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Water Quality Index (WQI) of East Kolkata Wetland using Dissolved Oxygen as Proxy

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Abstract: Land-use change in the East Kolkata Wetlands (EKW) area since the 18th century has led to the degradation of the water quality and a loss of the goods and services it provides. Here we perform an in-depth analysis of water quality with a data bank of 3 decades using dissolved oxygen (DO) as the indicator. The loss of head water feed from the River Hooghly, the gradual siltation of the River Bidyadhari, the rapid urbanization of the city of Kolkata and generation of huge quantum of waste water has degraded the water quality to a great extent as revealed from the gradual lowering of the DO level in the selected water body. The WQI has also decreased simultaneously except during premonsoon 2009 when the super cyclone Aila hit the study area and deviate the values of DO and WQI from the normal trend.

Keywords: East Kolkata Wetlands (EKW), Dissolved Oxygen (DO), Water Quality Index (WQI).

I. INTRODUCTION

The wetlands existing in the eastern side of the city of Kolkata comprises a large number of water bodies distributed in north and south 24 parganas districts of West Bengal. The area of the wetland ecosystem is some 2000 hectares, which encompasses aquatic ecosystem, sewage fed fisheries, agriculture and solid waste farms. In August 2002, the EKW received the crown of Ramsar Site, which is a flag of international importance. The rapid expansion of the city of Kolkata, the siltation of the Bidyadhari due to east ward shift of the River Ganga in the late 15th century has brought about a remarkable change on the aquatic health of the region. The aquatic system has been treated as garbage/waste disposal bin due to which the flow has reduced to a great extent. This has posed an adverse impact on the DO of the water bodies. The oscillation of DO level has a far reaching impact on the biotic community and for EKW this variation is of prime importance due to presence of some 264 sewage fed fisheries. Hence, a long term base line data of DO is essential to evaluate the water quality of this important Ramsar Site.

II. MATERIALS AND METHODS

A. Study area and Sampling

The analysis of DO was carried out in the Godrej water side (22^0 34′18.3″N and 88^0 26′ 22.9″ E) of EKW. For each observation, at least 5 surface water samples were collected from the study site, around 12'O clock in the noon. Glass bottles of 125 ml were filled to overflow the collected water samples and Winkler titration was performed for the determination of DO [1]. The sampling method did not change since 1984.

B. Water Quality Index (WQI) estimation

The water quality was evaluated for the Godrej water side using a web based formula downloaded from *http://www.fivecreeks.org/monitor/DO.html* [2]. This index was computed using the average seasonal temperature, DO and water level.

III. RESULTS

The temporal variation of DO in the study site exhibits a unique seasonal variation with highest value during monsoon (5.16 ppm) followed by postmonsoon (4.81 ppm) and premonsoon (4.53 ppm) (**Figures 1, 2 and 3**).

These values are the average of 3 decades (1984 – 2015). The sudden rise of the DO level during premonsoon 2009 may be related to Aila, which was a super cyclone that passed though the area on 25th May 2009 with a speed of 110 Km/hr.

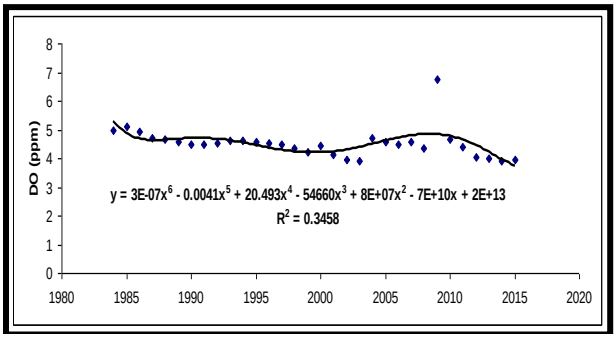

Figure 1: Temporal variation of DO level in the sampling site during premonsoon

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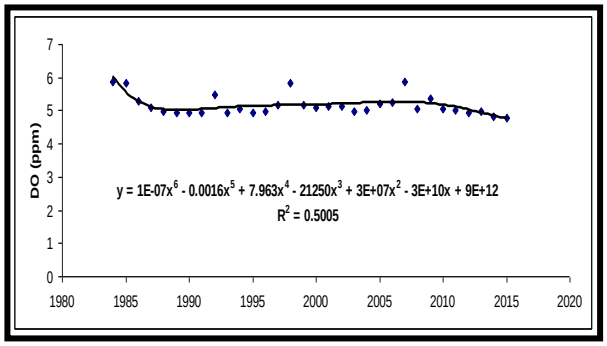

Figure 2: Temporal variation of DO level in the sampling site during monsoon

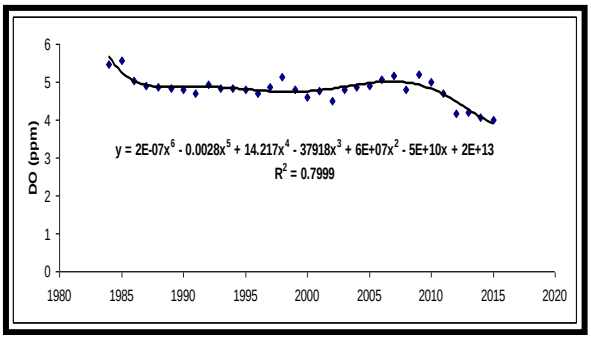

Figure 3: Temporal variation of DO level in the sampling site during postmonsoon

The WQI exhibits a gradual decrease with time except during premonsoon 2009, when the diffusion of oxygen was maximum due to the turbulence caused in the wetlands by the super cyclone (**Figure 4 and Table 1**). Similar observations on the sudden hike of DO due to cyclonic depression were observed by several researchers [3, 4, 5, 6, 7, 8, 9 and 10] in the present geographical locale.

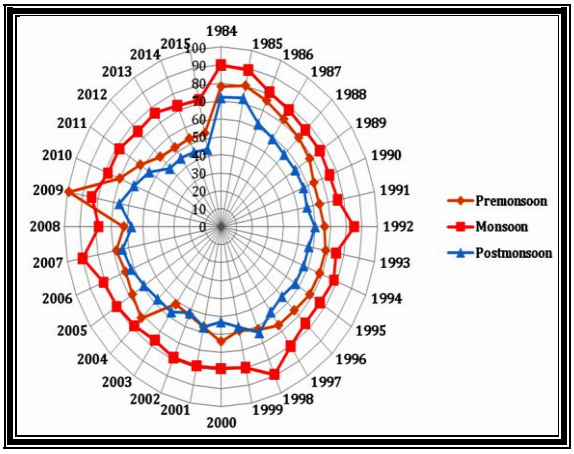

Figure 4: WQI in the sampling site based on DO data of 3 decades (1984-2015)

Table 1: Seasonal variations WQI values during 1984 – 2015

Year	Premonsoon	Monsoon	Postmonsoon
1984	78	90	72
1985	80	89	73
1986	76	81	62
1987	72	78	59
1988	70	76	57
1989	68	76	57
1990	64	75	57
1991	64	76	56
1992	66	85	60
1993	68	75	57
1994	68	78	57
1995	68	76	57
1996	66	76	55
1997	66	80	57
1998	62	89	64
1999	59	80	57
2000	64	79	53
2001	57	79	57
2002	53	79	52
2003	52	76	57
2004	72	78	57
2005	68	80	59
2006	66	81	62
2007	68	90	64
2008	62	78	57
2009	99	84	66
2010	70	78	60
2011	62	78	55
2012	55	75	46
2013	53	76	46
2014	53	73	45
2015	53	72	44

IV. DISCUSSION

The present sampling site receives the urban wastes from the city of Kolkata and is presently treated for dumping the constructional wastes adjacent to the wetland. It is observed that the DO level in the present study area has decreased by 20.6 %, 18.37 % and 27.19 % during premonsoon, monsoon and postmonsoon respectively, which is equivalent to a decrease of 0.033 ppm/yr in premonsoon, 0.034 ppm/yr in monsoon and 0.048 ppm/yr in postmonsoon.

The average WQI in the study site is 65.69, 79.25 and 57.41 during premonsoon, monsoon and postmonsoon respectively. These are the average values for the entire period of investigation. Such pronounced temporal variation in WQI may be attributed to the degree of anthropogenic stress in and around the study site that has amplified greatly in recent times. The relatively higher mean value of WQI during monsoon may be attributed to increase of fresh water load in the system due to precipitation and subsequent run-off from the adjacent land masses.

The Kolkata Municipal Corporation (KMC) generates around 600 million litres of sewage per day. The waste water is led to the pumping stations by underground sewers and pumped into open channels. There are six terminal pumping stations in KMC area which are used for pumping the wastewater into the open channel, which is then fed into the fisheries of EKW, where detention leads

to biodegradation of the organic compounds in the sewage and waste water. Organic loading rate in the ponds ranges between 20-70 Kg per hectare per day (in form of BOD). The cumulative effects of all these activities in the present study site have resulted in the gradual lowering of DO and deterioration of WQI with the passage of time. The present three decadal observation is a warning signal for the aquatic biodiversity of the area. Arresting the organic wastes at point sources or recycling the same at the origin is of utmost importance to keep the EKW sustainable and healthy.

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