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Is Central Indian Sundarbans Approaching towards Hypoxia?

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Abstract: *Land-use change in the coastal zone has led to worldwide degradation of marine and coastal waters and a loss of the goods and services they provide. Here we perform an analysis on the Dissolved Oxygen (DO) level in the surface water off Jharkhali, a sampling station in the central Indian Sundarbans in the lower Gangetic delta region. Our three decade analysis in three different seasons (premonsoon, monsoon and postmonsoon) exhibits a gradual decrease in the DO value with the passage of time. The DO level varies as per the sequence monsoon > postmonsoon > premonsoon. The sudden rise of DO level 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. We also attempt to forecast in this paper the DO value in the sampling station during 2050.*

Keywords: *Central Indian Sundarbans, Dissolved oxygen (DO), Aila, forecast data*

1. Introduction

The conditions of marine and coastal ecosystems are threatened globally as a result of multiple and interacting processes. These habitats have been degraded or transformed mainly through anthropogenic impacts such as land use change and habitat loss. The present study area receives wastes from agricultural wastes, brick kilns, shrimp farms, and urban sources (like the city of Kolkata). The study site is, however, highly productive due to presence of considerable standing stock of phytoplankton (Mitra and Banerjee, 2005; Mitra, 2013; Mitra and Zaman, 2014; Mitra and Zaman, 2015) that flourish abundantly due to nutrients sourced from mangrove litter and detritus. 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. It is also equally important to know the future of aquatic health for effective restoration of the system.

2. Materials and Methods

The entire prediction on DO level in the coming three decades (more specifically in 2050) stands on the secondary data collected from Jharkhali area since 1984. More than three decades of real time data (1984-2015) were compiled from several literatures (Chakraborty and Choudhury, 1985; Mitra et al., 1987; Mitra et al., 1992; Mitra and Choudhury, 1994; Saha et al., 1999; Banerjee et al., 2002; Banerjee et al., 2003; Mondal et al., 2006; Mitra et al., 2009; Mitra, 2013; Banerjee et al., 2013; Sengupta et al., 2013; Mitra and Zaman, 2014; Mitra and Zaman, 2015). Time series analysis was performed to forecast the trend of DO on the basis of the past 30 years' real-time data. Exponential smoothing method produces maximum-likelihood estimates and has been used to reflect the future trend of DO to visualize the status in 2050.

3. Results

The average values of DO in Jharkhali (considering the real time data during 1984-2015) are 3.82 ppm during premonsoon, 4.56 ppm during monsoon and 4.15 ppm during postmonsoon. The data reflects the seasonal order of DO in the sequence monsoon > postmonsoon > premonsoon (Figure 1). The forecast method predicts the average DO values to be 3.25 ppm in premonsoon, 4.64 ppm in monsoon and 3.85 ppm in postmonsoon at Jharkhali during 2050 (Figures 2-4). A sharp rise in DO level during premonsoon 2009 in study site may be attributed to Aila, a super cyclone that passed across this World Heritage Site with an approximate speed of 110 km/hr.

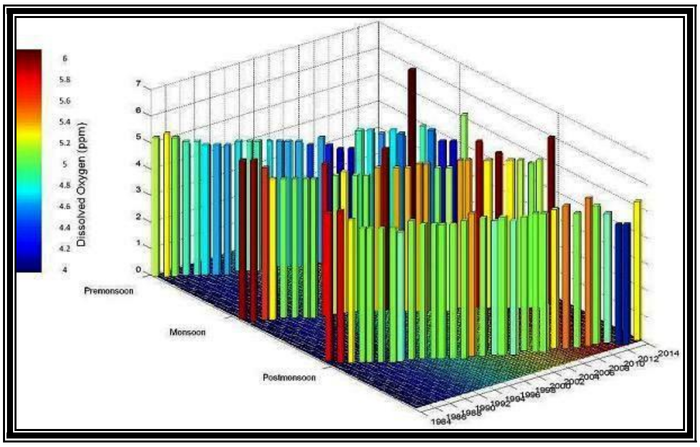

Figure1. *Temporal variations of surface water DO in Jharkhali*

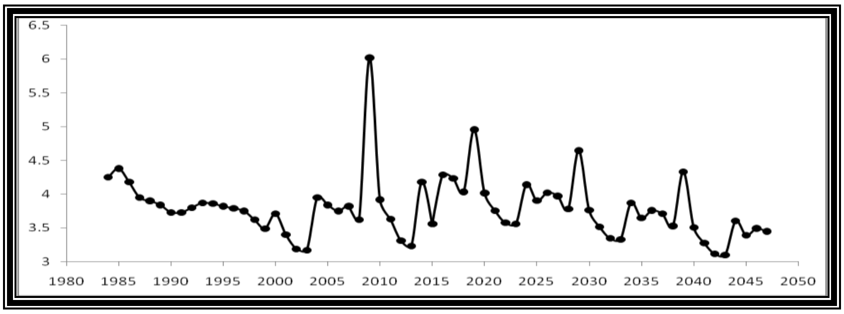

Figure2. *Temporal variation of DO real time data (1984-2015) and forecast data (2016-2050) during premonsoon at Jharkhali*

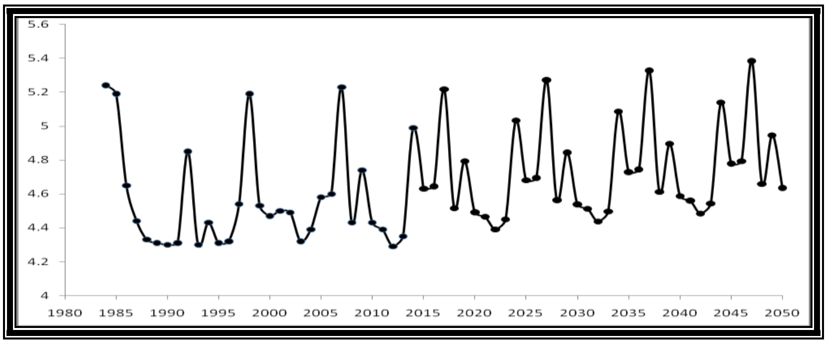

Figure3. *Temporal variation of DO real time data (1984-2015) and forecast data (2016-2050) during monsoon at Jharkhali*

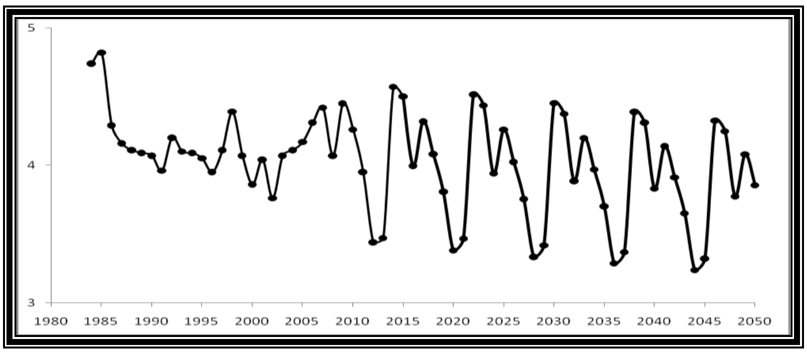

Figure4. *Temporal variation of DO real time data (1984-2015) and forecast data (2016-2050) during postmonsoon at Jharkhali*

4. DISCUSSION

The data sets since 1984-2015 reflect a gradual decrease of DO in study station. This may be attributed to high salinity in the central Indian Sundarbans due to complete blockage of fresh water in the region (Mitra, 2013; Sengupta et al., 2013; Mitra and Zaman, 2014; Mitra and Zaman, 2015; Mitra and Zaman, 2016). The siltation of Bidyadhari channel since late 15th century is the primary cause of blockage of fresh water supply in the Matla estuary of the central Indian Sundarbans (Chaudhuri and Chowdhury, 1994). The long history of gradual oxygen depletion and forecast values has important implications. The water of Indian Sundarbans is already polluted with organic matter generated from shrimp farms, brick kilns, sewage from highly urbanized cities of Kolkata, Howrah and Haldia port-cum-industrial complex, which are directly responsible for lowering the DO value in the system. Such activities such as discharge of significant quantity of additional oxygen demanding substances will worsen the system and have high probability to alter the ecological health of Indian Sundarbans. The importance of adequate circulation coupled with increase of dilution factor (by inter-linking Hooghly and Matla estuaries) must be emphasized in planning process for restoring the aquatic ecosystem in this World Heritage site.

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