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AN ANALYTICAL STUDY OF WATER QUALITY IN THE RIVER GANGA DURING COVID-19 LOCKDOWN

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ABSTRACT:
The work presented here has analyzed the water quality of the river Ganga at Varanasi, U.P. and Haridwar, Uttarakhand during the period of COVID-19 Lockdown. It has been observed that following indicators including Biological oxygen demand, dissolved oxygen, Total Dissolved Solids, Total Coliform bacteria and Faecal form bacteria values were within the acceptable limit at different sites. India has been placed under a three-week lockdown since March 24 with its 1.3 billion population was instructed to remain inside, on the view of the coronavirus outbreak.. Authorities in Uttar Pradesh and Uttarakhand have said the quality of water in the Ganga has improved significantly during the nationwide lockdown, recorded nearly 30% decrease in pollution level.
Keywords: Water Quality, Pollution, Ganga, Lockdown

INTRODUCTION:

The River Ganga one of the prominent river of northern India and is sacred for Hindu disciple. Around four hundred million populations live in the river area that is popularly, known as the Ganga River Basin. Apart from providing drinking water and irrigating fields, the Ganga River is extremely important to India's Hindu population for religious reasons. The Ganga River is their most sacred river, and it is worshiped as the goddess Ganga, Ma or "Mother Ganga." The Ganga River is vital not only to India but also to South Eastern Asia however the river is under constant threats of different kind e.g. Human and industrial pollutants fill the river in some areas, making It totally unsafe even for swimming. As the population in the coastal region surrounding the river swells, water demands for agriculture increases, further straining the water level. In addition to the situation, scientists have observed that climatic change has led to a decrease in glacial ice in the Himalayas, the source of the Ganges, and hypothesize that this will ultimately result into further decreased water levels in the river over time. Pollution within the river Ganga or Ganges has been increasing rapidly over the past few years which have resulted finally into one time considered the holy river to be one among the foremost polluted rivers in the world. There are numerous causative factors of pollution in Ganga which impacts various components on the environment and biosphere in multiple manner .This pollution drastically affects the bulk of more than 400 million population living and dependent in the Ganga river basin area. It also wreaks havoc with the massive number of plants and animals – both terrestrial also as marine – that have their habitat in this region. The Indian government has launched an integrated Ganga conservation mission called the "Namami Gange" ("We bow to you, Ganga" in Sanskrit) consolidating existing ongoing efforts and planning on Ganga rejuvenation. The government has set-up a special "Clean Ganga Fund" to finance various activities. This includes R & D also as innovative pilot projects for brand spanking new technology and processes for river purification and conservation. Despite of all above mentioned efforts water quality level has not improved to a satisfactory level. Considering very recent world wide pandemic covid-19 spread in India. Govt. Of India has initiated three-week lockdown since March 24 which was further extended, with its 1.3 billion people instructed to stay home as an effort to contain the corona virus outbreak but unfortunately it has claimed 6929 lives so far and infected over 246628 (6th june,2020 Arogya app)

people in the country. On the contrary the health of Ganga River water has seen significant improvement since enforcement of the nationwide lockdown that has led to reduction in dumping of commercial, domestic and various religious practice wastes into it. The Ganga river water quality has significantly improved at most of the Ganga basin coastal region.

REVIEW OF RELATED STUDIES:

Tyagi V., Bhatia, A. et. al (2012) , Effect of mass ritualistic bathing was studied on the water quality of Ganges River during Maha Kumbh festival in India. Significantly higher values of biochemical oxygen demand (BOD) (14 mg/L), chemical oxygen demand (67 mg/L), total suspended solids (55 mg/L), and ammonia nitrogen (2.15 mg/L) were observed during mass ritualistic bathing. Similarly, higher number of total coliforms (792 most probable numbers [MPN]/100 mL) and fecal coliforms (482 MPN/100 mL) were observed in water samples, which show the alarming level of fecal contamination consistent with Indian and European (100 MPN/100 mL) standards of outside bathing. . Rai P.K., Mishra A. &. Tripathi B.D. (2010) analyzed water samples from three sewage treatment plants which regularly discharge into the River Ganga. Biological oxygen demand and dissolved oxygen values were well above the permissible limit in the least sites, and were recorded as being at maximum at Dinapur sewage treatment plant. Heavy metals (Zn, Cu, Cd, Pb, Cr) in disposed effluents were above permissible limits atleast three sites. Likewise, the most probable number index of E. coli in water samples and coliform counts were recorded as being higher in irrigated water samples and vegetables, indicating a significant hazard posed by intense microbial and faecal pollution. .Bilgrami K.S. & K. Sanjib (2010) studied Bacterial analysis of Ganga water was carried out at three different sites in Bhagalpur town which discharges untreated municipal and industrial effluents in river at various points. Total bacterial density (TBD), total coliform (TC), faecal coliform (FC), faecal streptococci (FS), Escherichia coli and eubacteria were substantially high and far beyond the permissible limit of ISI and WHO standard. There was a marked correlation between physico-chemical quality of water and bacterial density. The presence of Actinomyces sp., Aerobacter aerogenes, A. Cloacae, Micrococcus sp., Salmonella sp., Staphylococcus aureus, Bacillus sp. and Shigella sp. indicated the level of faecal contamination in water. Hence, direct consumption of untreated Ganga water and bathing during this stretch poses an excellent health risk threat with regards to increased Dissolved Oxygen (DO) and reduced nitrate concentration." The report suggests that the absence of commercial wastewater discharge, agricultural runoff, and increased fresh flow has led to an improvement within the water quality. Srivastava A.,, Mehrotra .& Tiwari (2007) studied of the bank of river ganga sediments revealed the presence of toxic metals, some of them present in greater concentration than those recorded in average shale. The maximum concentrations of Cu, Pb, Ni and Zn within the region, 931, 226, 24 and 717 ppm, respectively, were recorded near the Oliar ghat (landing steps), whereas 138 ppm of Cr was found at an equivalent ghat. Likewise, the utmost value of Co (20 ppm) occurs opposite to the Fathua ghat. These metals present no direct danger to the ecosystem as long as they're tightly sure to the sediments. However, due to a change in the physico-chemical conditions, viz. pH, salinity, redox condition, etc., of the aquatic milieu, these metals from the sediments may pass into the water phase and thus may cause a hazard. Hamner S., Tripathi A. et.al (2007) also found heavy metal concentration in the bank of river ganga. Studies shows that water quality of river ganga becomes very poor due to human activities. Advancement of human civilization has put serious inquiries to the safe use of river water for drinking and other purposes.

OBJECTIVES

1. To analyse water quality of river Ganga during covid-19 lockdown.
2. To analyse Faecal. Coli. Form bacteria Count in river Ganga during covid-19 lockdown.
3. To analyse Total Coliform Bacteria count in river ganga during covid-19 lockdown.
4. To analyse BOD level in river Ganga during covid-19 lockdown.

5. To analyse DO level in river Ganga during covid-19 lockdown.

RESEARCH QUESTION

1. Has water quality of river Ganga improve during covid-19 lockdown?
2. Will Faecal coli. form count reduced in river ganga during covid-19 lockdown?
3. Will Total Coliform Bacteria reduced in river Ganga during covid-19lockdown?
4. Have any changes of BOD level in river Ganga during covid-19 lockdown?
5. Have any changes of DO level in river Ganga during covid-19 lockdown?

MATERIAL AND METHOD

The worldwide economic slowdown resulting from the Covid-19 pandemic and implementation of nationwide lockdown in India in particular as an effort to save human health and life on priority basis, surprisingly during this period. Water and environmental systems from local to regional scales have seen significant positive impacts, thanks to the reduction of pollutant loading from industries, vehicle emission, municipal waste and other sources. Anecdotal evidence indicates reduction in biochemical oxygen demand and coliform levels in various rivers including the river Ganga in particular.

In this study ex-post facto research method has been used. As an Independent variable, parameters of water quality in the river ganga and as Dependent variable, impact of lockdown and study area limited in Varanasi (U.P.) and Haridwar, Uttarakhand has been taken . For this study Secondary data has been used. In the study we have taken data from central pollution board (CPCB) , UPPCB, UKPCB and published news from different sources and expert views of noted environmental activist in India regarding impact of lockdown on water pollution. The real-time water monitoring data of the CPCB, out of the 36 monitoring units placed at various points of the Ganga river, the water quality around 27 points was observed.

Table 1: Water Quality Criteria, CPCB, India

WATER QUALITY

National Water Quality Monitoring Programme (NWMP)

WATER QUALITY CRITERIA

Use based Classification of Surface Waters in India		
Designated-best-Use/ Beneficial Use	**Classification of water**	**Criteria**
Drinking water source without conventional treatment but after disinfection	A	1. Total Coliforms Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 2 mg/l or less
Outdoor bathing (organised)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100 ml shall be 5000 or less 2. pH between 6 and 9 3. Dissolved Oxygen 4 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3 mg/l or less
Propagation of wild life and fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4 mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm maximum 2250 3. Sodium absorption ratio maximum 26 4. Boron maximum 2 mg/l

Source : CPCB, D

Table2: Water Quality of River Ganga in U.P.,India

Water Quality Of River Ganga in UP
Year- 2020

SAMPLING LOCATION

Month	15 a/c Tamsa river, Sirsa, Son Barsa				16 U/s Vindhyachal, Mirzapur				17 D/s Mirzapur				18 At Chunnar Pontoon Bridge			
	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)
Jan-20	11.2	2.5	4000	2100	9.7	1.8	1700	500	8.8	3.2	14000	8000	9.1	2.8	8000	5000
Feb-20	12.0	2.6	3200	1300	9.9	1.7	2100	1100	8.7	3.4	17000	8000	9.0	3.0	9000	5000
Mar-20	8.9	2.4	3300	1700	9.4	2.1	2200	1300	8.5	3.6	17000	8000	8.8	3.2	11000	5000
Apr-20																
May-20																
Jun-20																
Jul-20																
Aug-20																
Sep-20																
Oct-20																
Nov-20																
Dec-20																
Average	10.7	2.5	3500	1700	9.7	1.9	2000	966.7	8.7	3.4	16000	8000	9.0	3.0	9333	5000
Category	C				C				D				D			

Month	19 U/s Varanasi				20 D/s Varanasi				21 Tarighat D/s Ghazipur				22 a/c Gomti river, Bhusaula			
	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)	D.O. (mg/l)	B.O.D. (mg/l)	Total Coliform (MPN/100ml)	FaecalColiform (MPN/100ml)
Jan-20	9.3	2.2	2200	1300	8.4	3.6	17000	11000	8.6	3.5	22000	13000	8.8	2.9	7000	4000
Feb-20	9.7	2.1	2300	1300	8.8	3.7	22000	14000	8.9	3.4	24000	14000	9.1	2.8	8000	5000
Mar-20	9.3	2.6	2400	1100	8.4	3.7	24000	14000	8.9	3.5	21000	13000	9.0	3.0	7000	4000
Apr-20																
May-20																
Jun-20																
Jul-20																
Aug-20																
Sep-20																
Oct-20																
Nov-20																
Dec-20																
Average	9.4	2.3	2300	1233	8.5	3.7	21000	13000	8.8	3.5	22333	13333	9.0	2.9	7333	4333
Category	C				D				D				D			

Class of water		A	B	C	D	E	Below E
1	Dissolved oxygen (mg/l), min	6.0	5.0	4.0	4.0	_	_
2	Biochemical oxygen demand (mg/l), max	2.0	3.0	3.0	_	_	_
3	Total Coliform (MPN/100ml), max	50	500	5000	_	_	_

A = Drinking water source without conventional treatment but after disinfection
B= Outdoor bathing (organised)
C = Drinking water source after conventional treatment and disinfection
D = Propagation of wild life and fisheries.
E = Irrigation, Industrial cooling, controlled waste disposal
Below - E = Not meeting A,B,C,D & E criteria

Source: http://www.cpcb.nic.in/Water_Quality_Criteria.php

11/5/2020

Table3: Water Quality of River Ganga in Uttarakhand, India

WATER QUALITY CHRACTERSTICS OF RIVER GANGA AT RISHIKESH & HARDIWAR

RIVER GANGA AT RISHIKESH U/S LAXMANJHULA, SWARGAASHRAM, U/S RISHIKESH

Month	pH	BOD mg/L	COD mg/L	Total Coliform (MPN/ 100 mL)	Temp ℃	DO mg/L	Alkalinity CaCO3 mg/L	Chlorides mg/L	Calcium as Cl mg/L	Magnesium as Mg mg/L	Hardness as CaCO3 mg/L	TDS mg/L
2018												
Jan-18	7.38	<1	4	40	16	9.8	74	5	42	38	80	92
Feb-18	7.82	<1	4	60	16	10.2	70	5	42	34	76	105
Mar-18	7.32	<1	4	30	18	10.4	76	5	40	30	70	96
Apr-18	7.48	<1	4	40	19	9.8	70	5	42	32	74	87
May-18	7.5	<1	4	60	20	10.2	68	5	38	34	72	82
Jun-18	7.42	<1	4	70	20	9.8	64	5	40	34	74	84
Jul-18	7.45	<1	4	40	20	10	74	5	46	34	80	86
Aug-18	7.56	<1	4	30	22	9.8	76	5	44	38	82	80
Sep-18	7.68	<1	4	30	18	9.8	68	5	44	34	78	74
Oct-18	8.4	<1	4	60	18	9	74	5	42	40	82	126
Nov-18	7.62	<1	4	26	17	9.6	70	5	40	36	76	80
Dec-18	7.71	<1	4	30	17	10	68	5	40	34	74	84
Average	7.55		4.00	41.33	18.58	9.92	71.00	5.00	41.83	34.83	76.67	85.50
Min-Max	7.32-8.4			26-70	16-22	9-10.4	64-76		38-46	30-40	70-82	74-126
2019												
Jan-19	8.02	<1	4	40	17	10.4	64	5	38	32	70	114
Feb-19	7.42	<1	4	50	16	10	70	5	46	32	78	96
Mar-19	7.48	<1	4	40	19	9.8	62	4	42	30	72	66
Apr-19	7.62	<1	4	40	17	9.8	60	5	36	32	68	88
May-19	7.54	<1	4	50	18	10.2	68	5	38	34	72	80
June-19	7.62	<1	4	40	19	9.8	66	5	42	32	74	82
July-19	7.7	<1	4	50	18	10.2	62	4	44	26	70	78
Aug-19	7.48	<1	4	401	18	10.4	64	5	46	26	72	80
Sep-19	8.23	<1	4	50	20	9.8	58	7	40	28	68	73
Oct-19	8.12	<1	4	60	20	10	60	6	42	24	66	62
Nov-19	7.95	<1	4	58	19	11.8	50	5	40	20	60	69
Dec-19	7.94	<1	4	73	18	10.4	40	8	44	22	66	79
2020												
Jan-20	7.72	<1	4	40	16	11	70	9	48	30	78	79
Feb-20	7.72	<1	4	40	17	10.8	62	13	60	28	88	62
Mar-20	[illegible]	[illegible]	4	30	19	[illegible]	71	6.5	53	30	83	[illegible]
Apr-20	7.8	0.6	4	30	19	10.6	[illegible]	7.5	45	25	70	55

ANALYSIS AND DISSCUSION:

For this study, secondary data has been used which was collected from data base of central pollution control board, Delhi, UPPCB,UKPCB and published news and expert views from different sources. Content analysis was done and These data has been analysed to frame the research question and to reveal the answer of research question of the study. We have seen the environment around us rejuvenate during the lockdown and animals at places where we would normally not expect them to be at. Not only have air pollution levels come down, but the water quality of the polluted rivers has also improved in India. It has been reported that the quality of water in River Ganga has improved during the lockdown period as most of the coastal population stay in quarantine, keeping the Ganga Ghats deserted. With the factories discharging toxic industrial waste into the river closed, resulted into significant improvement in water quality of the holy river in Uttar Pradesh and Uttarakhand. It is interesting to note that industrial waste disposal in the river water constitute total one-tenth of the source of pollution to the river.

Following print media headlines are relevant and very significant as follows:

• According to economic times news (April 2020), Lockdown: Health of river Ganga improves, The health of Ganga River has seen significant improvement since enforcement of the nationwide lockdown that has led to reduction in dumping of commercial waste into it, experts have said. According to the important time water monitoring data of the CPCB, out of the 36 monitoring units placed at various points of the Ganga river, the water quality around 27 points was suitable for bathing and propagation of wildlife and fisheries.The Ganga river water was found to be suitable for bathing at most monitoring centres, the Central Pollution Control Board data showed.

• Environmentalist Vikrant Tongad said the improvement has been specially seen in the industrial clusters which used to see huge pollution level due to dumping by industries.Tongad said the improvement has been seen around Ganga in Kanpur, an industrial town, from where huge industrial waste is generated and thrown into rivers."The improvement within the quality of water has also been observed in Ganga's tributaries like Hindon and Yamuna," he said.

•Economic times (April,2020) reported that Lockdown impact: Ganga water in Haridwar becomes 'fit to drink' after decades according to the Uttarakhand Environment Protection and Pollution Board, there has been a 34 per cent reduction in faecal coliform and 20 per cent in biochemical oxygen demand in Haridwar.

• According to the Uttar Pradesh Pollution Control Board (UPPCB), healthy water should have a dissolved oxygen level of at least 7 mg/litre. The dissolved oxygen level upstream in river Ganga is 8.9 mg per litre while within the downstream it's 8.3 mg per litre. This clearly shows that water quality has improved significantly and is perfect for bathing.

Table 4: **Water Quality indicators Pre and during covid-19 Data**

S.N.	Parameters	Requirement acceptable limit CPCB	CPCB Data Base (2016)	During COVID-19 Lockdown (April,2020)
1.	pH value	6.5 – 8.5	6.3-7.8 (Haridwar) 7.4 – 8.5 (Varanasi)	7.8 (Haridwar)
2.	Faecal coli. Form	2500 MPN per 100ml	1300 -2300(Varanasi)	34% Reduced (Haridwar) 1100MPN/100ml(Varanasi)

3.	Total Coliform Bacteria	5000 MPN per 100ml	90-1600(Haridwar) 2200-3600 (Varanasi)	30 MPN/100ml (17% Reduced In Haridwar) 2400MPN/100ml(Varanasi)
4.	BOD (Biological Oxygen Demand) level	Less than 3mg/l	1 -6.4(Haridwar) 2.8-3.5(Varanasi)	0.6 mg/l (Haridwar) 20% Decreased in Haridwar 2.6mg/l(Varanasi) 30-35% Decreased in Varanasi
5.	Dissolved oxygen level (mg/l)	More than 6mg/l	4-10.6 (Haridwar) 7.8-9.8 (Varanasi)	10.6 (Haridwar) 9.3 (Varanasi)
6.	TDS (total Dissolved Solid mg/l	500-2000 mg/l	201	55 (Haridwar) 102 (Varanasi)

Source: central pollution control board. Delhi, Uttarakhand Pollution Control Board,U.P. Pollution Control Board.

• Data released amid the lockdown by the Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) showed there was a 47% reduction in faecal coliform at Lakshmanjhula.
• At the barrage in Rishikesh, there was a 46% reduction in faecal coliform and 25% reduction in total coliform. Similarly, at Bindughat Dudhiavan, there was a 25% and 11% reduction in faecal cooliform and total coliform, respectively.
• At Har Ki Pauri, there was a 20% reduction in BOD, 34% reduction in faecal coliform and 17% reduction in total coliform, whereas at Jagjeetpur in Haridwar, officials observed a 17% reduction in BOD and faecal coliform and a 27% reduction in total coliform.
• The CPCB report explains that the lockdown has resulted in "overall improvement in water quality of River Ganga.

CONCLUSION AND RESULT:

After the study of different sources of the above mention data it has been clearly observed that there is significant 30-40% reduction in pollution level of Ganga water. The overall data shows reduced pollution and increased water quality of river Ganga.
• Water quality of the river Ganga has improved upto 30-40% during lockdown.
• Faecal coli Form.bacteria count has been reduced to 34% in river Ganga during lockdown.
• Total Coliform Bacteria count has been reduced upto to 17% in the river water during lockdown.
• BOD level has decreased in river water during lockdown.
• pH level of the water has improved very significantly on positive side.
• Dissolved oxygen level has increased upto 8.9% in the river Ganga during lockdown.
• Total dissolved Solid (TDS) has also been decreased in the river Ganga during lockdown.
There has been an overall real positive effect on the river Ganga during lockdown period where by the river could show that it can rejuvenate itself. Clearly, nature has cleaned the river on its own due to comparatively lesser no of anthropological activities and there is an urgent need to take a cue from the lockdown to improve the water quality of river Ganga in future.

SUGGESTION:

 We have to ensure that no industrial waste is drained directly in the river water. Even after processing of industrial waste in the waste treatment unit, the finally processed solid industrial waste and the treated water remain, even should also be cautiously disposed, preferably not to be drained directly into the river water. Instead alternative options should be explored.
 Identify the most polluted areas and the reason for the pollution. If it is garbage, prevent the water pollution by means of mixing of cremation ashes and other materials in a separate chamber first and then it has to be recycled in the adjacently built the second chamber. The building of this two chamber unit adjacent to bank is a mandatory step to control water pollution out of which One will be used for

ashes and the second chamber will act as recycling unit. Then the finally treated water will be let out to the river.

 it is not possible to achieve this only by the involvement of government administration but also there is a need to identify and involve NGO's who are working on clean and green projects.

 Strict no liter dumping policy at and around the river bank should be framed at govt. level Strict vigil and punishment procedures should be there to protect river water pollution. The local municipal body should be encouraged to go for community awareness campaign And also to do I.E.C. activities along with provision of enough dustbins and other pollution control instruments in that area and allocation of sufficient fund. Total ban on use of non degradable materials like plastic etc. in and around the river bank.

 To form a committee which includes Govt, NGO's, environmental experts and groups working on similar projects in and outside the country and do a detailed analysis and to suggest appropriate controlling measures to contain water pollution of the area.

 Looking to the positive change observed in the quality of water during recent covid-19 lockdown it is suggested to go for intermittent elective lockdown in river coastal area .It can be tried to go voluntarily for intermittently regular lockdown at least for a month in a year or at least for duration of fortnight in every six months on a trial pilot project basis to improve water quality in the river . If found useful, later it can be implemented on regular basis as a part of policy to control river pollution in India in near future.

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