Scanning the water quality of lower Gangetic delta during COVID-19 lockdown phase using Dissolved Oxygen (DO) as proxy

Sondipon Chakraborty, Ankita Mitra, Prosenjit Pramanick, Sufia Zaman and Abhijit Mitra

Abstract

Dissolved Oxygen (DO) is the life line of aquatic lives. Wastes disposed from various sources when enriched with organic load deplete the DO level causing an adverse impact on aquatic biodiversity. In this paper we have initiated a first order analysis to scan the water quality of three stations in the lower Gangetic delta region (Diamond Harbour, Namkhana and Ajmalmari) using DO as proxy. We observed significant increase in DO during the COVID-19 lockdown phase (38.54%, 31.73% and 12.40% increase at Diamond Harbour, Namkhana and Ajmalmari respectively), when compared with the mean DO values of each station since the last three decades (1984-2019). The increasing trend of DO from 2nd April, 2020 to 23rd April, 2020 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: Dissolved Oxygen (DO), water quality, lower Gangetic delta, COVID-19

Introduction

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). Deposition of organic wastes results in the increase of Biological Oxygen Demand (BOD) in water. Relation between BOD and Dissolved Oxygen (DO) is inversely proportional. Dissolved oxygen (DO) concentration in water is essential for aquatic life (Banerjee, 2018). Concentration of DO is reciprocally correlated with the temperature of water bodies. Respiration by aquatic animal, decomposition of organic pollutant and several chemical reactions consume oxygen and increase the biological oxygen demand (BOD) of waterbody. Now a days' river pollution is an emerging issue in several developing countries due to rapid industrial development (Kan, 2009). Industrial effluents and sewage entering the water bodies are one of the prime sources of environmental toxicity, which endangers aquatic biota and deteriorates water quality. Quality of water is essential for mankind as it is directly linked with human life and associated aquatic biota (Abdel-Tawwab et al. 2015; Butler et al., 2010).

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 (Paul, 2017). Historical evidence says that the modern civilization in India have been initiated on the bank of River Ganga. In India, Ganga passes through 29 class I cities, 23 class II cities and approximately 50 towns (Paul, 2017). The River Ganga ends at Bengal and has formed the largest deltaic complex at the apex of the bay. The Hooghly-Matla estuarine complex envisages a wide spectrum of aquatic flora and fauna along with the dense mangrove ecosystem. The deltaic complex sustains 112 islands of which only 48 are inhabited by human. Sundarban is noted for its unique biodiversity (Mitra, 2013; Mitra and Zaman, 2014; Mitra and Zaman, 2016; Mitra, 2019). Sundarban also harbors a good number of rare and globally threatened animals including Estuarine Crocodile (*Crocodilus porosus*), Fishing Cat (*Felis viverrina* Bennett), Salvatore Lizard / Water Monitor (*Varanus salvator*), Gangetic Dolphin (*Platinista gangetica*), River Terrapin (*Batagur Baska*), marine turtles like Olive Ridley (*Lepidochelys olivacea*), Ground Turtle, Hawksbill Turtle and King Crab (Horse Shoe). It is the homeland for several endemic species also. It is no exaggeration to say that the lower Gangetic delta region supports the most diverse group of fauna and flora which sustains their life with immense tenacity in this dynamic ecosystem.

The pandemic COVID-19 has made Government/ruling bodies all over the World to go for lockdown phase. The lockdown phase 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. DO have immense role in controlling the metabolic activities and sustaining the life of most aquatic flora and fauna. The primary production of the aquatic phase is greatly dependent on the DO level, which in turn regulates the secondary productivity (zooplankton and fishes). Thus DO play a vital role in maintaining the food chain of the aquatic ecosystem and promote the fishery sector of the coastal and estuarine waters.

Materials and Methods

Study site

The present study is an approach to estimate the variation of DO between pre-COVID-19 and COVID-19 lock down phases at Hooghly-Matla estuarine complex, West Bengal. Entire study has conducted in three distinct geographical locations of the lower Gangetic delta namely, Diamond Harbour (22°11'4.2"N; 88°11'22.2"E), Namkhana (21°45'53.7"N; 88°13'51.5"E) and Ajmalmari (21°49'42.9"N; 88°37'13.7"E) (Fig. 1).

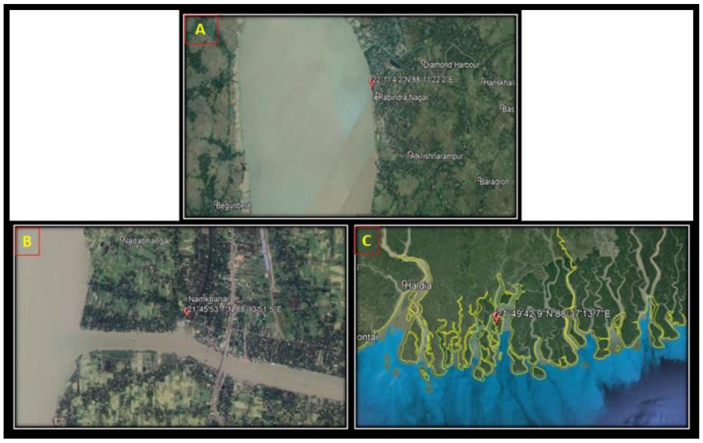

Fig. 1. GPS location of three sampling sites in the Hooghly-Matla estuarine complex. A. Diamond Harbour B. Namkhana C. Ajmalmari

Analysis

The entire network of the present study consists of random sampling of water at each station for estimating the DO during the COVID-19 lock down phase. Estimation of DO was carried out by Winkler's Method as per the standard protocol (Mitra and Zaman, 2015). Our analytical method did not change since the last 3 decades and the results are the mean of triplicate analysis. For the purpose of scanning the effect of COVID-19 lockdown phase, we segregated our data in to two distinct sets, one considering DO level during COVID-19 lock down phase (2nd April to 23rd April) and the other comprising the DO values during pre- COVID-19 phase (pre-monsoon, 1984-2019). Necessary statistical model was developed by using 'Sigma Plot 11.0.'

Results

Data evaluated from three different sampling sites at Hooghly-Matla estuarine complex have revealed a significant variation of dissolved oxygen (DO) concentration between pre-COVID and COVID-19 lockdown phase (Fig. 2).

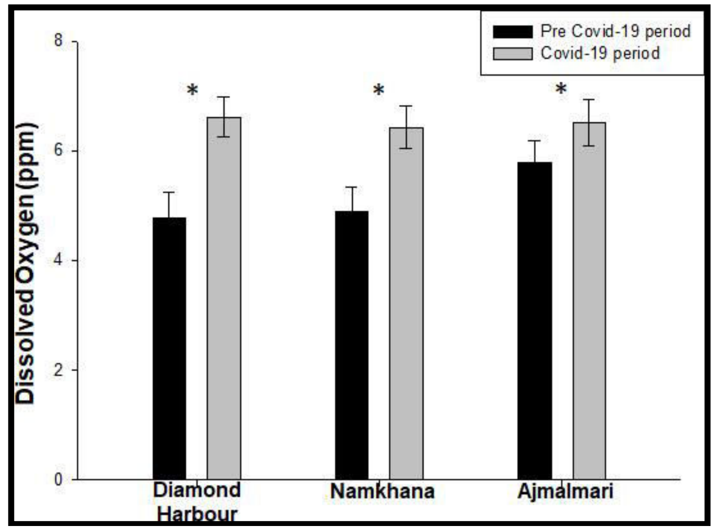

Fig. 2. Spatio-temporal variation of DO (in ppm) during between the pre-COVID-19 (1984-2019) and Covid-19 lockdown (April, 2020) phases (* = p< 0.05)

The percentage of DO increased during the month of COVID-19 lockdown than pre-COVID-19 phase years (Fig. 3). Among three different study sites, percentages of DO increased maximum at Diamond Harbour (38.54%) and minimum at Ajmalmari (12.40%) adjacent to the core area of Sunderban Biosphere Reserve (Fig. 3).

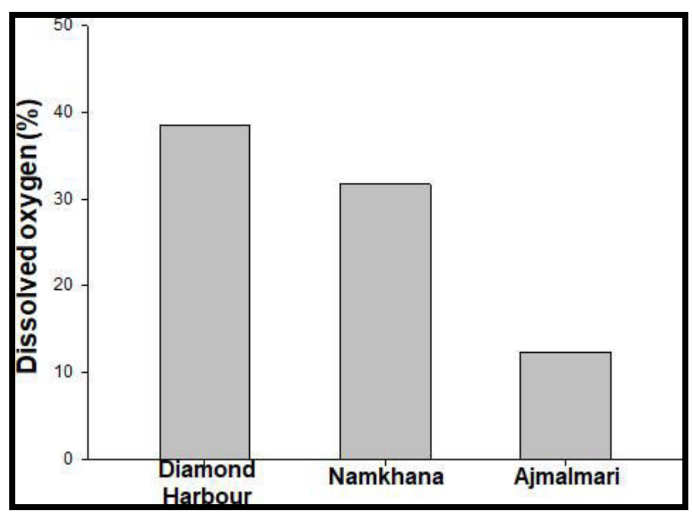

Fig. 3. Percentage increase of DO in three selected stations during lockdown period

DO values were highest near Ajmalmari (5.79 ± 0.40 ppm) whereas no statistical significant difference was observed in DO values between Diamond Harbour and Namkhana ($p < 0.05$) during pre-COVID-19 years (Fig. 4A). Notably, no significant difference in DO concentration has been observed among three different sites during COVID-19 lock down period (Fig. 4B).

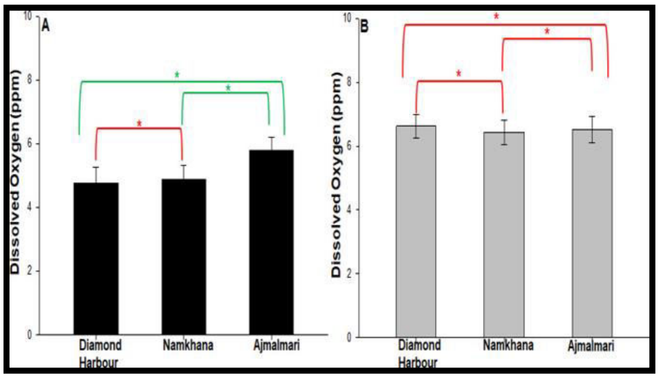

Fig. 4 Variation of DO among three different study sites at Hooghly-Matla estuarine complex, in the lower Gangetic delta, West Bengal, A. pre-COVID-19 Outbreak (1984-2019), B. Covid-19 Outbreak lock down phase (*= $p < 0.05$; *= $p < 0.05$)

Year wise trends of Dissolved Oxygen (DO) concentration at three stations in the Hooghly-Matla estuarine complex during pre-COVID (1984-2019) have shown a decreasing trend (Fig. 5).

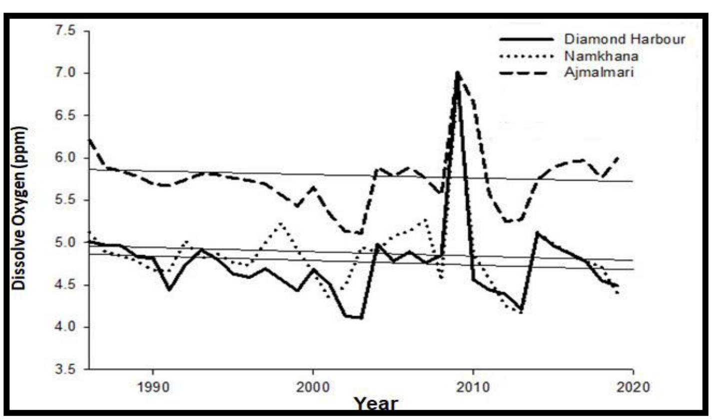

Fig. 5 Year wise trends of Dissolved Oxygen (DO) concentration at three stations in the Hooghly-Matla estuarine complex during pre-COVID (1984-2019) and COVID-19 lockdown phase (April, 2020)

During the lockdown phase, the DO level has increased day by day and similar trend is observed in all the selected stations (Fig. 6). These values are comparatively higher than the predicted values (means if no lockdown would have occurred) during this period (Fig. 7).

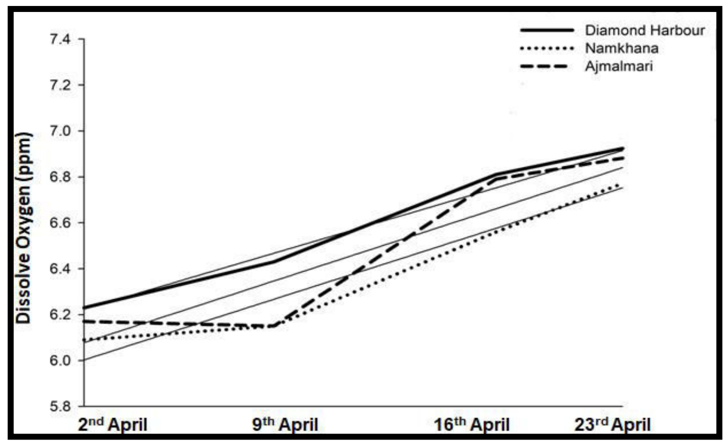

Fig. 6. Trends of Dissolved Oxygen (DO) concentration at three stations in the Hooghly-Matla estuarine complex during COVID-19 lockdown phase

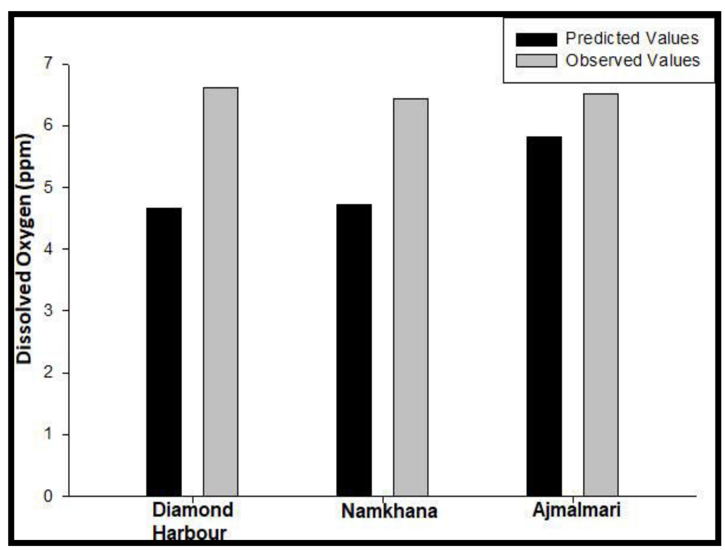

Fig. 7. Difference between the observed and predicted values of DO at Hooghly-Matla estuarine water during COVID-19 Out break period, April, 2020

Discussion

COVID-19 lockdown phase turned the chapter of environment to a great extent (Mitra et al., 2020). The aquatic ecosystem in and around Indian Sundarbans is no exception to this rule. The DO level has exhibited two peaks during the entire data sets (i) 2009 peak due to super cyclone AILA (Mitra et al., 2011) and (ii) 2020 peak during COVID-19 lockdown phase. The second peak is the issue of the present article, which may be due to negligible input of wastes from several anthropogenic sources that arise from industrial and domestic activities. 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 hike in DO values. The increase of DO level has several positive implications particularly in the domain of sustaining the fish resources of the estuarine system.

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