Alteration of dissolved Zinc concentration during COVID-19 lockdown phase in coastal West Bengal

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Abstract

The coastal water of the maritime state of West Bengal is highly stressed due to anthropogenic activities like discharges from tourism units, industrial operations, repairing of fishing vessels and trawlers, fish landing etc. All these activities release variety of heavy metals in the coastal waters. This paper highlights a sudden dip in the rising trend of dissolved Zn in three selected stations (342.47 ppb in Kakdwip, 362.86 ppb in Shankarpur, 153.44 ppb in Bony Camp) during the COVID-19 lockdown phase. Considering the previous data (1984-2019), it is observed that there has been a decrease in dissolved Zn level by 4.96%, 9.92% and 13.72% at Kakdwip, Shankarpur and Bony Camp respectively when compared to the COVID-19 lockdown phase during April 2020.

Keywords: Dissolved Zn, COVID-19, Kakdwip, Shankarpur, Bony Camp

Introduction

River and estuarine systems have facilitated human settlements on their banks since the beginning of human civilization. The Hooghly estuarine system which is constituted by the first offshoot of the River Ganga – Bhagirathi system, flows southwards through the lower Ganga deltaic plane and joins the Bay of Bengal in Sundarbans. It is one of the most important estuarine systems of the country because of (1) its origin from the largest mountain river, (2) heavy monsoonal discharge from a very vast basin and (3) very long tidal zone. Being a very active tidal estuary, it has physico-chemical and biological characteristics of its own.

The varied and increasingly complex problems created by humans have affected the health of these coastal and estuarine systems leading to rapid depletion of estuarine resources. The anthropogenic activities in and around the estuaries like the discharges from tourism units, industrial operations, repairing of fishing vessels and trawlers, fish landing etc. are leading the estuaries and coastal zone to stressful condition. The extent of this stress is not only dependent on the amount of sewage generated by the residents living around the estuaries, but also on the disposals by the industries situated in the neighborhood. The sewage load in the River Ganga accounts for 70% of the total pollution load. Not only the sewage but discharging effluents from the industrial units also find their way into the nearby water bodies. As the population is growing, the agricultural activities are also increasing causing a burden on the environment. To sustain increased agricultural output, the consumption of fertilizers and pesticides has increased over the years. The agricultural run-offs in the water bodies are escalating the already

polluted water bodies which are also leading to eutrophication.

Thus unplanned proliferation of urban and industrial set-ups leads to escalation in marine discharges and total load of pollutants being dispensed into the sea (Knauer, 1977; Stoffers et al., 1986; Gbem et al., 2001; Al-Masri et al., 2002; Khare and Singh, 2002; Duzgoren-Aydin et al., 2006; Florea and Busselberg, 2006; Jadeja et al., 2006). These discharges may contain heavy metals which can bioaccumulate and bio-magnify as they get transferred in the food chain.

We have selected three sampling stations namely Kakdwip, Shankarpur and Bony Camp situated in the Hooghly-Matla estuarine complex in West Bengal at the apex of Bay of Bengal. The effluents released by the industrial units into the bay contain appreciable amount of Zn, Cu and Pb. The antifouling paints used for conditioning fishing vessels and trawlers also contribute to the heavy metal load. In addition, the sewage from shrimp farms along the estuarine stretch and untreated wastes from Haldia port-cum-industrial complex also add substantially to the existing load of heavy metals (Mitra and Bhattacharyya, 2003; Mitra et al., 2010; Mitra, 2013; Mitra and Zaman, 2016; Mitra, 2019).

The outbreak of Coronavirus disease 2019 (COVID-19) has affected over 210 countries and territories around the world and has infected over 2 million people globally. This epidemic started in Wuhan, China and quickly spread its wings all over the world and is now a pandemic. A person infected by this novel corona virus can infect around 2.5 persons and so COVID-19 infections are more contagious than caused by other coronaviruses such as SARS or MERS-CoV.

This deadly virus has no cure till date and so as to curb and contain the spread of this highly contagious disease most parts of the world are under complete lockdown. In order to restrict the spread of this terrible virus, we need to minimize human to human contact as no proven treatment or vaccine is available presently. Moreover, COVID-19 can spread asymptomatically too. Hence, people all over the world are emphasizing on social distancing. Since novel coronavirus spreads rapidly, many countries have tried to bring down the transmission rate by calling social lockdown. This can help in minimizing the spread of infection and also would give some breather to the already overburdened healthcare systems.

To contain the spread of the novel coronavirus the Government of India also announced lockdown for 21 days starting from 25th March, which constituted phase 1 and this was further extended for another 19 days that is phase 2. During the lockdown phase all kinds of transport services were suspended except for essential goods, fire, police and emergency services. All schools and colleges, places of worship, commercial and private establishments and hospitality services were also closed.

This paper is an attempt to show how controlled human activities can bring a change in the water quality of coastal West Bengal preferably with respect to dissolved zinc, which is a very common heavy metal sourced from industries, painting units,

repairing and conditioning units of vessels and trawlers.

Materials & Methods

Study area

The total length of tidal Hooghly estuary is about 295 km and it lies between the latitude $21^0$31' N and $23^0$30' N and longitude $87^0$45' E and $88^0$45' E and covers the districts of Nadia, Hooghly, North and South 24-Parganas, Howrah and East Midnapur in the maritime state of West Bengal. The present sampling stations were selected at Kakdwip (21°52'22.69" N 88°11'58.61" E), Shankarpur (22°50'54.20" N 88°27'4.54" E) and Bony Camp (21°69.05' N, 88°56.83' E). Samplings were carried out in these stations since 1984 during the month of April, which is a pre-monsoon month in India, characterized by high salinity and minimum dilution factor in the coastal waters (Mitra, 2013; Mitra and Zaman, 2014; Mitra and Zaman, 2016; Mitra, 2019).

Sample collection

Pre-COVID PHASE

Water samples were collected during the month of April (pre-monsoon), for a period of 36 years (1984-2019) in the three selected sampling stations.

COVID PHASE

Water samples were collected during the month of April 2020 (weekly) in the three sampling stations chosen.

Analysis of dissolved Zinc

Water samples collected from all the three stations (during high tide) were analyzed to determine the content of dissolved heavy metal, Zn. Before analysis, each water sample was collected and stored in clean TARSON bottles and was filtered through a 0.45 µm Millipore membrane. The filtrate was treated with diethyl dithio-carbamate and extracted in carbon tetrachloride (Chakraborti et al., 1987). The extracted was evaporated to dryness and the residue was mineralized with 0.1 ml of concentrated nitric acid. The analytical blank was prepared and treated similarly using the same reagents. Analyses were done in triplicate by direct aspiration into AAS (Perkin-Elmer Model: 3030) equipped with a HGA-500 graphite furnace atomizer and a deuterium background corrector. The accuracy of the dissolved heavy metal determinations is indicated by good agreement between our values and reported for certified reference seawater materials (CASS 2) (Table 1).

Table 1. Analysis of reference material for near shore seawater (CASS 2)

Element	Certified value ($\mu g\ l^{-1}$)	Laboratory results ($\mu g\ l^{-1}$)
Zn	1.97 ± 0.12	2.01 ± 0.14
Cu	0.675 ± 0.039	0.786 ± 0.058
Pb	0.019 ± 0.006	0.029 ± 0.009

Statistical analysis

Analysis of Variance was used as an exploratory tool to determine the significance of variation of dissolved Zn between the pre-COVID and COVID phases and also between stations ($p < 0.01$).

Results

The variation of dissolved Zn between the three sampling stations over a period of 37 years (1984-2020) is highlighted in Fig. 1. Maximum value of dissolved Zn was found to be 545.89 ppb, 566.18

ppb, 287.11 ppb at Kakdwip, Shankarpur and Bony Camp respectively over a period of 37 years and these values are for pre-monsoon season of the year 2019. The authors observed that there was a dip in increasing trend of dissolved Zn in three selected stations (342.47 ppb in Kakdwip, 362.86 ppb in Shankarpur, 153.44 ppb in Bony Camp) during COVID-19 lockdown phase in West Bengal (Fig. 2). The dissolved Zn content decreases from 1st week of April 2020 to 4th week of April 2020 and this trend is followed in all three sampling stations (Fig. 3).

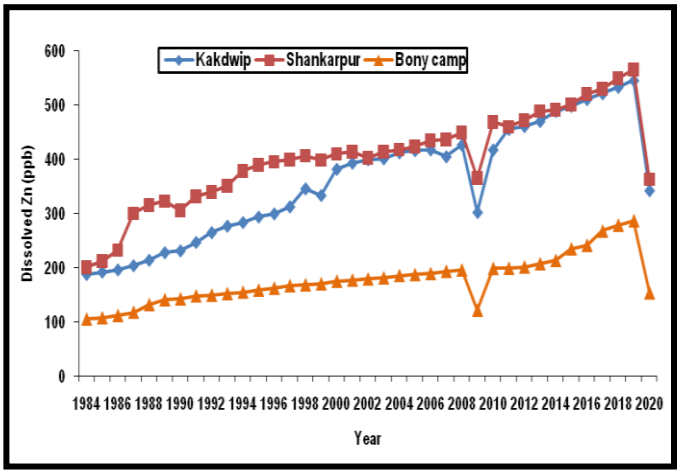

Fig. 1. Variation of dissolved Zn during the study period (1984-2020)

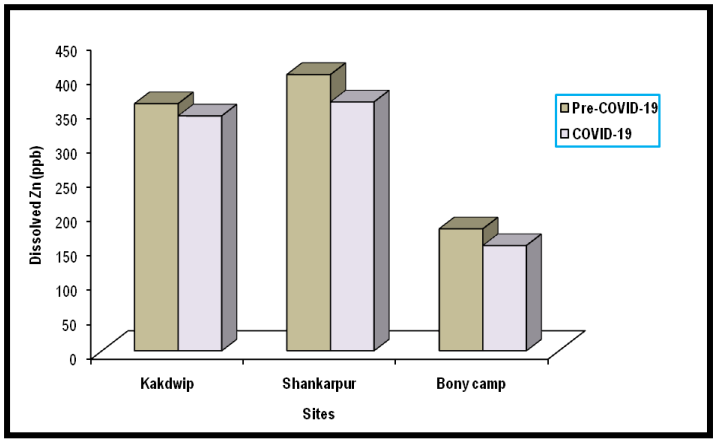

Fig. 2. Variation of dissolved Zn during the Pre-COVID-19 and COVID-19 lockdown

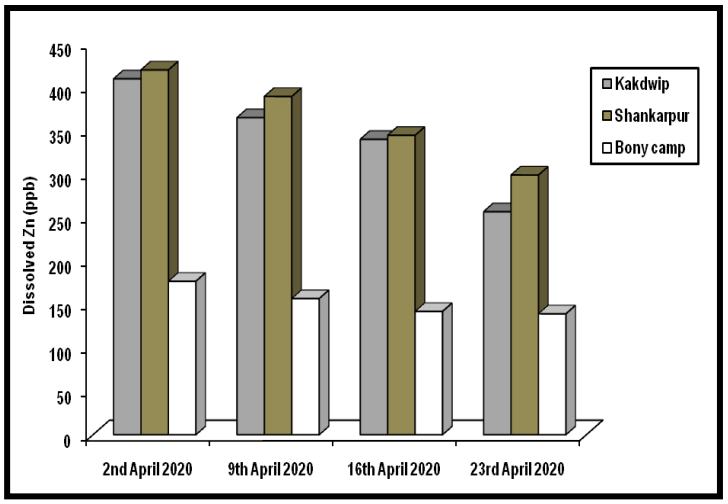

Fig. 3. Variation of dissolved Zn during April 2020 (COVID-19 lockdown)

ANOVA data showed pronounced variation in dissolved Zn concentration between stations and between pre-COVID-19 and COVID phase ($p < 0.01$) (Table2).

Table 2. ANOVA of dissolved Zn between stations and between pre-COVID-19 and COVID-19 phase

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Stations	55119.83	2	27559.92	428.5258	0.002328	19
Between pre-COVID-19 and COVID-19	1127.236	1	1127.236	19.52726	0.052593	18.51282
Error	128.6266	2	64.31332			
Total	56375.7	5				

Discussion

The COVID-19 lockdown phase is the real witness of eco-restoration of environmental quality (Mitra et al., 2020), and coastal waters of West Bengal is no exception to this rule. Considering the previous data (1984-2019), it is observed that there has been a

decrease of dissolved Zn content by 4.96%, 9.92% and 13.72% at Kakdwip, Shankarpur and Bony Camp respectively when compared to the April 2020 data. It is observed that during COVID-19 lockdown there has been a gradual decrease of dissolved Zn content by 37.34%, 28.83%, and 21.23% at Kakdwip, Shankarpur and Bony Camp respectively over a period of four weeks. The entire discussion along with the results lead us to conclude that sharp decrease in dissolved Zn level in all the selected stations in coastal West Bengal during April 2020 is the direct outcome of COVID-19 lockdown in which the primary sources of Zn in the coastal zone of West Bengal like conditioning fishing boats, industrial discharges, fish landing etc. have been ceased, to abide by the rules of lockdown. Thus COVID-19 lockdown has brought out the positive face of coastal water quality without any major investment in the treatment process.

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References

1. Al-Masri MS, Aba A, Khalil H, Al-Hares Z. (2002). Sedimentation rates and pollution history of a dried lake: Al-Oteibeh Lake. Science of the Total Environment, 293 (1-3), 177-189.
2. Chakraborti D, Adams F, Van Mol W, Irgolic JK. (1987). Determination of trace metals in natura waters at nanogram per litre levels by Electrothermal Atomic Absorption Spectrophotometry after extraction with sodium diethyldithiocarbamate. Analytica Chemica Acta, 196, 23-31.
3. Duzgoren-Aydin N, Wong C, Song Z, Aydin A, Li X, You M. (2006). Fate of heavy metal contamination in road dusts and gully sediments in Guangzhou, SE China: A chemical and mineralogical assessment. Human and Ecological Risk Assessment, 12, 374-389.
4. Florea A, Busselberg D. (2006). Occurrence, use and potential toxic effects of metals and metal compounds. Biometals, 19, 419-427.
5. Gbem TT, Balogun JK, Lawaland FA, Annune PA. (2001). Trace metals accumulation in *Clarias gariepinus* Teugules exposed to sun lethal levels of tannery effluent. Science of the Total Environment, 271, 1-9.
6. Jadeja BA, Odedra NK, Thaker MR. (2006). Studies on ground water quality of industrial area of Dharampur, Porbandar city, Saurashtra, Gujrat, India. Plant Archives, 6 (1), 341-344.
7. Khare S, Singh S. (2002). Histopathological lesions by copper sulphate and lead nitrate in the gills of fresh-water fish Nandus. Journal of the Ecotoxicology and Environmental Monitoring, 12, 105-111.
8. Knauer GA. (1977). Immediate industrial effects on sediment metals in a clean coastal

environment. Marine Pollution Bulletin, 8, 249-254.

9. Mitra A, Banerjee K, Ghosh R, Ray SK. (2010). Bioaccumulation pattern of heavy metals in the shrimps of the lower stretch of the River Ganga. Mesopotamian Journal of Marine Science, 25 (2), 1-14.
10. Mitra A, Bhattacharyya DP. (2003). Environmental issues of shrimp farming in mangrove ecosystem. Journal of Indian Ocean Studies, 11 (1), 120-129.
11. Mitra A, Ray Chadhuri T, Mitra A, Pramanick P, Zaman S. (2020). Impact of COVID-19 related shutdown on atmospheric carbon dioxide level in the city of Kolkata. Parana Journal of Science and Education, 6 (3), 84-92.
12. Mitra A, Zaman S. (2014). Carbon sequestration by Coastal Floral Community, India. Published by The Energy and Resources Institute (TERI) TERI Press. ISBN 978-81-7993-551-4.
13. Mitra A, Zaman S. (2016). Basics of Marine and Estuarine Ecology; Publisher Springer India, ISBN 978-81-322-2707-6, 1-481.
14. Mitra A. (2013). In: Sensitivity of Mangrove Ecosystem to Changing Climate. Publisher *Springer* New Delhi Heidelberg New York Dordrecht London, 2013 edition; ISBN-10: 8132215087; ISBN-13: 978-8132215080.
15. Mitra A. (2019). Estuarine Pollution in the Lower Gangetic Delta. Published by Springer International Publishing, ISBN 978-3-319-93305-4, XVI, 371.
16. Stoffers P, Glasby GP, Wilson CJ, Davis KR, Walter P. (1986). Heavy metal pollution in Wellington Harbour. New Zealand Journal of Marine and freshwater Research, 20, 495-512.