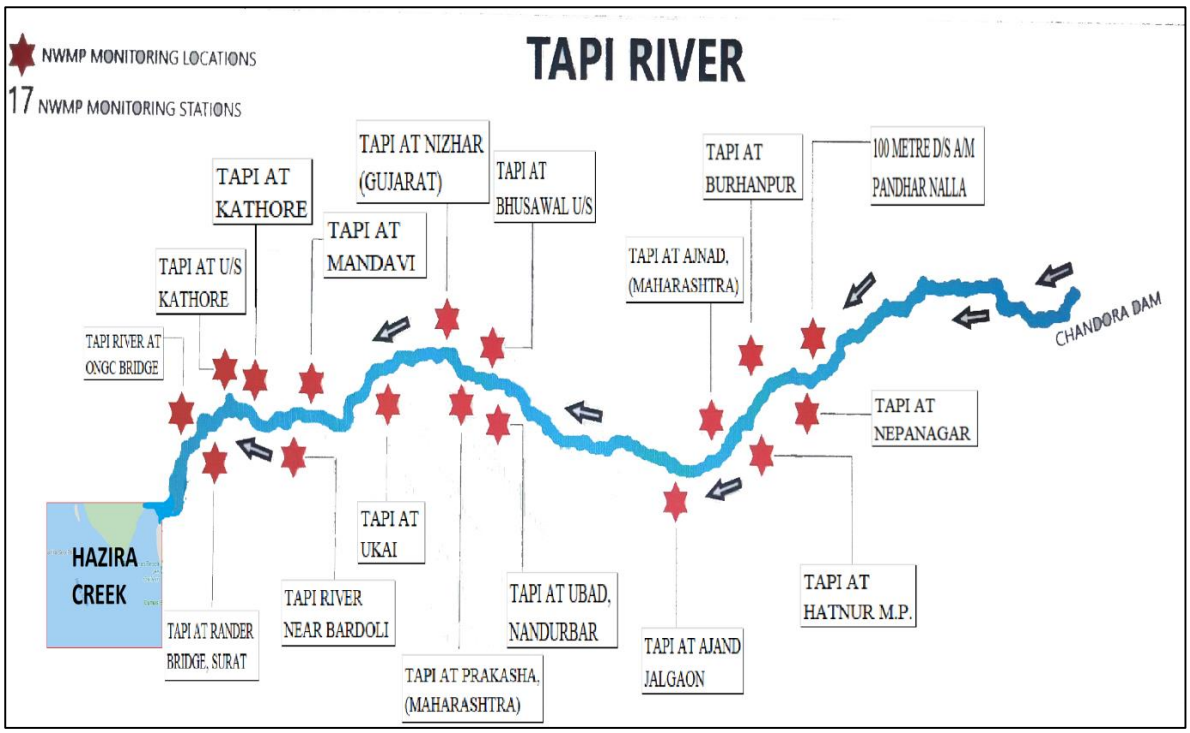


Figure 19.2: The State-wise Distribution of Water Quality Monitoring Locations Under NWMP on River Tapi

19.3 Analytical Results

Water quality of river Tapi was carried out at 9 locations [(Maharashtra-2 and Gujarat -7)] during Pre-lockdown (March 2020) and at 8 locations [(Maharashtra-2 and Gujarat -6)] during lockdown period (April 2020) to assess the impact on river water quality. **(Figure 19.3)**

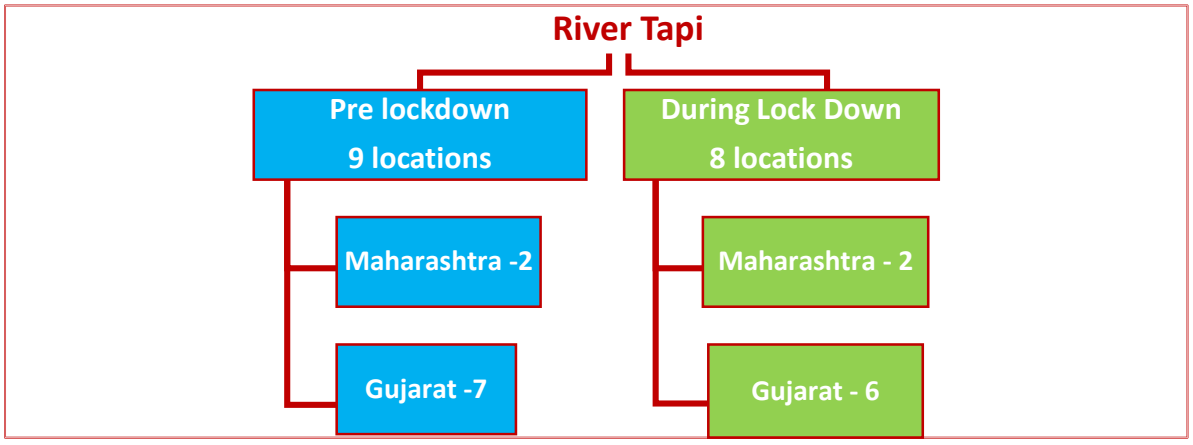


Figure 19.3:Water Quality Monitoring Locations carried out during pre and Lockdown period on River Tapi

19.4. Observations

Based on the analytical results of samples collected from river Tapi, following findings/observations are made:

Maharashtra -Observations

During the pre-lock down period (March 2020)

The analysis results of 02 monitored locations for the four critical parameters in the order of pH (7.81-7.84), DO (5.8 – 6.0 mg/L), BOD (3.2 - 4.0 mg/L) and FC (14 - 17 MPN/100 mL).

Minimum DO (5.8 mg/L) was observed at U/s Bhusawal Village, maximum DO (6 mg/L) was observed at Ajnad Village while maximum BOD (4 mg/L) was observed at U/s Bhusawal Village and minimum BOD (3.2 mg/L) was observed at Ajnad Village. Maximum FC (17 MPN/100mL) was observed at Ajnad Village and minimum FC (14 MPN/100 mL) was observed at U/s Bhusawal Village.

2 monitored locations complying with the parameters (i.e. DO, pH and FC) of Outdoor Bathing Criteria while BOD found to be not complying at any of the 02 monitored locations.

During the lock down period (April 2020)

The analysis results of the 02 monitored locations for the four critical parameters in the range of pH (7.72-7.80), DO (6.2– 6.7 mg/L), BOD (2.8 -4.0 mg/L) and FC (11- 13 MPN/100mL).

Minimum DO (6.2 mg/L) was observed at U/s Bhusawal Village, maximum DO (6.7 mg/L) was observed at Ajnad Village while maximum BOD (4 mg/L) was observed at U/s Bhusawal Village and minimum BOD (2.8 mg/L) was observed at Ajnad Village. Maximum FC (13 MPN/100mL) was observed at U/s Bhusawal Village and minimum FC (11 MPN/100 mL) was observed at Ajnad Village.

1 location is not complying to BOD limit prescribed under bathing criteria limit i.e., one out of 2 monitored location complying to the bathing criteria limit for DO, pH, BOD and FC parameters.

Overall Observations

Increasing trend of DO (7 -12 %) at 2 locations and decreasing trend of BOD (13 %) at 1 location, FC (7-35 %) at 2 locations and ‘no’ variation in BOD was observed at 1 location.

Gujarat-Observations

During the pre-lock down period (March 2020)

The analysis results of the 07 monitored locations for four critical parameters observed to be in the order of pH (7-7.7), DO (7 – 7.2 mg/L), BOD (0.8 to 1.6 mg/L) and FC (06- 09 MPN/100 mL).

Minimum DO (7 mg/L) was observed at 6 monitored locations, maximum DO (7.2 mg/L) was observed at Kathore (NH-8 Bridge) while maximum BOD (1.6 mg/L) was observed at ONGC Bridge and minimum BOD (BDL mg/L) was observed at 5 monitored locations. Maximum FC (9 MPN/100mL) and minimum FC (6 MPN/100 mL) was observed at 3 monitored locations each.

All 7 monitored locations complying to the parameters (i.e. pH, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of the 06 monitored locations for the four critical parameters observed to be in the order of pH (7.1-7.5), DO (6.9 – 7.2 mg/L), BOD (0.7 -1.2 mg/L) and FC (6-9 MPN/100mL).

Minimum DO (6.9 mg/L) was observed at ONGC Bridge, maximum DO (7.2 mg/L) was observed at Kathore (NH-8 Bridge) while maximum BOD (1.2 mg/L) was observed at ONGC Bridge and minimum BOD (BDL mg/L) was observed at 5 monitored locations. Maximum FC (9 MPN/100mL) was observed ar 2 locations and minimum FC (6 MPN/100 mL) was observed at 4 monitored locations.

All the 06 monitored locations complying to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend of FC (50 %) at 2 locations whereas decreasing trend of DO (1.42 %) at 1 location, BOD (10-25 %) at 4 locatios, FC (33 %) at 4 locations .‘No’ variation in DO at 5 locations and BOD at 2 locations was observed within Gujarat stretch of river Tapi.

19.5 Overall Observations on River Tapi (covering Maharashtra and Gujarat)

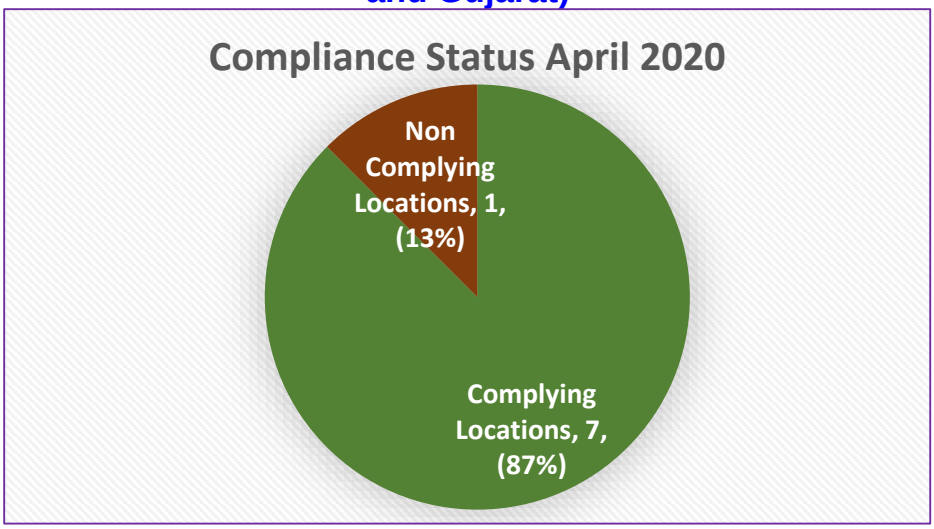


Figure:19.4 Compliance Status of River Tapi during Lockdown

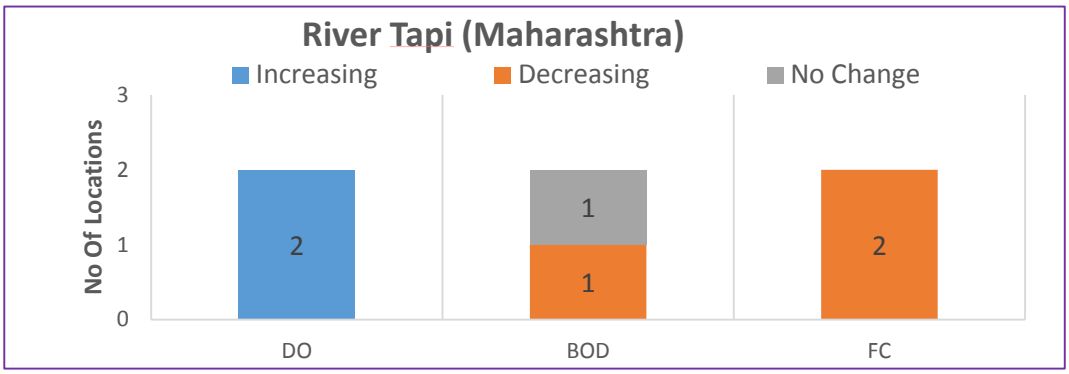
The analysis results revealed that

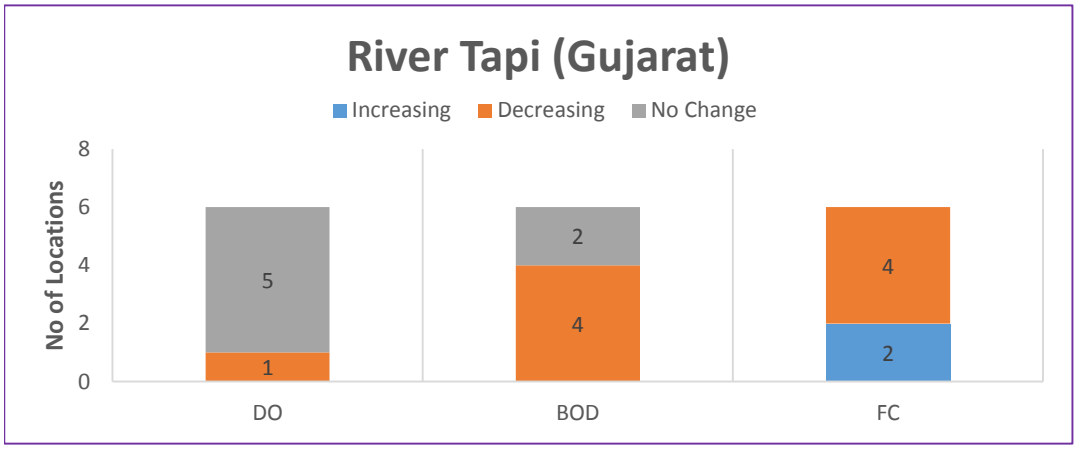
- During pre-lockdown period (April 2020), 9 monitored locations for the four critical parameters observed to be in the order of pH (7 -7.84), DO (7– 7.2 mg/L), BOD (BDL (0.8)-4.0 mg/L) and FC (6-17 MPN/100mL).

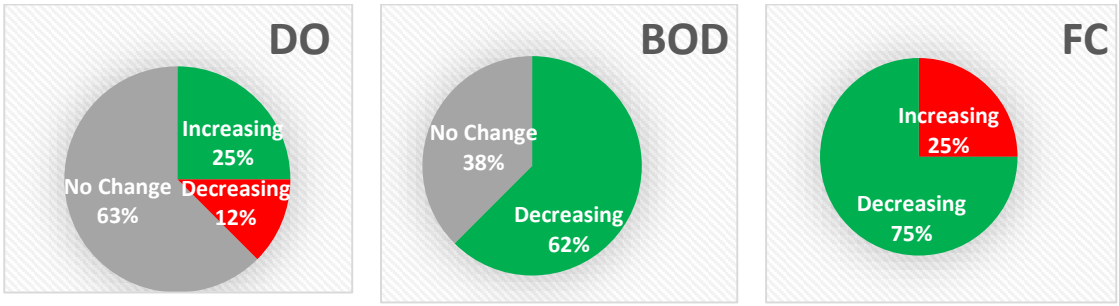
- During lockdown period (March 2020), 8 monitored locations for the four critical parameters observed to be in the range of pH (7.1 -7.8), DO (6.2- 7.2 mg/L), BOD (0.7-4.0 mg/L) and FC (6-13 MPN/100mL). The analysis results also revealed maximum DO was observed at Kathore (NH-8 bridge) (7.2 mg/L) and minimum observed at U/s Bhusawal Village, Railway Colony (6.2 mg/L). Maximum BOD was observed at U/s Bhusawal Village, Railway Colony (4.0 mg/L) and minimum at 02 locations- Mandavi and Bardoli (Kapp Bridge) (0.7 mg/L). Maximum FC count was observed at U/s Bhusawal Village, Railway Colony (13 MPN/100 mL) and minimum at 04 locations- Mandavi, Surat U/s Kathore, Rander Bridge and ONGC bridge (6 MPN/100 mL). Compliance Status of River Tapi during Lockdown is given at **Figure:19.4**.

- Over all increasing trend of DO (7 to 12 %) at 2 locations, FC (50 %) at 2 locations and decreasing trend of DO (1.43%) at 1 location, BOD (10-25 %) at 5 locations, FC (7-35 %) at 6 locations and 'no' variation in DO at 5 locations & BOD at 3 locations were observed **Figure:19.5**.

Figure 19.5 River Tapi - Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)







19.6 Conclusion

- *During pre-lockdown (March 2020), 7 out of 9 monitored locations, 7 out of 8 monitored locations during lockdown period (April 2020) were observed to be complying with the Primary Water Quality Criteria for Outdoor Bathing parameters viz., pH, DO, BOD and FC.*
- *Overall, marginal improvement in water quality of river Tapi was observed during the lockdown period with respect to DO, BOD and FC as well as in terms of compliance of monitoring locations (87.5 %) to the bathing criteria limits, during the lockdown period.*

20 Impact of Lockdown on Water Quality of River Yamuna

20.1 About Yamuna River

The Yamuna river originates from Yamunotri glacier in the Bandarpunch in the Himalayas in Uttarakhand State. From its source, the river Yamuna **(Figure 20.1)** flows south through the Himalayan foothills of Uttarakhand into the Indo-Gangetic Plains. The Yamuna river traverses a distance of 1,376 km through the States of Himachal Pradesh, Haryana, Delhi and Uttar Pradesh and finally confluences with River Ganga at Prayagraj. River Yamuna is polluted mainly due to discharge of treated/partially treated industrial effluents, municipal sewage generated from Haryana, Delhi and U.P States apart from lack of adequate infrastructure for management of wastes from the afore-said States.

Facts at a Glance

The major urban centres *on the River Yamuna are Yamunanagar, Karnal, Panipat, Sonepat, Baghpat,Delhi, Noida, Mathura, Agra, Firozabad, Etawah, Kalpi, Hamirpur, and Prayagraj.*

The major tributaries *of the Yamuna River are Tons, Hindon, Ken, Chambal, Sasur Khedri, Betwa or Betravati.*

Major industrial establishments *on the banks of river Yamuna are at Yamunanagar, Panipat, Karnal, Delhi and Ghaziabad.*

Figure 20.1 River Yamuna at D/s Wazirabad Barrage and D/s of ITO Barrage

20.2 Water Quality Monitoring Locations under National Water Quality Monitoring Programme (NWMP)

The Water Quality of river Yamuna is examined at 30 locations by Central Pollution Control Board (CPCB) in association with the State Pollution Control Boards of Uttarakhand, Himachal Pradesh, Haryana, Uttar Pradesh and CPCB HQ. State-wise Distribution of Water Quality Monitoring Locations under NWMP on river Yamuna is depicted in **Figure 20.2.**

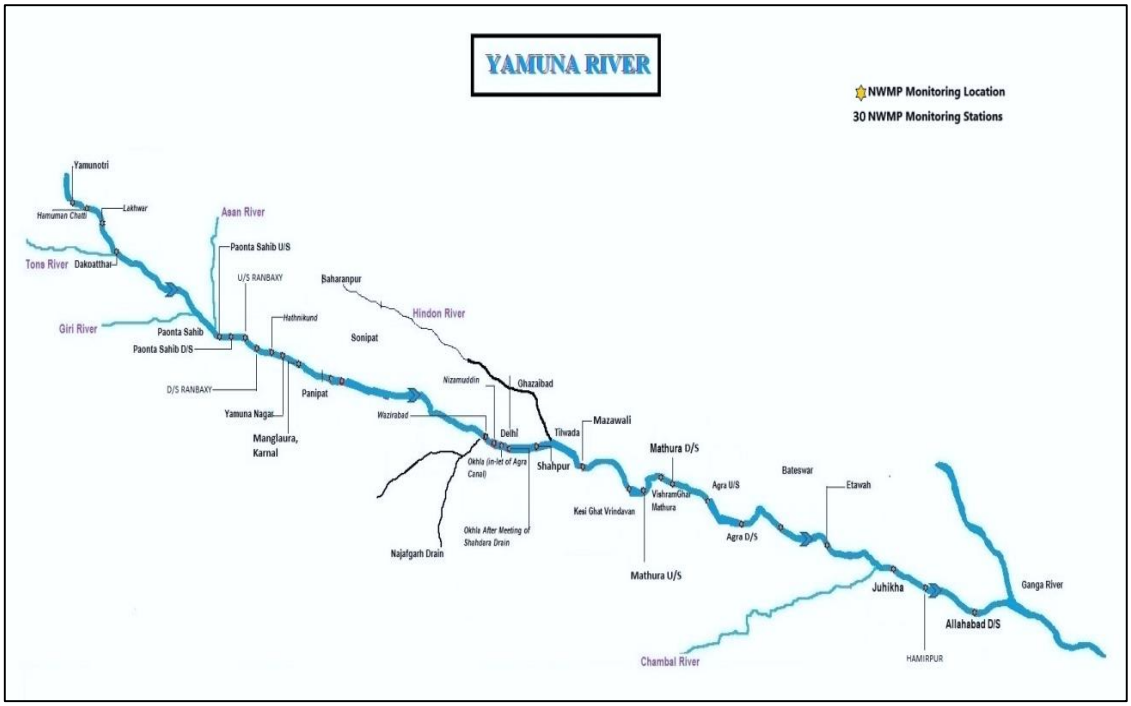


Figure 20.2: State-wise Distribution of Water Quality Monitoring Locations under NWMP on River Yamuna

20.3 Analytical Results

Monitoring of river Yamuna was carried out by the 4 States at 14 locations [(HP (04), Haryana (04), Delhi (05) and UP (1)] during Pre-Lockdown (March 2020) and 12 locations [(HP (04), Haryana (04), Delhi (03) and UP (1)] during Lockdown period (April 2020) to assess impact of lock-down on water quality of river Yamuna (**Figure 20.3**)

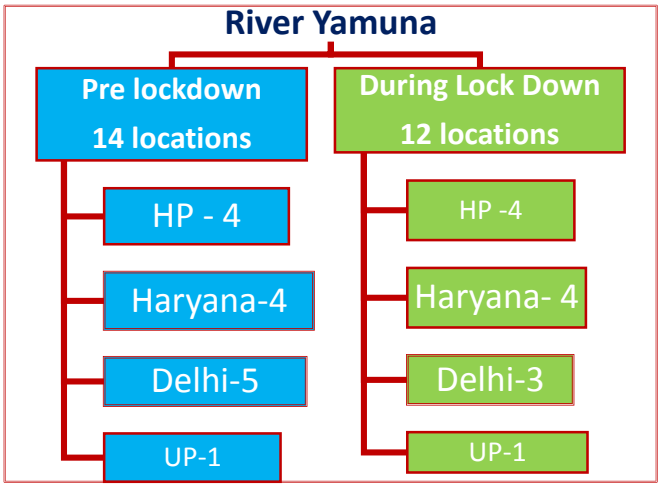


Figure 20.3 Water Quality Monitoring Carried out during Pre-lockdown and Lockdown

20.4 Observations

Based on the analytical results of the samples collected from river Yamuna, following findings/observations are made:

Himachal Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 4 monitored locations revealed that

The analysis results for four critical parameters were found to be in the order of pH (6.9-7.2), DO (8.6-8.9mg/L), BOD (0.6-0.8 mg/L) and FC (10-17 MPN/100 mL) at 04 monitored locations.

All 04 monitored locations are within the desirable limits for the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing

During the lock down period (April 2020)

The analysis results of 4 monitored locations revealed that

The analysis results for four critical parameters were observed to be in the order of pH (6.9-7.5), DO (8.8-9.1 mg/L), BOD (Consistent at 0.4 mg/L) and FC (10-12 MPN/100 mL) at 04 monitored locations.

All 04 monitored locations were found to be complying to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Decreasing trend was observed for BOD (33.3% - 50%) at 04 locations, FC (16.67% - 29.41%) at 03 locations and 'no' variation in FC at 1 location whereas increasing trend was observed for DO (1.12%- 3.49%) at 04 monitored locations.

Haryana-Observations

During the pre-lock down period (March 2020)

The analysis results of 4 monitored locations revealed

The analysis results for four critical parameters were observed to be in the order of pH (7.2-8.1), DO (7.9-8.4 mg/L), BOD (2.2-7.0 mg/L) and FC (600-92000 MPN/100 mL) at 04 monitored locations

Only 01 out of 4 monitored locations were found to be complying to the outdoor bathing criteria parameters (i.e. pH, DO, BOD and FC). Also, pH and DO at 04 locations, BOD at 02 locations and FC at 01 location were found to be within the desirable limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 4 monitored locatios revealed that

The analysis results for four criteria parameters were found to be in the order of pH (7.6-8.2), DO (8.2-8.4 mg/L), BOD (Not reported by the HSPCB) and FC (200-46000 MPN/100 mL) at the 04 monitored locations.

2 out of 4 monitored location were observed to be complying to the parameters (i.e. pH, DO and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing. Also, pH & DO were found to be complying at 04 locations and FC complying at 02 locations for the limits prescribed under Primary Water Quality Criteria for Outdoor Bathing .

Overall Observations

Decreasing trend was observed for DO (2.38 %) at 1 location and FC (42.55 - 99.71 %) at 04 locations whereas increasing trend for DO (2.44 -6.33 %) at 3 locations. Overall, 1 out of 4 monitored locations were found to be complying to the Primary Water Quality Criteria for Outdoor Bathing.

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Delhi-Observations

During the pre-lock down period (March 2020)

The analysis results of 5 monitored locations revealed that

The analysis results for four critical parameters were found to be in the order of pH (7.2-8.7), DO (17.1 mg/L), BOD (7.9-78 mg/L) and FC (1300-920000 MPN/100 mL) at the 05 monitored locations.

None of the monitored locations were found to be complying to the prescribed Primary Water Quality Criteria for Outdoor Bathing.

Also, pH at 04 locations, DO at 01 location and FC at 01 location were found to be complying whereas BOD at all the 5 monitored locations were observed to be not complying to the limits prescribed under Primary Water Quality for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 3 monitored locations revealed that

The analysis results for four critical parameters were found to be in the range of pH (7.1-7.8), DO (1.2-8.3 mg/L) and BOD (2-6.1 mg/L) at the 05 monitored locations and FC parameter not reported for both the months.

Also, pH at 03 locations, DO at 01 location and BOD at 01 monitored location were found to be within the desirable limits prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Decreasing trend was observed for DO (51.46%) at 01 location and BOD (74.70% - 90.20%) at 03 locations.

Uttar Pradesh-Observations

During the pre-lock down period (March 2020)

The analysis results of 1 monitored location revealed

The analysis results for four critical parameters were found to be in the order of pH (8.0), DO (8.1 mg/L), BOD (2.4 mg/L) and FC (1300 MPN/100 mL) at 01 monitored location.

01 monitored location observed to be complying to the parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

During the lock down period (April 2020)

The analysis results of 1 monitored location revealed that

The analysis results for four critical parameters were found to be in the range of pH (7.9), DO (9.3 mg/L), BOD (2.0 mg/L) and FC (310 MPN/100 mL) at 01 monitored location.

01 monitored location was observed to be complying to all the criteria parameters (i.e. pH, DO, BOD and FC) prescribed under Primary Water Quality Criteria for Outdoor Bathing.

Overall Observations

Increasing trend was observed for DO (14.81%) at 1 location while decreasing trend was observed for BOD (16.70 %) at 1 location and FC (76.15 %) at 1 location

20.5 Overall Observations on Water River Yamuna (covering HP, Haryana, Delhi & UP)

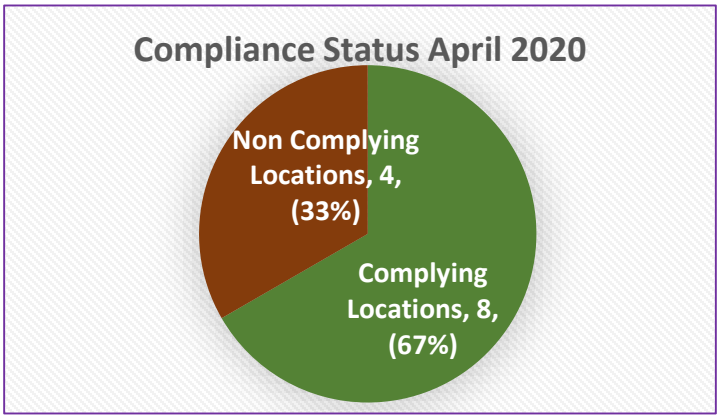


Figure 20.4 Compliance Status of River Yamuna During Lockdown

Over all observations on river Yamuna revealed that

- During pre-lockdown, 13 out of 14 locations, 10 out of 14 locations, 07 out of 14 locations, 07 out of 14 locations were found to be within the desirable limits for the criteria parameters viz., pH, DO, BOD and FC respectively.

- During lockdown, pH at 12 locations, DO at 10 locations, BOD at 06 locations, FC at 07 locations were found to be complying to the criteria parameters prescribed under Primary Water Quality Criteria for Outdoor Bathing. Compliance status of monitored locations for Primary Water Quality Criteria for Outdoor Bathing during lockdown is given in **Figure 20.4**.

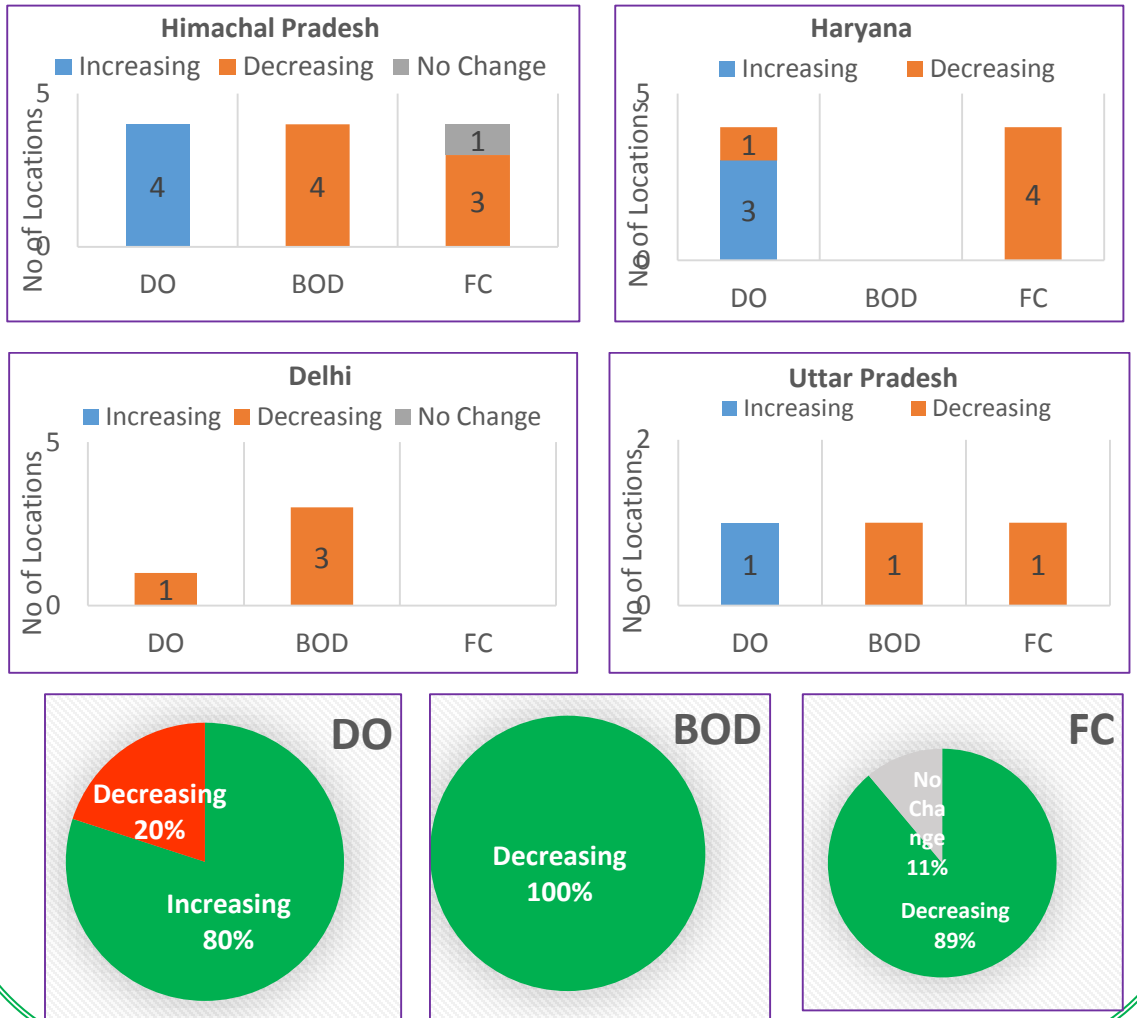
- During lockdown, maximum DO (9.3 mg/L) was at Allahabad D/s Balua Ghat, U.P and minimum DO (1.2 mg/L); at Okhla Bridge (Inlet of Agra Canal, Kalindi Kunj. Maximum BOD (6.1 mg/L) was at Okhla Bridge (Inlet of Agra Canal, Kalindi Kunj and minimum BOD (0.4 mg/L) was at 04 locations (viz., U/s Paonta Sahib, D/s Paonta Sahib, U/s Ranbaxy & D/s Ranbaxy in H.P) while maximum FC count (46000 MPN/100 mL) was at Palla, Sonepat and minimum (10 MPN/100 mL) was at 02 locations (viz., U/s Ranbaxy & D/S Ranbaxy).

- Increasing trend was observed for DO (1.12% -14.81%) at 08 monitored locations while decreasing trend were marked for DO (2.38% - 51.46%) at 02 locations, BOD (16.70% -90.20%) at 08 monitored locations and FC (16.67% - 99.71 %) at 08 locations and 'no' variation was observed in case of FC at 01 location. (**Figure 20.5**)

20.6 Water Quality Trend of River Yamuna:-

Water Quality trend of river Yamuna as observed during pre-lockdown and lockdown are given in **Figure 20.5**

Figure 20.5 River Yamuna- Water Quality Trend During Pre (March 2020) and Lockdown (April 2020)



20.7 Conclusion

- *06 out of 14 locations during pre-lockdown and 8 out of 12 locations during lockdown were complying with the Primary Water Quality Criteria for Outdoor Bathing. Also, overall marginal enhancement in water quality of river Yamuna with respect to BOD and FC was observed.*

21 Overall Analysis of Water Quality of all Major Rivers and Conclusions

21.1. Overall Analysis

Twenty State Pollution Control Boards (SPCBs) have participated in the assessment and collected water samples from the 19 major rivers namely river Beas, Brahmaputra, Baitarani, Brahmani, Cauvery, Chambal, Ganga, Ghaggar, Godavari, Krishna, Mahanadi, Mahi, Narmada, Pennar, Sabarmati, Sutlej, Swarnarekha, Tapi and Yamuna during the lockdown period (April 2020). All designated water quality monitoring locations under NWMP could not be monitored during the lockdown due to restrictions. Samples were collected from 387 number of monitoring locations during pre-lockdown (March 2020) and 365 number of monitoring locations during lockdown (April 2020). The collected samples were analysed for the critical parameters viz. pH, DO, BOD and FC by the respective SPCBs/PCCs. River-wise minimum and maximum values for DO, BOD and FC as observed during the pre-lockdown and lockdown period are given in the **Table 21.1** below.

Table 21.1. River-wise minimum and maximum values for DO, BOD and FC as observed during the pre-lockdown and lockdown period

Name of the River	DO (in mg/L)				BOD (in mg/L)				FC (in MPN/100ml)			
	March 2020 (Pre-Lockdown)		April 2020 (Lockdown)		March 2020 (Pre-Lockdown)		April 2020 (Lockdown)		March 2020 (Pre-Lockdown)		April 2020 (Lockdown)	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Baitarani	6.3	7.8	6.8	7.8	0.2	1.8	0.1	0.8	45	2400	20	1400
Beas	7.2	9.7	7.1	10	BDL	1.6	BDL	1.3	2	210	8	170
Brahmani	4.6	8.6	5.4	8.4	BDL (0.5)	24	BDL (0.2)	2.8	110	7900	1.5	2200
Brahmaputra	5.1	10.4	6.6	10.3	1.6	2.4	1.1	2.1	300	730	300	730
Cauvery	2.1	7	6	7.8	1.5	7.5	1	2	31	700	21	320
Chambal	BDL	7.9	2	8	1.8	30	1.5	28	2	14000	2	14000
Ganga	5	11.6	3.9	10.7	1	4.6	BDL (0.6)	5.5	17	160000	12	140000
Ghaggar	0.9	9.2	3.1	8	4	64	5	22	2700	35000	1400	64000
Godavari	3.1	8.5	4	7.6	1.4	8.8	1.2	6.2	2	70	2	47
Krishna	4.6	7.8	4.8	7.7	1	6.3	1	2.9	2	900	3	900
Mahanadi	6.5	8.6	6.3	8.8	BDL (0.3)	2.4	BDL (0.2)	1.6	1.8	1700	1.8	220
Mahi	4.4	8.3	4.9	8.4	BDL (0.4)	2	BDL (0.3)	1.8	BDL(1)	75	BDL (1)	64
Narmada	6.9	8.7	7	8	BDL (0.3)	1.9	BDL (0.4)	1.2	1	110	1	94
Pennar	6.2	7.4	5.7	6.9	1.4	1.7	1	2.8	3	200	3	200
Sabarmati	BDL(0.1)	7.7	BDL(0.1)	8.2	BDL (0.7)	87	BDL (0.5)	57	2	1100	2	170
Sutlej	2.8	9.7	2.8	10.6	1	14	1	16	34	230000	31	70000
Swarnarekha	3.6	7.9	3.7	8.2	1.2	2.9	BDL (0.4)	6.4	140	1300	-	220
Tapi	7	7.2	6.2	7.2	BDL (0.8)	4	BDL (0.7)	4	6	17	6	13
Yamuna	7.9	17.1	1.2	9.3	BDL (0.6)	78	BDL (0.4)	6.1	10	9200000	10	46000

The State-wise, river-wise number of locations monitored, number of locations complying to the Primary Water Quality Criteria for Outdoor Bathing (PWQC) is presented in **Table 21.2**. Percentage compliance of Water Quality of 19 major rivers monitored during pre-and Lockdown is given in **Figure 21.1**.

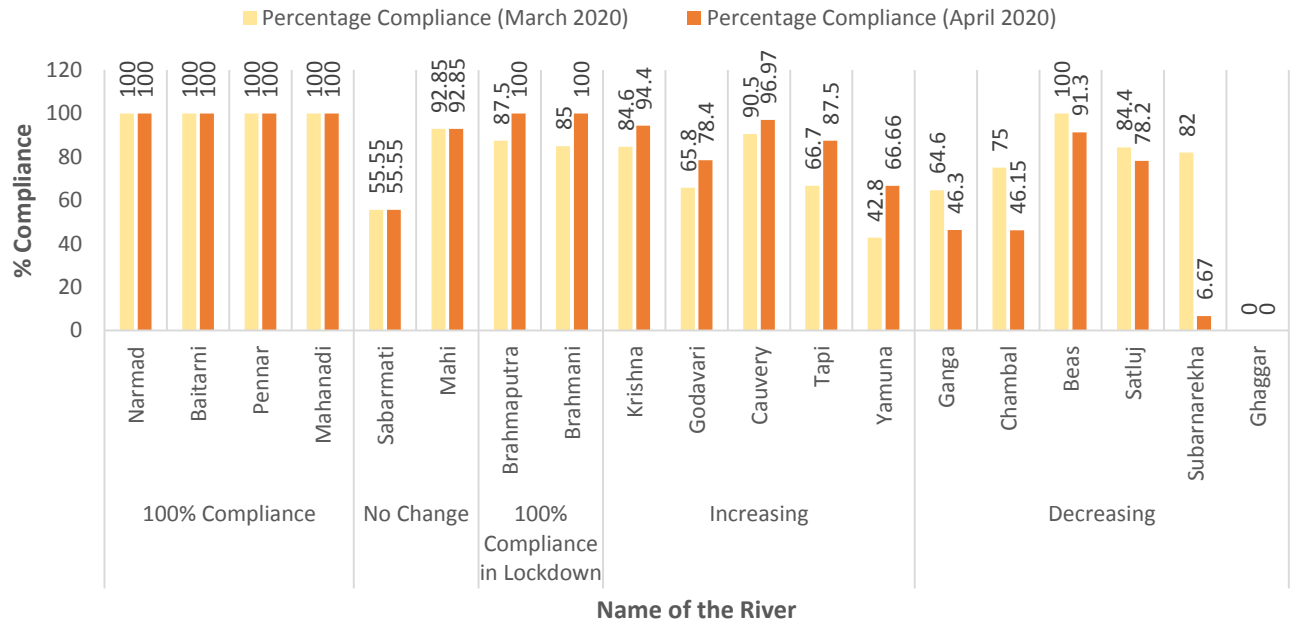
Table 21.2. The State-wise and river-wise status of compliance to the Primary Water Quality Criteria for Outdoor Bathing

S. No	Name of the River	State	Number of Monitoring Locations under NWMP	Number of Monitoring Locations Monitored		No of Locations Complying to the Primary Water Quality Criteria for Outdoor Bathing Parameters								Compliance Status W.r.t Primary Water Quality Criteria for Outdoor Bathing	
						DO (in mg/L)		pH		BOD (in mg/L)		FC (in MPN/100ml)			
				March 2020	April 2020	March 2020	April 2020	March 2020	April 2020	March 2020	April 2020	March 2020	April 2020	March 2020	April 2020
1	Beas	HP	20	16	12	16	12	16	12	16	12	16	11	22/22 (100%)	21/22 (95.45 %)
		Punjab	11	6	10	6	10	6	10	6	10	6	10		
2	Sutlej	HP	17	14	5	14	5	14	5	14	5	14	5	27/31 (87.1%)	18/23 (78.3%)
		Punjab	25	17	18	13	14	17	18	13	13	13	14		
3	Ganga	Uttarakhand	16	6	5	6	5	6	5	6	5	6	5	42/65 (64.6%)	25/54 (46.2%)
		UP	30	27	14	27	14	25	11	14	9	15	8		
		Bihar	33	17	17	17	17	17	17	17	17	17	6		
		Jharkhand	4	4	4	4	4	4	4	4	4	NA	NA		
		West Bengal	14	11	14	11	11	10	14	5	6	1	2		
4	Yamuna	Uttarakhand	4	-	-	-	-	-	-	-	-	-	-	6/14 (42.8%)	8/12 (66.67%)
		HP	4	4	4	4	4	4	4	4	4	4	4		
		Haryana	4	4	4	4	4	4	4	2	NA	1	2		
		Delhi	5	5	3	1	1	4	3	0	1	1	NA		
		UP	13	1	1	1	1	1	1	1	1	1	1		
5	Chambal	MP	9	7	6	6	5	7	6	5	4	6	5	6/8 (75%)	6/13 (46.15%)
		Rajasthan	7	1	7	1	2	1	3	1	4	1	7		
		UP	2	-	-	-	-	-	-	-	-	-	-		
6	Brahmaputra	Assam	11	8	10	8	10	8	10	8	10	7	10	7/8 (87.5%)	10/10 (100%)
7	Mahi	MP	5	4	4	4	4	4	4	4	4	4	4	13/14 (92.85%)	13/14 (92.85%)
		Rajasthan	2	1	1	0	0	1	1	1	1	1	1		
		Gujarat	10	9	9	9	9	9	9	9	9	9	9		
8	Sabarmati	Gujarat	13	9	9	5	5	9	9	5	5	9	9	5/9 (55.55%)	5/9 (55.55%)
9	Mahanadi	Chhattisgarh	9	5	5	5	5	5	5	5	5	3	4	13/13 (100%)	22/22 (100 %)
		Odisha	18	8	17	8	17	8	17	8	17	8	177		
10	Tapi	MP	4	-	-	-	-	-	-	-	-	-	--		
		Gujarat	8	7	6	7	6	7	6	7	6	7	6	7/9 (77.8%)	7/8 (87.5%)
		Maharashtra	5	2	2	2	2	2	2	0	1	2	2		
11	Narmada	Gujarat	6	5	5	5	5	5	5	5	5	5	5	32/32 (100%)	24/24 (100%)
		MP	48	27	19	27	19	27	19	27	19	27	19		
12	Swarnarekha	Jharkhand	20	4	14	3	13	4	14	4	7	4	-	4/5 (80%)	8/15 (53..33%)
		Odisha	2	1	1	1	1	1	1	1	1	1	1		
		West Bengal	2	-	-	-	-	-	-	-	-	-	-		
13	Godavari	AP	8	7	7	7	7	6	7	7	7	7	7	25/38 (65.78%)	29/37 (78.37%)
		Telangana	17	17	16	14	14	16	15	16	15	17	16		
		Maharashtra	14	14	14	13	14	14	14	5	8	14	14		
14	Krishna	AP	9	8	8	6	7	8	8	8	8	8	8	22/26 (84.61%)	17/18 (94.44%)
		Karnataka	7	5	6	5	6	5	5	5	6	5	6		
		Telangana	4	4	-	4	-	3	-	3	-	4	-		

		Maharashtra	10	9	4	9	4	9	4	8	4	9	4		
15	Pennar	AP	4	3	3	3	3	3	3	3	3	3	3	3/3 (100%)	3/3 (100%)
16	Cauvery	Karnataka	24	22	22	22	22	22	22	22	22	22	22	38/42 (90.47%)	32/33 (96.96%)
		Tamil Nadu	40	20	11	20	11	16	10	19	11	20	11		
17	Ghaggar	Punjab	18	14	14	2	4	14	14	0	0	0	12	Nil/18	Nil/19
		Haryana	9	4	5	2	5	3	5	0	0	0	0		
		Rajasthan	1	-	-	-	-	-	-	-	-	-	-		
18	Brahmani	Odisha	20	20	20	19	20	20	20	17	20	17	20	17/20 (85%)	20/20 (100%)
19	Baitarani	Odisha	10	10	9	10	9	10	9	10	9	10	9	10/10 (100%)	9/9 (100%)
TOTAL			576	387	365	351	331	375	355	315	298	324	299	299/387 (77.26%)	277/365 (75.89%)

Note: Do in mg/L; BOD in mg/L & FC in MPN/100ml

Figure 21.1 Overall Water Quality of Major Rivers (% Compliance)



During pre-lockdown (March 2020):-

The analysis results revealed that

- 351 out of 387 locations for DO, 375 locations for pH, 315 locations for BOD and 324 monitored locations for FC complied with Outdoor Bathing Criteria.
- 299 out of 387 monitored locations complied (77.26 %) with criteria parameters listed under the Primary Water Quality Criteria for Outdoor Bathing.
- River wise compliance status of monitored locations during pre-Lockdown given in **Figure 21.2**.

Figure 21.2 River wise Compliance status in March 2020 (Pre-Lockdown)

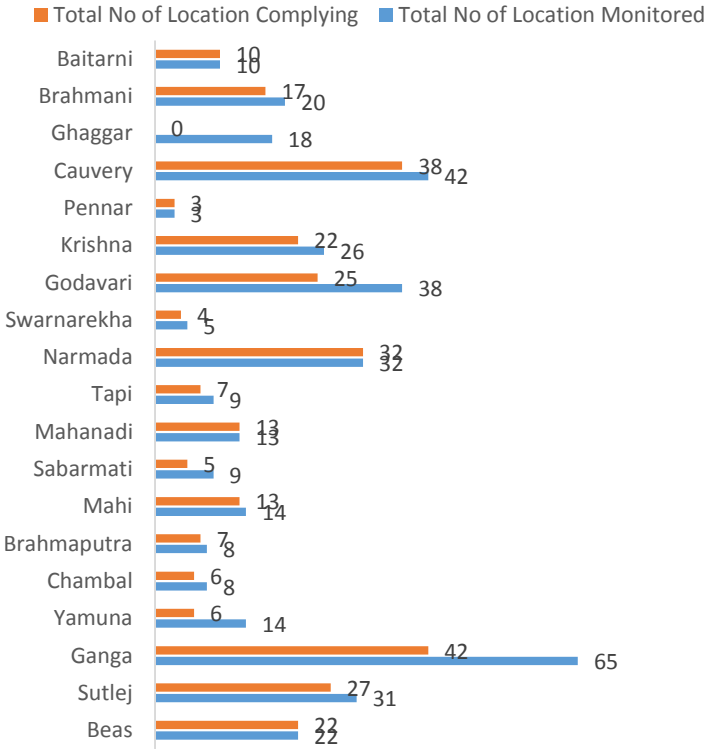
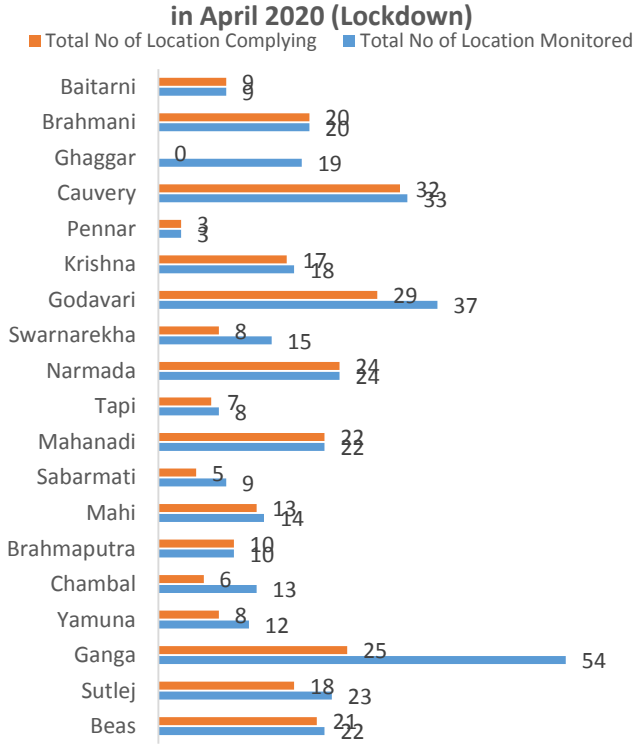


Figure 21.3 River wise Compliance status in April 2020 (Lockdown)



During lockdown (April 2020):-

The analysis of results showed that

- 331 out of 365 monitored locations for DO, 355 locations for pH, 298 locations for BOD and 299 locations for FC are complying with the outdoor bathing criteria.
- 277 out of 365 locations in April 2020 complied (75.89 %) with Primary Water Quality Criteria for Outdoor Bathing, which implies that there is no significant improvement in water quality of major rivers monitored during the lockdown period.
- River wise compliance status of monitored location during lockdown in given at Figure 21.3

21.2 Overall Observations on 19 Major Rivers Monitored during Pre-lockdown (March 2020) and Lockdown Period (April 2020)

100 % COMPLIANCE

- **Four rivers viz., Baitarani, Mahanadi, Narmada and Pennar compliance to the Outdoor Bathing Criteria during Pre-lockdown and lockdown period.**

100 % NON-COMPLIANCE

- **River Ghaggar failed to comply with the Primary Water Quality Criteria for Outdoor Bathing during Pre-lockdown and lockdown period.**

NO CHANGE DURING LOCKDOWN AND PRE-LOCKDOWN

- **Two Rivers viz.,1.Sabarmati (55.6 %) and 2.Mahi (92.9 %) remains unchanged in terms of compliance to Outdoor Bathing Criteria.**

IMPROVEMENT IN WATER QUALITY IN CASE OF 7 RIVERS

- 1.Brahmani (from 85 % to 100%), 2.Brahmaputra (87.5 % to 100 %), 3.Cauvery (90.5 % to 96.97 %) , 4.Godavari 65.8 % to 78.4 %), 5.Krishna 84.6 % to 94.4 %), 6.Tapi 77.8 % to 87.5 %) and 7.Yamuna (42.8 % to 66.67 %)

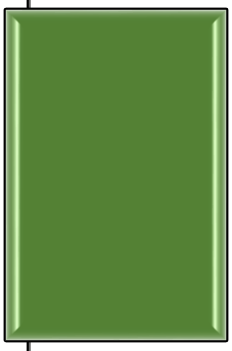
DETERIORATED PERCENT COMPLIANCE IN CASE OF 5 RIVERS

- 1. Beas (100 % to 95.45 %), 2. Chambal (75 % to 46.15 %), 3. Ganga (64.6 % to 46.2 %), 4. Sutlej (87.1 to 78.3%) and 5. Swarnarekha (80 % to 53.33 %)

CENT PERCENT COMPLIANCE DURING LOCKDOWN

- 1.Baitarani, 2.Brahmani, 3.Brahmaputra, 4.Mananadi, 5.Narmada and 6.Pennar.

21.3. Conclusions



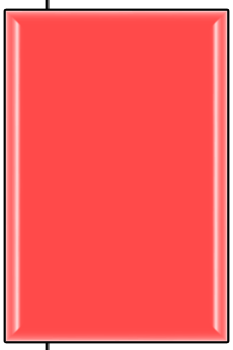
Improvement in water Quality of few major rivers which may be attributed to

(i) Minimal industrial effluent discharges in view of closure of almost all industries.

(ii) No human activities involving disposal of worshipped puja materials and garbage.

(iii) No anthropogenic activities such as outdoor bathing, washing of clothes, vehicle washing and cattle washing, no pilgrimage activities etc. during lockdown phase and

(iv) The cattle movement was also reduced considerably reducing biological contamination of surface water bodies.



Deterioration in Water quality of few major rivers which may be attributed to

(i) discharge of untreated or partially treated sewage;

(ii) pollutant concentrations are usually at their highest levels due to negligible dry season flow; and

(iii) no fresh water discharges from the upstream

MINISTRY OF' ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 25th September. 2000

93. Primary Water Quality Criteria for Bathing Waters.

In a water body or its part, water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose. Among the various types of uses there is one use that demands highest level of water quality or purity and that is termed as "Designated Best Use" in that stretch of water body. Based on this, water quality requirements have been specified for different uses in terms of primary water quality criteria. The primary water quality criteria for bathing water are specified along with the rationale in table 1.

Table 1.

PRIMARY WATER QUALITY CRITERIA FOR BATHING WATER
(Water used for organised outdoor bathing)

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

CENTRAL POLLUTION CONTROL BOARD

Ministry of Environment, Forest & Climate Change

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