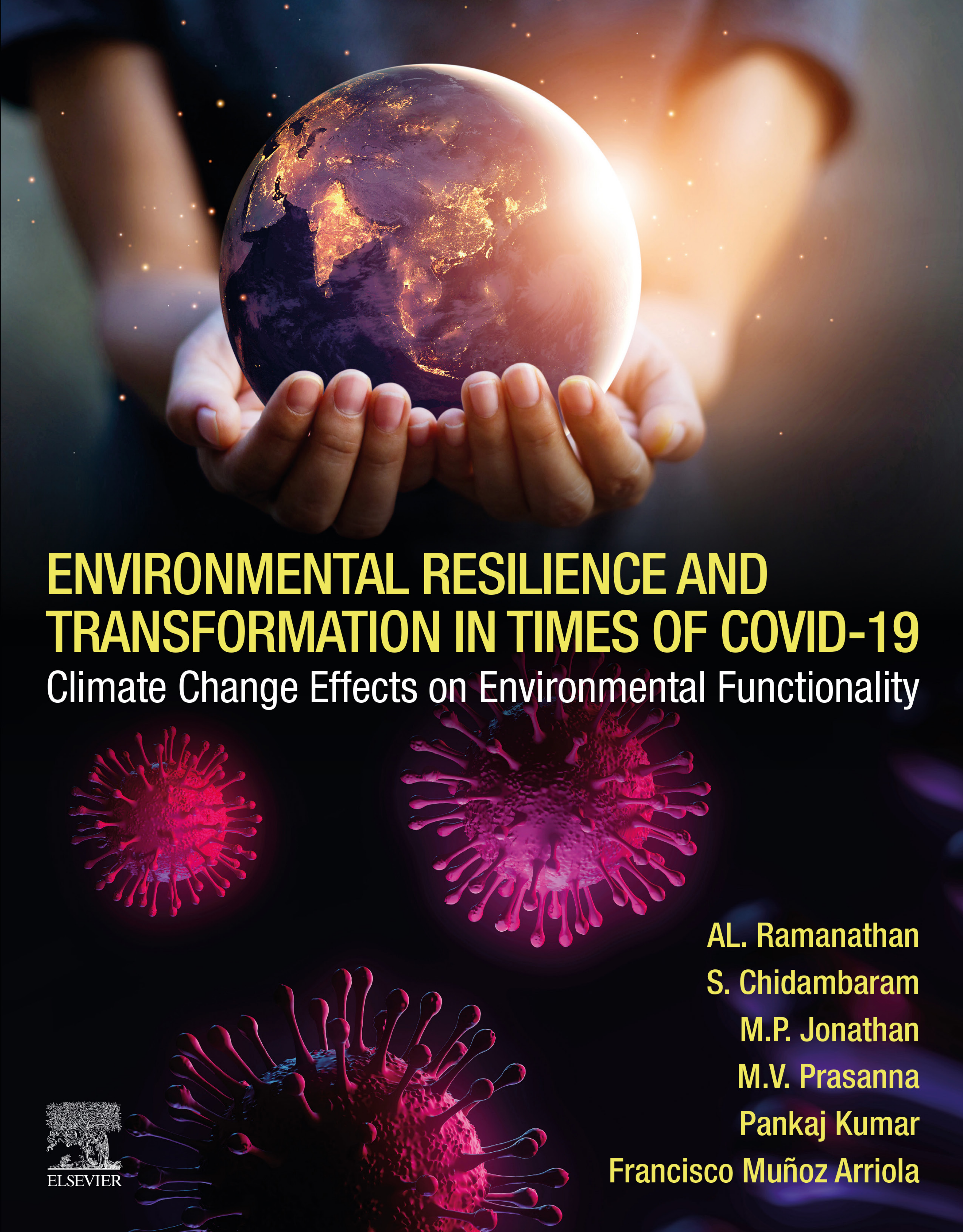

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CLIMATE CHANGE EFFECTS ON ENVIRONMENTAL FUNCTIONALITY

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C H A P T E R

12

Impact of COVID-19 lockdown on real-time DO–BOD variation of river Ganga

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12.1 Introduction

The corona virus disease (COVID-19) pandemic hit the world during January/February months of 2020. To reduce the severity of this disease and save their citizens, most countries adopted lockdown strategy, resulting to which most human activities came to a standstill. In India, the nationwide lockdown was imposed with effect from the mid night of March 24, 2020, to curb the spread of COVID-19. The lockdown has given a suitable opportunity to researcher to study the impact of anthropogenic intervention on environmental pollution/degradation (Saadat et al., 2020) (Das et al., 2020) (Layard et al., 2020) (Cadotte, 2020).

The Ganga river basin is one of the most densely populated area and with largest groundwater repositories (Misra, 2011; Pal et al., 2020). The Ganga river basin inhabit 43% of the population of India that spreading over 860,000 km covering 26.3% of the India's total geographical land (Trivedi, 2010). Recently, there have been several reports highlighting overall improvement in the river Ganga water quality claiming that this might be due to the increase in the dissolved oxygen (DO) and reduction in the biochemical oxygen demand (BOD; Arora et al., 2020). This could be attributed primarily to the restriction of the industrial wastewater discharge and increased fresh water flow. There are several polluting industries such as sugar, textiles, paper and pulp, automobiles, fertilizers, and distilleries along the tributaries of Ganga such as Yamuna, Ramganga, Kali, and Hindon rivers contributing pollution load to the river Ganga. According to the number of grossly polluting industries in Ganga river basin in April 2019 was 1072. In addition to grossly polluting industries, domestic wastewater, and industrial effluent from 97 towns situated along the banks of river Ganga are the main source of water pollution. Out of the estimated quantity of 3500 MLD (million liters per day) of sewage generated from 97 Ganga front towns, only 1100 MLD is treated before discharge and remaining 2400 MLD is discharged untreated into river Ganga directly or indirectly. The industrial effluent is estimated to be about 300 MLD, which is about 9% of the total wastewater being discharged into the river every day. The reduction in BOD concentration was relatively less due to continued discharge of domestic wastewater into the river. Reduced activities at Ghats and entrainment of solid organic waste into the river may also have contributed to better water quality.

A comparative assessment of pollution during prelockdown and lockdown periods was made through analysis of data generated from 36 real-time water quality motoring systems (18 on river Ganga, 09 on its tributaries and 09 on a few drains). To study the Impact of Lock down, the concentration data for DO and BOD was examined for

(i) Prelockdown period (March 15–21, 2020) and
(ii) Lockdown period (March 22–April 22, 2020).

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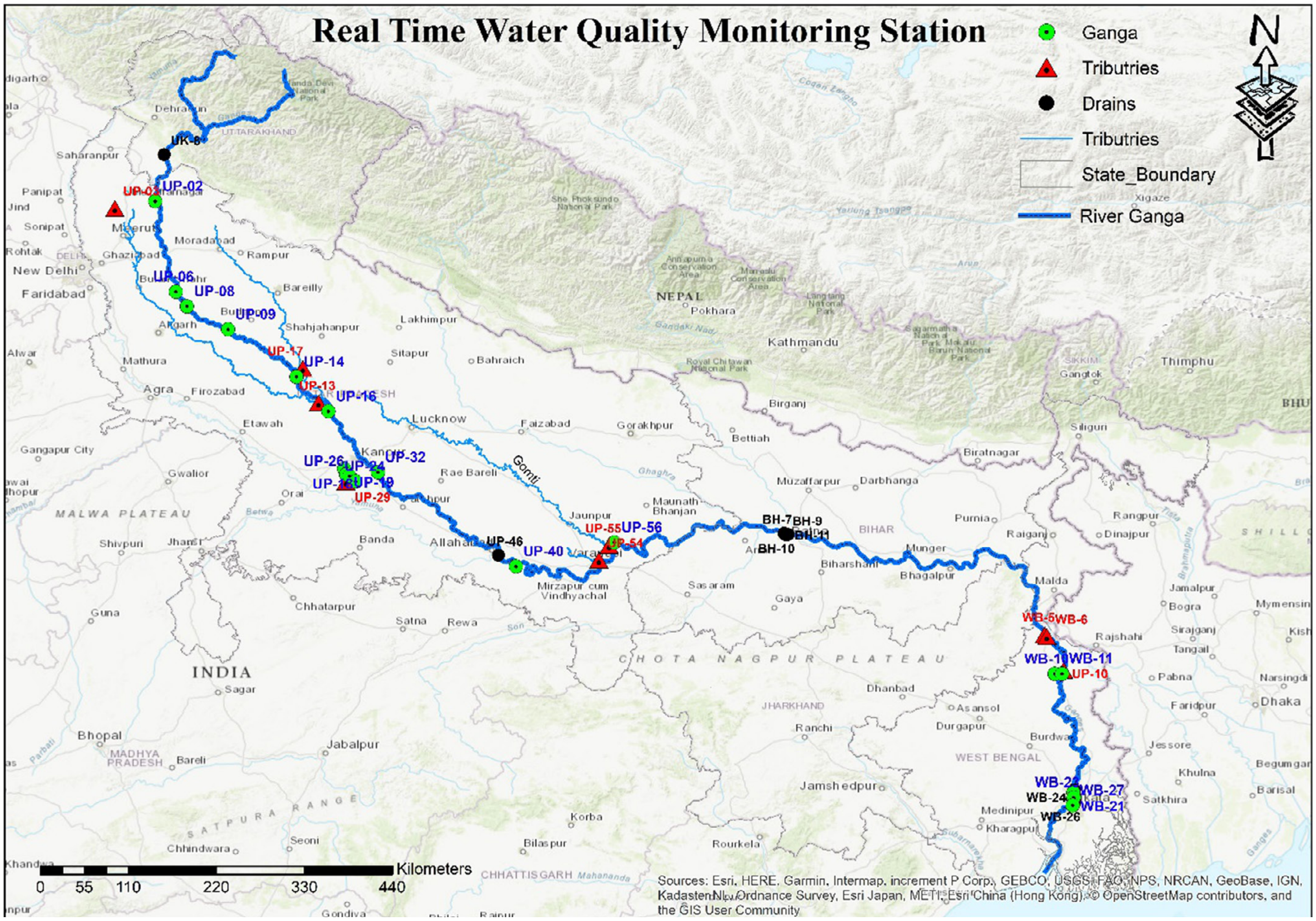

FIG. 12.1 Location map of real-time monitoring stations.

Lockdown phase was further subdivided into

- **(i)** Week 1—March 22–28, 2020
- **(ii)** Week 2—March 29–April 4, 2020
- **(iii)** Week 3—April 5–11, 2020,
- **(iv)** Week 4—April 12–18, 2020, and
- **(v)** Week-5—April 19–22, 2020.

The location of monitoring stations is shown in Fig. 12.1. Data analysis is presented in Figs. 12.2–12.9 and discussed in following sections, separately for main stem of river Ganga and its tributaries. Percent variation is calculated using average value during the prelockdown and lockdown periods with prelockdown as reference, and depicted through height of bars, positive for increase and negative for decrease.

12.2 Impact of lockdown on main stem of river Ganga

Variation in DO and BOD is shown in Figs. 12.2, 12.3 and 12.4, 12.5 at various locations along Ganga from Bijnore (UP) to Howrah (WB) during prelockdown (March 15–21) and lockdown weeks—Week 1 (March 22–28), Week 2 (March 29–April 4), Week 3 (April 5–11), Week 4 (April 12–18), and Week 5 (April 19–22).

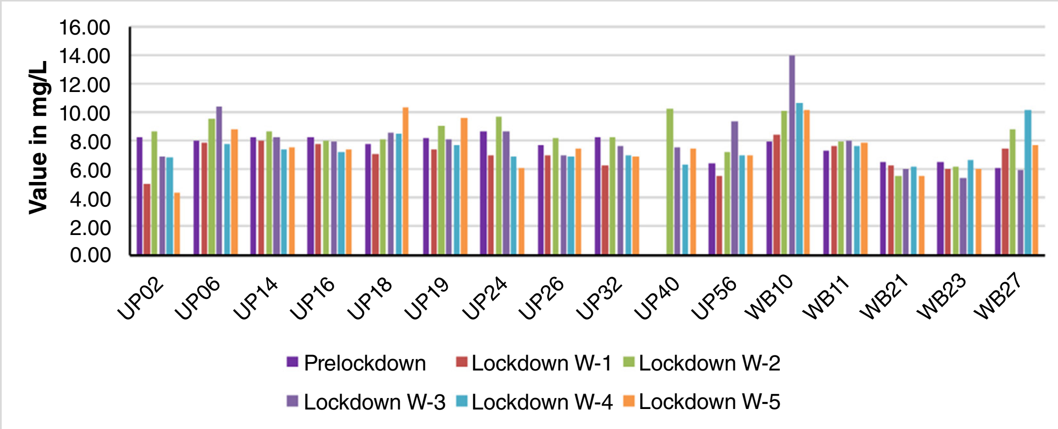

FIG. 12.2 Variation in DO before and after lockdown.

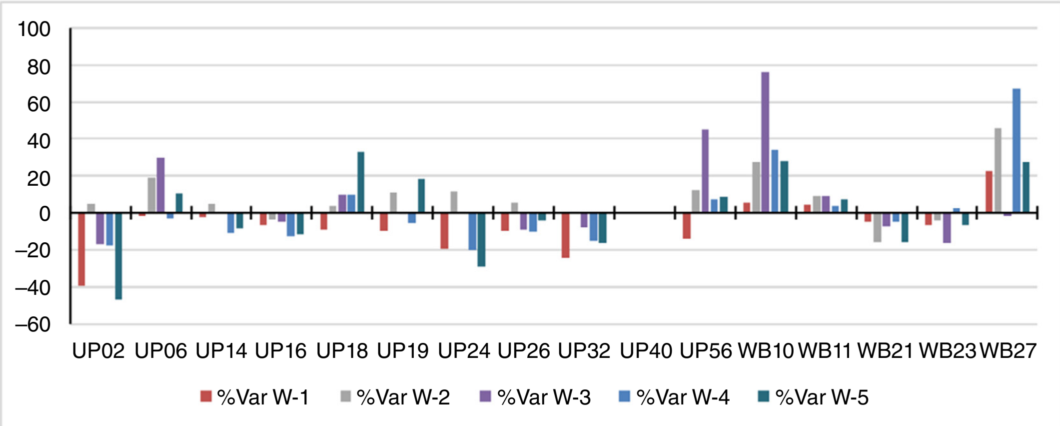

FIG. 12.3 Percentage variation in DO before and after lockdown.

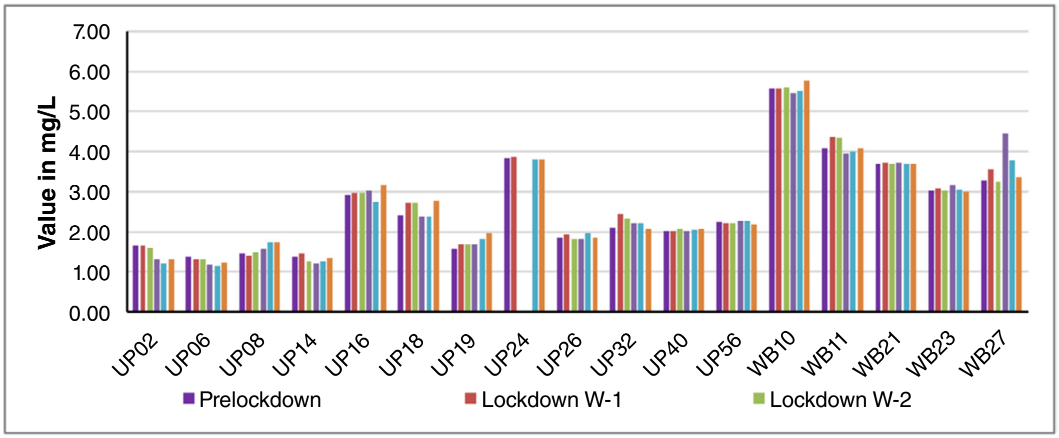

FIG. 12.4 Variation in BOD before and after lockdown.

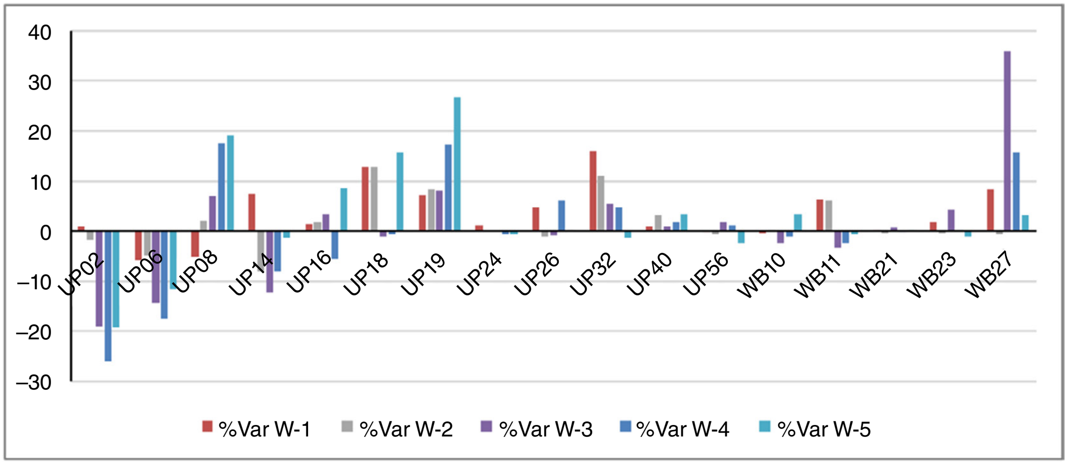

FIG. 12.5 Percentage variation in BOD before and after lockdown.

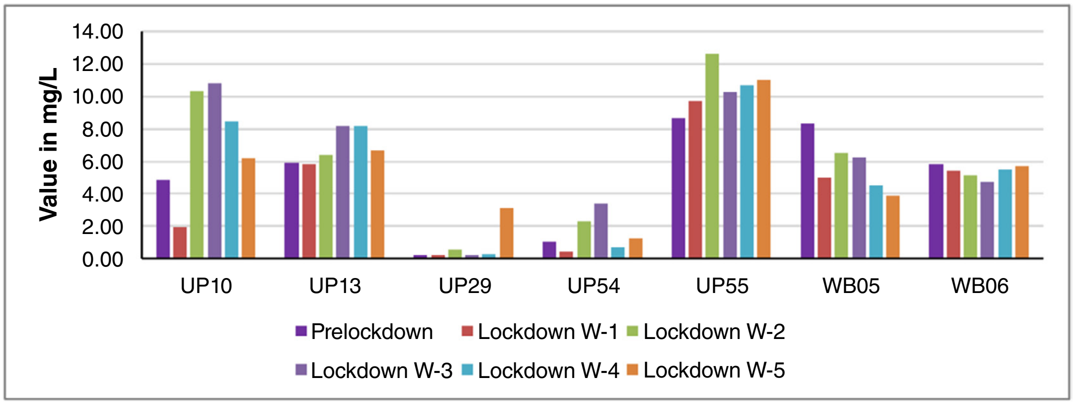

FIG. 12.6 Variation in DO before and after lockdown.

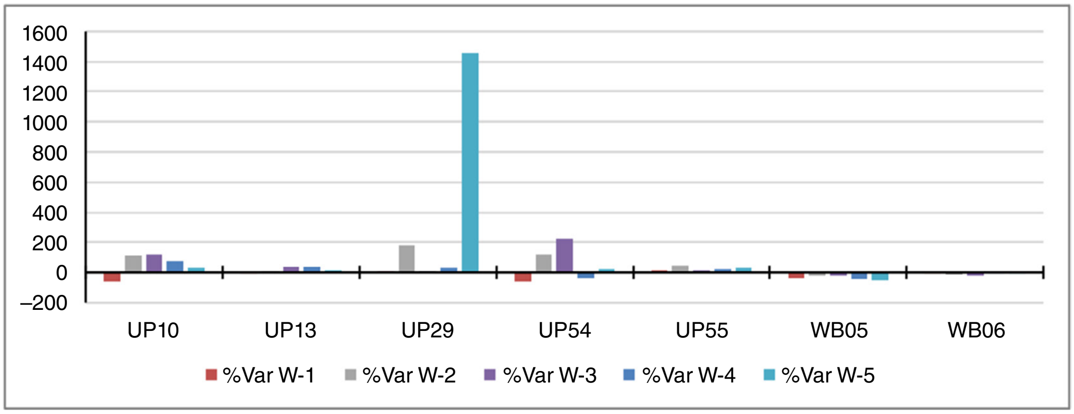

FIG. 12.7 Percentage variation in DO before and after lockdown.

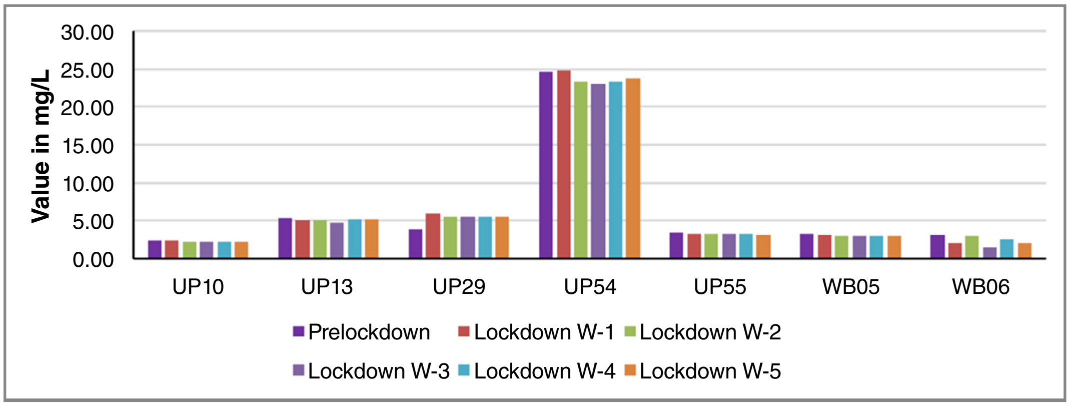

FIG. 12.8 Variation in BOD before and after lockdown.

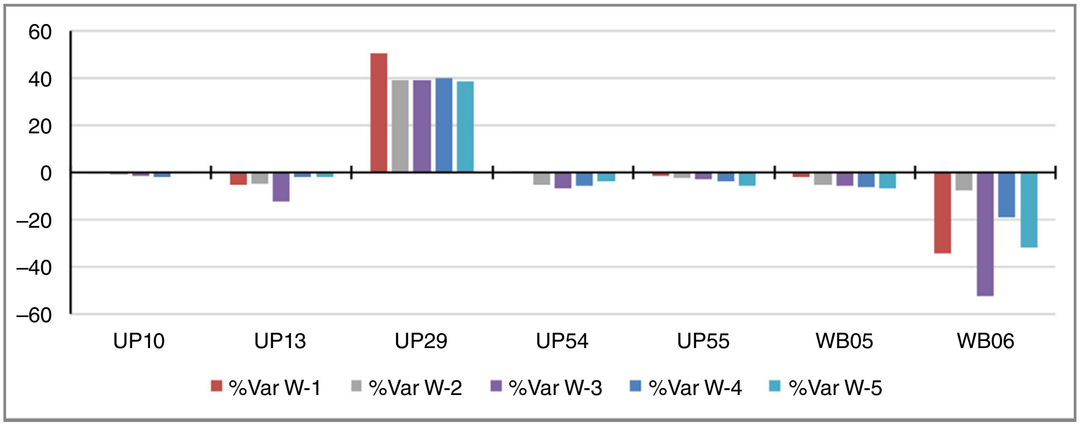

FIG. 12.9 Variation in BOD before and after lockdown.

12.2.1 Dissolved oxygen

Fig. 12.2, depicts the values of DO in river Ganga at various monitoring stations from Madhya Ganga Barrage (UP02, Bijnore, UP) to Millennium Park Bridge (WB27, Howrah, WB) during prelockdown period up to the fourth week of lockdown. Fig. 12.3 shows percentage variation in DO relative to its value during the prelockdown period.

The slight decrease in DO observed at all location during the first week after national lockdown may be due attributed to the increased levels of suspended solids and turbidity in the river water because of heavy rains. Beginning the second week, DO level has shown slight improvement toward the saturation DO. It is observed that on an average there is about 3 to 20% decrease, however the Station UP02 (Bijnore) has recorded 40% decrease during the first week (Fig. 12.3). On an average, DO concentrations remained above the bathing criteria norms (5 mg/L or more) at all locations.

In UP, the DO during national lockdown, Week 4 has shown a decreased value as compared to the prelockdown period at most of the locations which may be due to sewage generation and reduced freshwater flow in the fourth week of lockdown. However, in West Bengal the DO has increased in lockdown Week 4 (except WB23, Belgharia, WB). The graph clearly indicates an increasing trend in the values of DO of the river at most of the monitoring locations in Weeks 2 and 3. Similar, trend has been reported in the study of Dhar et al. (2020) showing impact of lockdown on DO of river Ganga. This may be attributed to high freshwater flow in the river Ganga.

12.2.2 Biochemical oxygen demand

Fig. 12.4 depicts concentration (mg/L) and Fig. 12.5 depicts percentage variation for BOD for prelockdown (March 15–21, 2020) and lockdown period (March 22–April 15, 2020).

Overall, there was no steep reduction in BOD at most monitoring stations, though lower BOD values were recorded during fourth week as compared to previous weeks. There is gradual increase in BOD in the river water along its downstream stretch, with the maximum being in its WB stretch. It is seen that the BOD level up to Station UP14 (Farrukhabad) has remained below 3 mg/L and no effect of lockdown is discernible. It is seen that at Station UP24 (Dhodhi Ghat, Kanpur) the BOD has shown an increasing trend during lockdown period with high value of around 15 mg/L. The station UP32 (Fatehpur) has shown higher BOD during the lockdown period that may be attributed to the discharge of polluted wastewater through Pandu river. In the remaining stretch of river within UP, the BOD has remained unchanged. In the entire WB stretch of the river BOD concentrations varied from 3 to 5 mg/L and has shown a marginal increase over the prelockdown level. There is a positive impact, though not substantial, of lockdown on BOD level. The increased levels observed at Stations UP16 (Kannauj), UP24 (Kanpur), UP32 (Fatehpur), and WB-11 (Behrampore, West Bengal) indicate continual discharge of wastewater. In earlier study river water was not found to be suitable for outdoor bathing standards at most of the monitoring centers along the river Ganga, excluding the upper stretch of river Ganga till Haridwar (Kamboj and Kamboj, 2019).

BOD value ranged between 1.13 mg/L and 5.56 mg/L during lockdown period, more or less similar to prelockdown range of 1.37–5.58 mg/L.

12.3 Impact of lockdown on river Ganga tributaries

From Uttar Pradesh (UP) to West Bengal (WB) there are 09 real-time water quality monitoring stations (RTWQMS) on rivers Banganga, Rāmgangā, Kali, Pandu, Varuna, and Gomati located in UP, and Falguni and Maya located in WB. These tributaries of river Ganga receive both domestic and industrial effluent from cities, towns and industries situated along their course before joining Ganga. In view of this, water quality data for these tributaries were also analyzed.

12.3.1 Dissolved oxygen

Figs. 12.6 and 12.7 depict concentration (mg/L) and percentage variation for DO for prelockdown (March 15–21, 2020) and lockdown period (March 22–April 15, 2020), respectively.

There is a large variation in the DO level (0.2–12.7 mg/L) in these rivers. Extremely low values of DO were recorded in Pandu (UP29, Hamirpur–Kanpur Road) and Varuna (UP54, Varanasi). It may be appropriate to mention that these two rivers do not have their own natural water flow, all that they carry is sewage, agricultural run-off, storm water flow, and industrial effluent. The velocity of water flow is extremely slow and insufficient to cause aeration through atmospheric oxygen. High value of DO (>12 mg/L) recorded in UP55 (Gomati) is likely to be due to photosynthetic activity of algal growth in the river. Except during prelockdown period, all rivers in UP have shown increase in DO level beginning second week of lockdown. But, slight decrease in DO has been recorded in WB rivers. Most of stations have recorded increase in DO, high increase has been observed at UP10 (Ramganga), UP 29 (Pandu), and UP54 (Varuna), which may be attributed to the suspension of industrial activity in the industrial areas of Kanpur (Panaki, Kakanagar, Rooma, etc.), and Fatehpur, etc. Also, appreciably low discharge of wastewater form hotels, vehicle repairing shops and other small industries situated in city limits may have contributed to improved water quality. The concentration range varied from 0.2 to 8.66 mg/L during prelockdown and 0.21–12.7 mg/L during lockdown.

12.3.2 Biochemical oxygen demand

Figs. 12.8 and 12.9 depict concentration (mg/L) and percentage variation for BOD for prelockdown (March 15–21, 2020) and lockdown period (March 22–April 15, 2020), respectively.

BOD in various tributaries has varied from as low as 2.0 (WB06, Maya) to as high as 25 mg/L (UP54, Varuna). In comparison to prelockdown period almost all stations have recorded marginal decrease in BOD values. Station UP29 (Pandu) has recorded higher BOD (>5 mg/L) value during lockdown weeks. Station UP54 (Varuna) has consistently recorded very high BOD values (23–25 mg/L) though during lock down period it has recorded a consistent decrease.

All stations, except UP29 (Pandu), have recorded a decrease during the lockdown weeks compared to the prelockdown period that has varied from about 2%–10%. The highest decrease (8%–50%) is recorded at station WB06

(Maya). Station UP29 (Pandu) recorded an increase of 50% during first week that got reduced to 40% during subsequent weeks. This is likely to be due to continual discharge of untreated wastewater.

12.4 Conclusion

The Ganga main stem recorded much improved water quality levels with respect to DO at most locations during lockdown as a cumulative effect of rains and decreased industrial & commercial activities. With DO reaching saturation value at most locations, the concentration as high as 14 mg/L was observed at Behrampore Bridge, apparently due to cumulative effect of lockdown and favorable local conditions. The BOD concentration reduction was comparatively less significant owing to continual discharge of untreated or inadequately treated sewage. However, due to local circumstances resulting in microbial digestion of organic matter and lower organic load due to reduced flow, BOD concentration was appreciably reduced at a few locations.

With regard to water quality of tributaries of river Ganga, the concentration of DO increased during lockdown period. Initially the improvement was marginal due to heavy rains resulting in increased runoff, substantial increase was noted from second week onward reaching saturation value at various locations. Overall, decreasing trend in BOD was observed compared to prelockdown phase at most locations. Marginal increase in ammonical nitrogen concentration was recorded at all location compared to prelockdown period.

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