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Research Article

Decadal Variation of Dissolved Oxygen in the Lower Gangetic Delta Water

Abstract

We analyzed the Dissolved Oxygen (DO) level in the surface water off Namkhana, a sampling station in the lower Gangetic delta region. Our three decade analysis in three different seasons (premonsoon, monsoon and postmonsoon) exhibits a decrease in the DO value with the passage of time. Based on the DO value we carried out a premilinary Water Quality Index (WQI) analysis using the average seasonal temperature of the study region. This index can be used as proxy to aquatic health in the study site, provided other relevant variables remain within the optimum range. The DO level varies as per the sequence monsoon > postmonsoon > premonsoon. The sudden rise of DO level and WQI during premonsoon 2009 is attributed to Aila, a super cyclone that passed across the lower Gangetic delta on 25th May, 2009 with a speed of ~110 km/hr.

Introduction

The DO level in the coastal and estuarine waters is a function of several physical, chemical and biological factors. The physical factor encompasses waves, tides, turbulence etc. through which diffusion of atmospheric oxygen occurs at the air-sea interface. The chemical factor encompasses release of waste from industrial and urban sources, leakage of oil from tankers, ship wrecks, etc. The biological factor primarily includes the standing stock of phytoplankton community in the estuarine water. The rate of photosynthesis, respiration and decomposition by microbes regulate the DO level in the aquatic system.

The present study area receives wastes from industries (mainly concentrated in the western bank of the Hooghly estuary) and urban sources (like the city of Kolkata, Howrah and Haldia port-cum industrial complex). The study site is highly productive due to presence of considerable standing stock of phytoplankton [1-4]. The study area also witnesses norwesters every year and the super cyclone Aila during May, 2009 is one such storm that hiked the DO level to 6.96 ppm compared to the average premonsoonal DO level of 4.77 ppm in the study area. The oscillation of DO level has a far reaching impact on the biotic community and hence a baseline data of DO is essential to evaluate the water quality in context to biodiversity of the area.

The present paper is an approach to acquire an insight on the water quality depending on the DO value and seasonal temperature of the study area. The seasonal temperature has been obtained from the secondary sources [2,4].

Materials and Methods

Study area and sampling

The analysis of DO was carried out in a sampling station off Namkhana (21°45'53.7"N; 88°13'51.5"E) in the Hooghly estuary located in the maritime state of West Bengal, India. For each observation, at least five samples were collected from the study site during high tide condition. Glass bottles of 125 ml were filled to overflow the collected water samples and Winkler titration was performed for the determination of DO. The sampling method did not change since 1984.

Water Quality Index (WQI) estimation

A web based formula downloaded from http://www.fivecreeks.org/monitor/do.html [5], was used to analyze the WQI in the study area. This index was computed using the average seasonal temperature, DO and water level.

Results

The temporal variation of DO in the sampling station off Namkhana exhibits a unique seasonal variation with lowest value of 4.11 ppm during premonsoon 2003 and highest value of 6.96 ppm during premonsoon 2009 (Figure 1). The average seasonal order of DO follows the sequence monsoon (5.37 ppm) > postmonsoon (5.05 ppm) > premonsoon (4.77 ppm). The sudden rise of DO level during 2009 premonsoon is attributed to Aila, which was a super cyclone that passed through the area on 25th May, 2009 with a speed of some 110 km/hr. This caused high wave action and subsequently the diffusion of atmospheric oxygen increased resulting in the rise of DO value.

The water quality index exhibits a gradual decrease with time, except during premonsoon 2009, (Figure 2) when the diffusion of

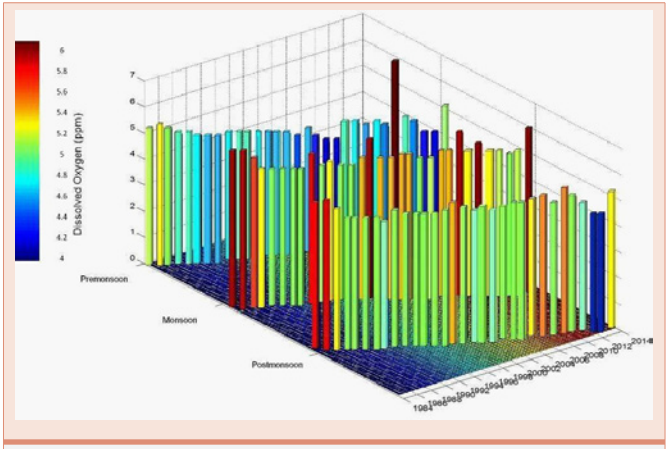

Figure 1: Temporal variation of surface water DO in Namkhana.

The water quality index exhibits a gradual decrease with time, except during premonsoon 2009, (Figure 2) when the diffusion of oxygen was maximum due to turbulent wave action caused by the super cyclone.

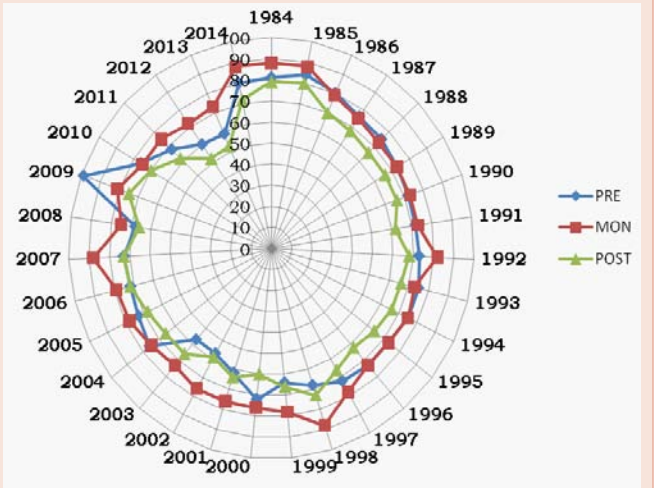

Figure 2: Seasonal variation of Water Quality Index (WQI) with respect to dissolved oxygen (DO) at Namkhana during 1984-2014.

oxygen was maximum due to turbulent wave action caused by the super cyclone.

Discussion

The present sampling site off Namkhana receives the industrial and urban wastes from the cities of Kolkata, Howrah and Haldia port-cum industrial belt. It is also the navigational channel and is adjacent to two major fish landing stations Kakdwip and Namkhana. The waste waters from these fish landing stations contaminate the area with biodegradable waste, which utilize the DO of the aquatic system for their decomposition leading to a fall of DO and WQI values. The average WQI in the study site is 72.19, 77.48 and 66.64 during premonsoon, monsoon and postmonsoon respectively. The mean WQI value (considering the three seasons) is 72.10, which reflects a relatively deteriorated condition compared to Ajmalmari area (WQI value = 89.38) [6]. This pronounced spatial variation in WQI may be attributed to the degree of anthropogenic stress in and around the sampling site. The WQI increased to 99 during 2009 premonsoon, but high salinity due to intrusion of sea water during Aila is antagonistic to the overall health of the aquatic ecosystem [4].

It is to be noted that the present data bank is not full proof and is not an ideal representation of the system. The limitation of this data is that all the samples were collected during high tide and therefore may not include the minimum dissolved oxygen concentration witnessed during the very early morning hours, before sunrise. From the quality assurance point of view, it is essential to install continuous monitoring buoys in the study site to measure the diurnal changes in the DO concentrations.

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