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Water quality of the Ganges in West-Bengal during covid-19 lockdown and unlock period shows the betterment of bod level: An analytical study

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Abstract
Biological Oxygen Demand (BOD) is the life line of aquatic lives. In India, people have great dependency on the River Ganga (Paul, 2017). River Ganga is the resources of 25.2% water bodies in the country. The pandemic COVID-19 has made Government/ruling bodies all over the World to go for lockdown phase, which has immense effect on the biodiversity of the aquatic water bodies due to less anthropogenic waste discharges. In this present scenario a study was undertaken in three stations of the lower Gangetic delta (with the data bank of pre-COVID-19 lockdown and COVID-19 lockdown phases) to scan the DO level. In this paper we have tried to analyze the data available from Central Pollution Control Board database of different ghats of Ganga in West Bengal, 7 districts in total through which districts it has already flowed. Water quality data of upper and lower Gangetic delta region (Murshidabad, Hooghly, Howrah, N-24 Parganas, Kolkata, Nabadwip, S-24 Parganas) using BOD as major parameter were analyzed. A very significant decrease in BOD level during the COVID-19 lockdown phase was also observed. The decreasing trend observed from April 2020, w.r.t. March 2020 during full lockdown speaks in favour of the positive role of COVID-19 lockdown phase in terms water quality, which may be due to complete closure of industrial operations, vessel movements, fish landing and tourism activities at these sites.

Keywords: biological oxygen demand (bod), water quality, Ganga, pollution, covid-19, CPCB

Introduction

Ganga is not an ordinary river. It is a life line, a symbol of purity and virtue for countless people of India. Ganga water is considered to be pure and sacred even in the Caharaksanhita ancient medical journal. It has been believed from medieval times that Ganga water has no germs bacteria or fungi. But the condition has changed during past several decades. The Ganga basin is the largest river basin of Indian subcontinent. It covers over one –fourth of the country's total geographical area and it originate in the state of Uttarakhand. According to a report of National Water Quality Monitoring Programme 2011, organic matter and bacterial population of faecal origin continue to dominate the pollution problem in the river Ganga. The heavily polluted river is the major sources of municipal sewage, industrial waste, residues of chemical fertilizers which are dumped into water courses without any treatment unfit for drinking and even for bathing. Nearly all the sewage industrial effluents, runoff from chemical fertilizer and pesticide used in agriculture within basin and large quantity of solid waste, including thousands of animals' carcasses and human crapes are now dumped in the river (Pardo *et al*., 1990; Boughriet *et al*., 1992; Yu *et al*., 2001; Klavins *et al*., 2000). In Bonn Declaration of Global water security 2013 the river Ganga was christen as one of the large polluted river in the world.

Water pollution is now a day's considered not only in terms of public health but also in terms of conservation, aesthetics and preservation of natural beauty and resources. In Bonn Declaration of Global water security 2013 the river Ganga was christen as one of the large polluted river in the world. Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, manure, sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens, much of the available dissolved oxygen is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live. Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste.

If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline. Nitrates and phosphates in a body of water can contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. Pollution of water is a major threat in the Gangetic delta region of West Bengal. The reasons behind water pollution are release of organic wastes and heavy metals in water. Industrial wastes, factory discharges, agricultural runoffs, wastes from shrimp farms are some of the major pollutants discharged from these point sources (Mitra, 2018).

Biological Oxygen Demand (BOD) and Water

Biochemical oxygen demand (BOD) represents the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic (oxygen is present) conditions at a specified temperature. When we look at water in a lake the one thing we don't see is oxygen. In a way, we think that water is the opposite of air, but the common lake or stream does contain small amounts of oxygen, in the form of dissolved oxygen. Although the amount of dissolved oxygen is small, up to about ten molecules of oxygen per million of water, it is a crucial component of natural water bodies; the presence of a sufficient concentration of dissolved oxygen is critical to maintaining the aquatic life and aesthetic quality of streams and lakes. The presence of a sufficient concentration of dissolved oxygen is critical to maintaining the aquatic life and aesthetic quality of streams and lakes. Determining how organic matter affects the concentration of dissolved oxygen (DO) in a stream or lake is integral to water- quality management. The decay of organic matter in water is measured as biochemical or chemical oxygen demand. Oxygen demand is a measure of the amount of oxidizable substances in a water sample that can lower DO concentrations.

Certain environmental stresses (hot summer temperatures) and other human-induced factors (introduction of excess **fertilizers** to a water body) can lessen the amount of dissolved oxygen in a water body, resulting in stresses on the local aquatic life. One water analysis that is utilized in order to better understand the effect of bacteria and other microorganisms on the amount of oxygen they consume as they decompose organic matter under aerobic (oxygen is present) is the measure of biochemical oxygen demand (BOD). Determining how organic matter affects the concentration of dissolved oxygen in a stream or lake is integral to water-quality management. BOD is a measure of the amount of oxygen required to remove waste organic matter from water in the process of decomposition by aerobic bacteria (those bacteria that live only in an environment containing oxygen). The waste organic matter is stabilized or made unobjectionable through its decomposition by living bacterial organisms which need oxygen to do their work. BOD is used, often in wastewater-treatment plants, as an index of the degree of organic pollution in water.

'Biochemical oxygen demand' is a measure of how much dissolved oxygen is being consumed as microbes break down organic matter. A high demand, therefore, can indicate that levels of dissolved oxygen are falling, with potentially dangerous implications for the river's biodiversity.

High biochemical oxygen demand can be caused by:

- high levels of organic pollution, caused usually by poorly treated wastewater;
- high nitrate levels, which trigger high plant growth.

Both result in higher amounts of organic matter in the river. When this matter decays, the microbiological activity uses up the oxygen. Biochemical oxygen demand is therefore one of the main parameters used in the Urban Wastewater Treatment Directive for controlling discharges. Unsurprisingly, large rivers - where wastewater plants are more likely to be located - registered higher levels of oxygen demand than smaller rivers. Improvements in wastewater management saw biochemical oxygen demand fall in all sizes of river during the early 1990s. However, levels have begun increasing slightly more recently in all but the smallest rivers.

Despite this recent trend, the picture is far from bleak. As the Figure shows, over 80% of rivers in northern Europe have a biochemical oxygen demand of under 2 mg O2/l, which indicates a relatively clean river. This figure drops to under 40% for southern Europe, however, where over 20% of the monitoring stations registered readings of over 5 mg O2/l, which indicates relatively high pollution.

The Ganga River System

- The headwaters of the Ganga called the *'Bhagirathi'* is fed by the Gangotri Glacier and joined by the *Alaknanda* at Devprayag in Uttarakhand.
- At *Haridwar*, Ganga emerges from the mountains to the plains.
- The Ganga is joined by many tributaries from the Himalayas, a few of them being major rivers such as the Yamuna, the Ghaghara, the Gandak and the Kosi.
- The Ganga bifurcates at Farakka Barrage; the *Bhagirathi-Hooghly* (a distributary) flows southwards through the deltaic plains to the Bay of Bengal. The mainstream flows southwards into Bangladesh and is joined by the Brahmaputra leading to the *Sunderbans Delta*.

Ganga and latest pollution measurement observations

The Central Pollution Control Board (CPCB) scientifically validated what have been visible on the ground in river Ganga during the lockdown period. India's national river has, indeed, become cleaner — clean enough to support aquatic life and allow you to take a dip without facing health risk. Though the river water still cannot be used for drinking purposes unless it's chemically treated, the visible difference is, at least, in sync with what the CPCB found through its analysis of pollution loads in Ganga during pre-lockdown (March 15-21) and lockdown (March 22-April 15) periods. The country's national pollution watchdog in its report says the "nationwide lockdown has resulted in overall improvement in water quality of river Ganga especially with regard to increased Dissolved Oxygen (DO) and reduced nitrate concentration" - it means the water quality of entire river stretch from Uttarakhand to West Bengal has attained the bathing standard and become organically rich enough to support aquatic life. The report also shows that the water quality of the river stretch in Uttar Pradesh has seen higher improvement compared to what its stretch in West Bengal witnessed. Though the Biochemical Oxygen Demand (BOD) level - a key indicator of organic pollution - is still much higher in many stretches in UP (specifically near Dhodhi Ghat in Kanpur) than its level in West Bengal, the former has seen higher improvement during lockdown period compared to its pre-lockdown period levels.

Water quality in upper reaches of the river in Uttarakhand (till Haridwar-Rishikesh) is comparatively much cleaner than the rest of the river stretch in four states - UP, Bihar, Jharkhand and West Bengal. The CPCB analysed pre-lockdown and lockdown periods data from 36 real time water quality monitoring stations along the river Ganga and its tributaries. The pollution watchdog has analysed concentration level for Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate (NO3-) and Ammoniacal Nitrogen

(NH3-N) at those monitoring stations. The water bodies having BOD more than 3 mg/l are considered as polluted. More than 3 mg/l of BOD doesn't meet the desired water quality, but it doesn't affect DO level in water bodies. If BOD exceeds 6mg/l in water body, the DO is reduced below desired levels. The low DO level adversely affects aquatic life. The CPCB's report, however, doesn't talk about drinking quality of water as it hasn't measured the coilform level at this juncture. For the BOD level, the report in its conclusion says, "Reduction in BOD concentration has been less significant owing to continual discharge of untreated or inadequately treated sewage. Marginal reduction can be seen only in fourth week (April 12-15 period). Further, there is gradual increase in BOD levels towards downstream stretches of the river, with the maximum values in West Bengal stretch."

Research Methodology and collection of sample

The study was conducted on before lockdown time period to the end of 3rd unlock period of 2020, during the pandemic of Covid-19. All samples were collected from the mid stream of the river in different capacity container by the Central Pollution Control Board, India. All the data collected from their website, respectively from 7 sites, Bahrampur of Murshidabad, Srirampur of Hoogly, Sibpur of Howrah, Palta of N-24 parganas, Nabadwip of Nadia, Dakshmineswar of Kolkata and lastly Diamond Harbour of South 24 parganas. In total, 58 days sample were taken for this BOD study of Ganga in West Bengal, within that time period. Bathing and washing were found as human activities of basin of the river. Weather was sunny, clear and colour and intensity-colour was muddy. Approximate depth was taken as 2 mts Also, no odour was found. According to CPCB data and tables, all the samples were stored preserved in ice immediately after collection and were analyzed within 24 hours from the time of collection. The limits set by WHO for drinking water and designated best use by Central Pollution Control Board were considered as standard for the study of the above mentioned parameters.

Table 1: Data analysis and graphical representation

Murshidabad	**5/3/2020**	**20/3/20**	**14/4/20**	**15/5/20**	**28/5/20**	**11/6/20**	**25/6/20**	**14/7/20**	**30/7/20**
	4.10	4.10	3.7	2.75	1.0	1.65	1.2	2.4	2.0
Hoogly	2/3/20	13/4/20	11/5/20	22/5/20	10/6/20	19/6/20	2/7/20	24/7/20	
	2.55	2.8	1.85	3.9	2.2	2.75	3.05	1.45	
Howrah	2/3/20	17/3/20	13/4/20	18/5/20	1/6/20	15/6/20	2/7/20	16/7/20	10/8/20
	4.3	3.4	1.25	3.6	1.6	2.05	1.25	1.15	2.6
N-24 Parganas	4/3/20	16/3/20	13/4/20	11/5/20	27/5/20	3/6/20	19/6/20	2/7/20	16/7/20
	3.45	3.25	3.6	2.8	2.9	2.9	2.05	3.15	1.85
Kolkata	2/3/20	7/4/20	18/5/20	10/6/20	18/6/20	3/7/20	17/7/20		
	4.5	4	4.35	3.1	2.9	2.4	2.5		
Nadia	4/3/20	16/3/20	13/4/20	11/5/20	27/5/20	3/6/20	19/6/20	2/7/20	16/7/20
	3.0	3.4	2.8	2.1	1.35	2.3	2.8	5.3	4.15
S-24 Parganas	5/3/20	19/3/20	8/4/20	18/5/20	1/6/20	24/6/20	7/7/20	21/7/20	
	1.75	1.9	2.7	3.2	1.8	1.5	1.6	1.2	

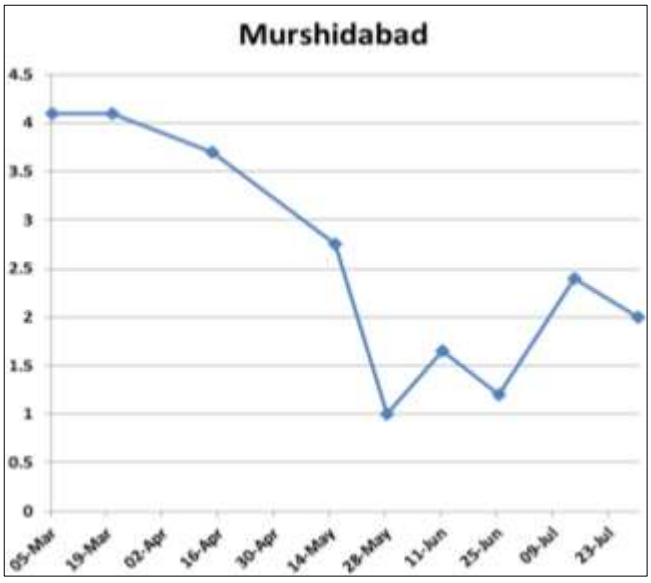

Fig 1

Fig 2

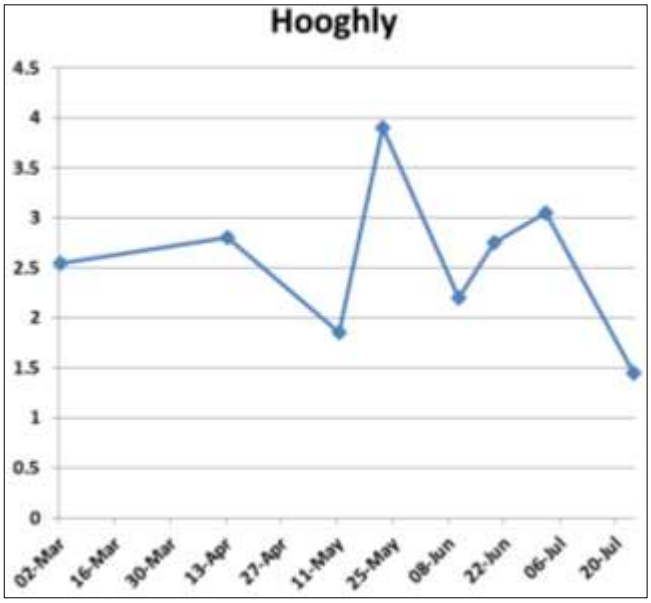

Fig 3

Fig 4

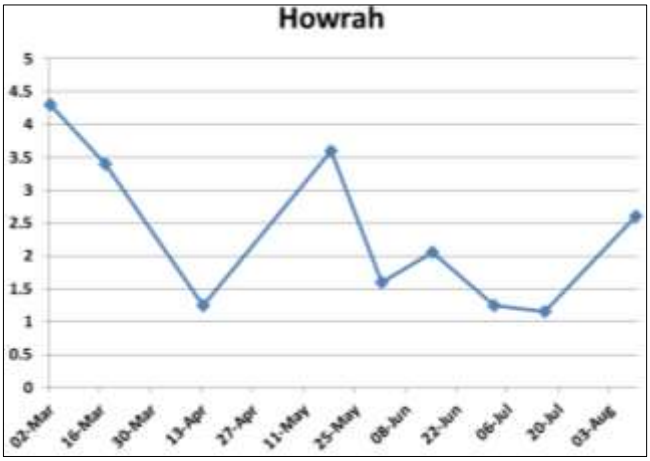

Fig 5

Fig 6

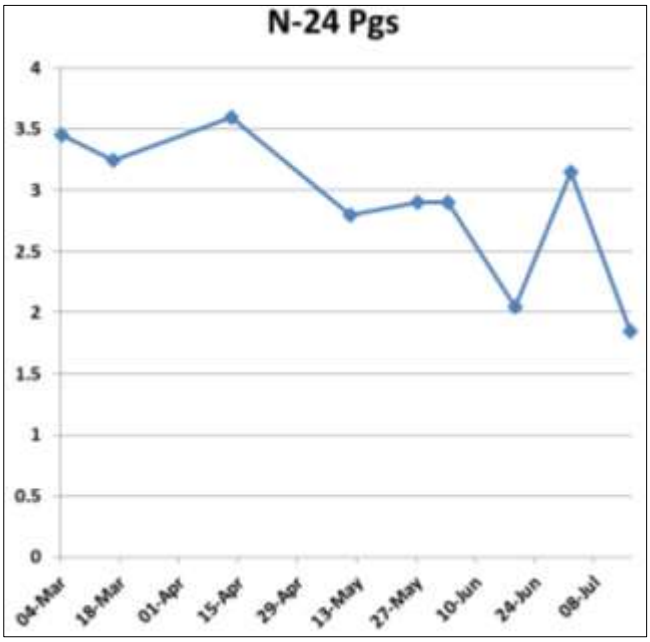

Fig 7

Fig 8

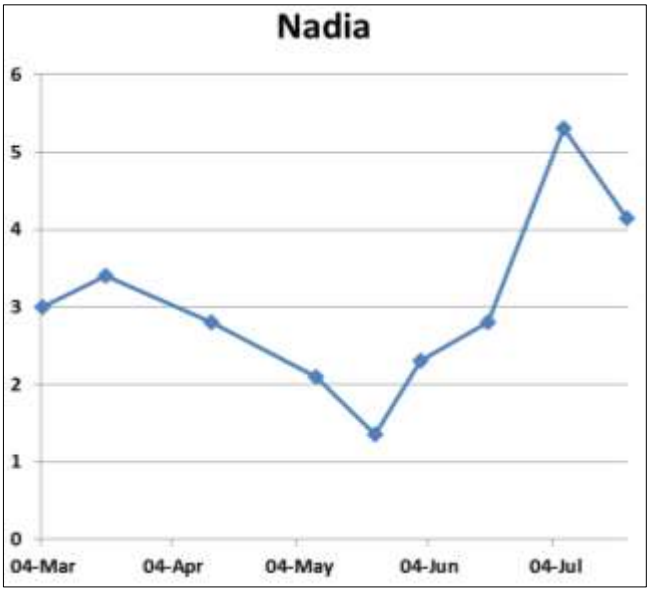

Fig 9

Fig 10

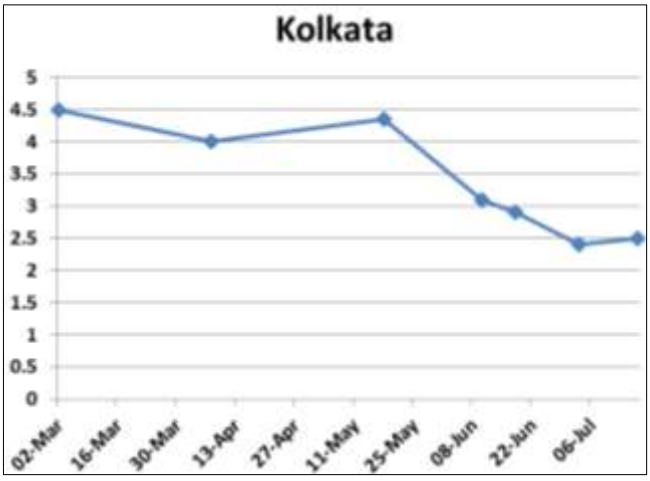

Fig 11

Fig 11

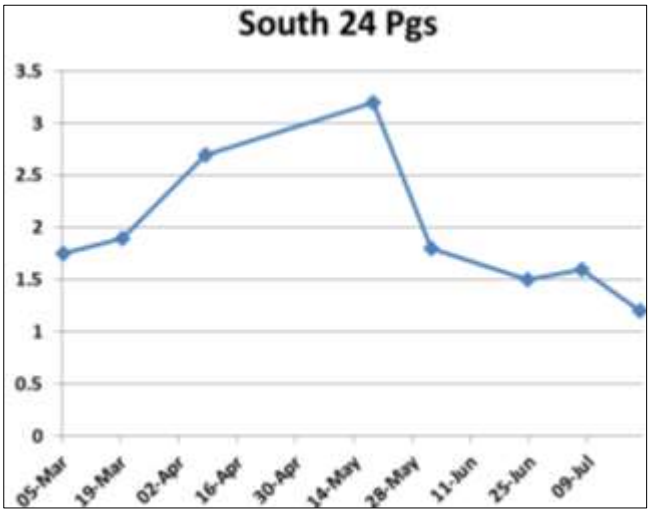

Fig 12

Fig 13

Conclusion

COVID-19 lockdown phase turned the chapter of environment to a great extent (Mitra *et al*., 2020). The aquatic ecosystem in and around West Bengal Ganga basin is no exception to this rule. Considering the previous data (March 2020), it is observed that there has been a decrease of Biological Oxygen Demand content

by 25% to 75% when compared to the March 2020 data. It is observed that during COVID-19 lockdown there has been a steef gradual decrease of BOD content at Bahrampur of Murshidabad, Srirampur of Hooghly, Shibpur of Howrah, Palta of N-24 Parganas, Nabadwip of Nadia, Dakshmineswar of Kolkata and Diamond Harbour of S-24 Parganas respectively over a period of 20 weeks, 5 months. The results lead to conclude that sharp decrease in BOD level in all the selected stations in coastal West Bengal is the direct outcome of COVID-19 lockdown and consequtive unlock period, because conditioning fishing boats, industrial discharges, fish landing etc. have been ceased, to abide by the rules of lockdown. The lockdown phase, initiated on and from 25th March, 2020 completely ceased all the industrial operations and movements of water transports that ultimately upgraded the estuarine water quality as revealed by the lowering in BOD values.

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