

Decadal Variation of Major Nutrients in the Aquatic Phase of East Kolkata Wetlands

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ABSTRACT: Considering the three decade data bank of nitrate, phosphate and silicate, we attempt to evaluate the temporal trend of these nutrients in an aquatic system of East Kolkata Wetlands (EKW). The trend for nitrate is uniform throughout the observation periods as revealed from the R^2 values (0.8726 during premonsoon, 0.9055 during monsoon and 0.9356 during postmonsoon). In case of phosphate, exception was observed during premonsoon, which may be attributed to AILA, a super cyclone that hit the area during May 25, 2009. The temporal trend of silicate does not exhibit any uniformity as revealed from the R^2 values.

KEYWORDS: East Kolkata Wetlands (EKW), Dissolved Nitrate, Dissolved Phosphate, Dissolved Silicate, Trend line analysis.

I. INTRODUCTION

Wetlands throughout the globe are facing a variety of adverse impact affecting both the biotic community of the ecosystem as well as the human health depending on this biotic community. The sewage enriched waste water discharge and disposal practices often cause introduction of high nutrient load, hazardous chemicals and pathogen causing diseases. The present study area where waste water of industrial and domestic origin flows through Dry Weather Flow (DWF) and Storm Weather Flow (SWF) canals has been contaminated to a great extent due to unplanned urban development in and around the city of Kolkata. The adverse public health, environmental, socio-economic, food quality, security and aesthetic impact from sewage contamination in coastal areas are well documented [1, 2, 3, 4, 5, 6, 7]. However, not much report are available on the long-term data bank of nutrient like nitrate, phosphate and silicate in the EKW, which is a Ramsar Site and therefore an area of international importance. The present paper is an attempt to evaluate the temporal variation of nutrients in the Munshir Bheri of EKW. An important output of the present work is the characterization of pond water which is strongly under the influence of urban pollution from the city of Kolkata. The deterioration of the water quality due to untreated waste water may cause nutrient overloading, which may have irreparable loss of pond ecosystem in terms of poor fish yield, loss of biodiversity and inefficient nutrient cycling [8].

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II. MATERIALS AND METHODS

A. Study area and Sampling

The analysis of nutrients was carried out in the Munshir Bheri (22° 34' 18.3" N and 88° 26' 22.9" E) of EKW. For each observation, at least 5 samples were collected from the study site, around 12'0 clock in the noon. This replication is a representation of the quality of the data.

B. Nutrient analysis

Surface water samples collected for nutrient analysis were filtered through a 0.45 µm polycarbonate filters (Millipore 47 mm diameter) and then deep frozen for further analysis in the laboratory. The standard spectrophotometric method [9] was adopted to determine the nutrient concentrations in surface water. Nitrate was analyzed by reducing it to nitrite by means of passing the sample with ammonium chloride buffer through a glass column packed with amalgamated cadmium filings and finally treating the solution with sulphanilamide. The resultant diazonium ion was coupled with N – 1 - naphyl ethylene diamine to give an intensely pink azo dye. Estimation of the phosphate was carried out by treatment of an aliquot of the sample with an acidic molybdate reagent containing ascorbic acid and a small proportion of potassium antimony tartarate. Dissolved silicate was analyzed by treating the sample with acidic molybdate reagent. The resultant silico-molybdic acid was reduced to molybdenum blue complex by ascorbic acid and incorporating oxalic acid prevented formation of similar blue complex by phosphate.

C. Statistical analysis

Trend line analysis was performed for each of the three selected nutrients separately for three seasons to evaluate the uniformity of their oscillation. R² values were used to understand the level of significance of the linear trend line equations

III. RESULTS

A. Dissolved nitrate

Dissolved nitrate concentrations ranged from 24.17 µg at l⁻¹ (during premonsoon in 1984) to 55.89 µg at l⁻¹ (during monsoon in 2015). The trend line analysis reflects the equation to be $y = 0.7164x - 1396.6$ (R² = 0.8726), $y = 0.6637x - 1288.5$ (R² = 0.9055) and $y = 0.6236x - 1209.3$ (R² = 0.9356) during premonsoon, monsoon and postmonsoon respectively. Figure 1, 2, and 3 represents the trend lines for nitrate during premonsoon, monsoon and postmonsoon respectively. During premonsoon the dissolved nitrate exhibited an uniform trend, except during 2009, which is due to Aila that hit the study area during May 25, 2009 (Fig. 1).

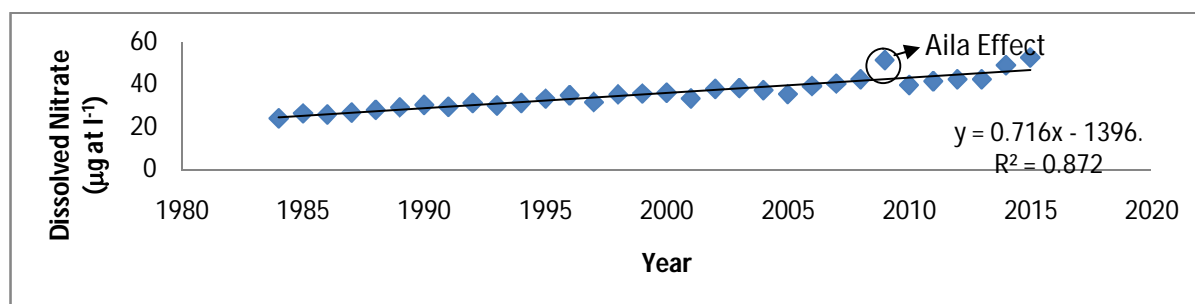


Fig.1 Trend line equation of dissolved nitrate during premonsoon

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The picture during monsoon is uniform with respect to dissolved nitrate as observed from the trend line pattern in Fig. 2.

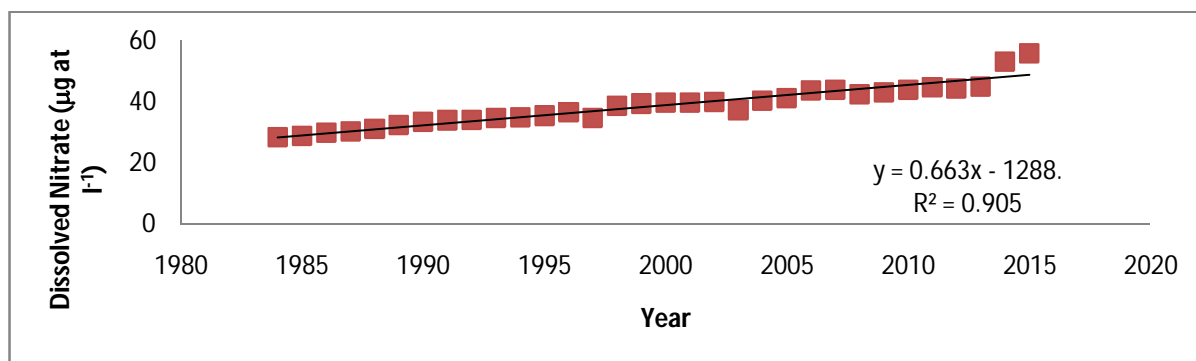


Fig.2 Trend line equation of dissolved nitrate during monsoon

The postmonsoon season in the study area is calm with limited discharge of waste water due to absence of monsoonal runoff and hence an uniformity is observed in the trend line pattern of nitrate (Fig. 3).

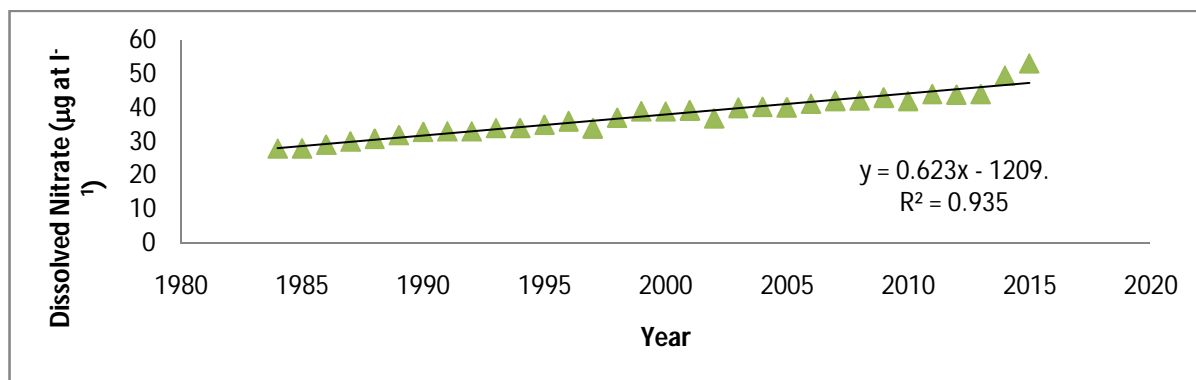


Fig.3 Trend line equation of dissolved nitrate during postmonsoon

B. Dissolved phosphate

Concentrations of dissolved phosphate ranged from 2.51 µg at l⁻¹ (during premonsoon in 1984) to 6.73 µg at l⁻¹ (during monsoon in 2015). The trend line analysis reflects the equation to be $y = 0.0563x - 109.17$ ($R^2 = 0.366$) during premonsoon, $y = 0.0712x - 137.98$ ($R^2 = 0.8276$) during monsoon and $y = 0.0608x - 118.22$ ($R^2 = 0.8343$) during postmonsoon (Figure 4, 5 and 6).

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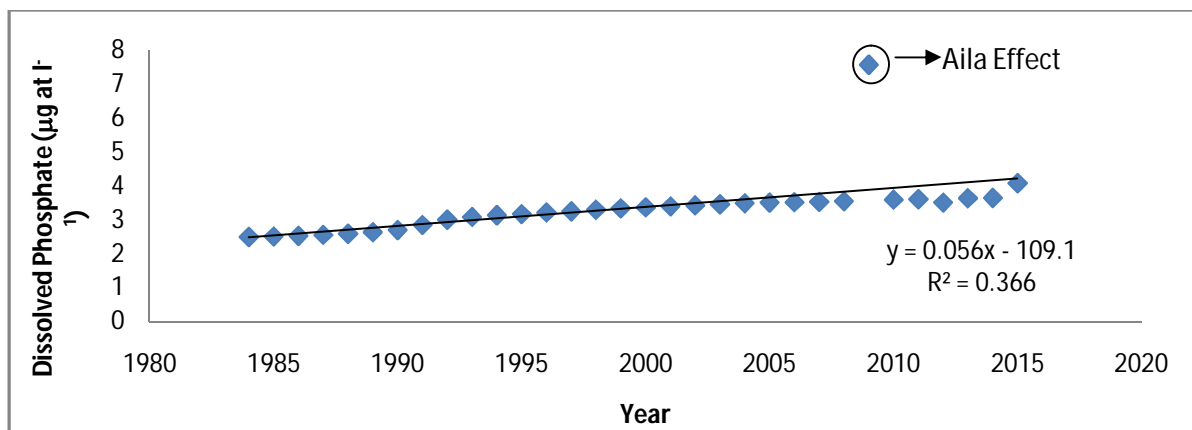


Fig.4 Trend line equation of dissolved phosphate during premonsoon

Unlike the phosphate level in premonsoon (Fig. 4), the trend line pattern during monsoon and postmonsoon are extremely uniform in nature as there was no perturbation due to natural disaster like Aila (Fig. 5 and 6).

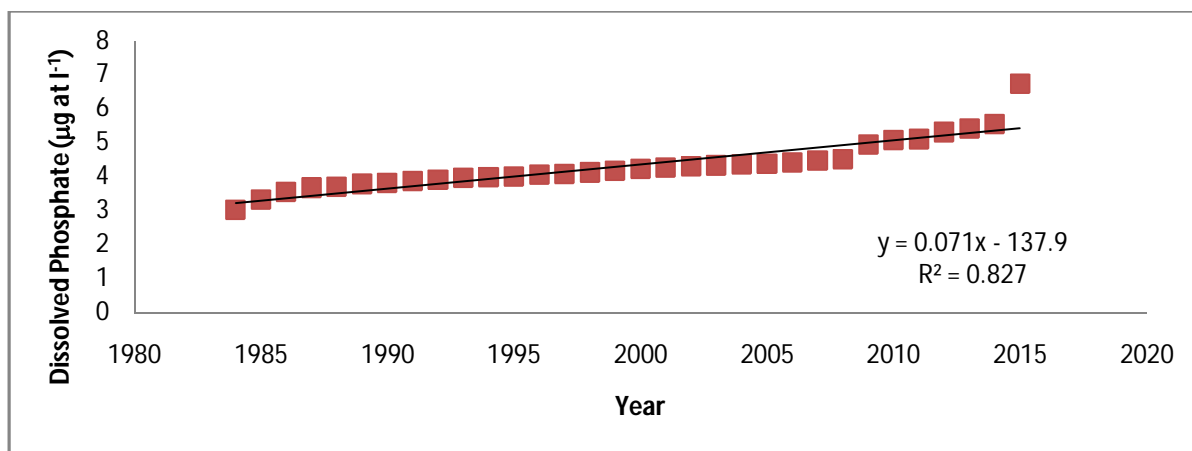


Fig.5 Trend line equation of dissolved phosphate during monsoon

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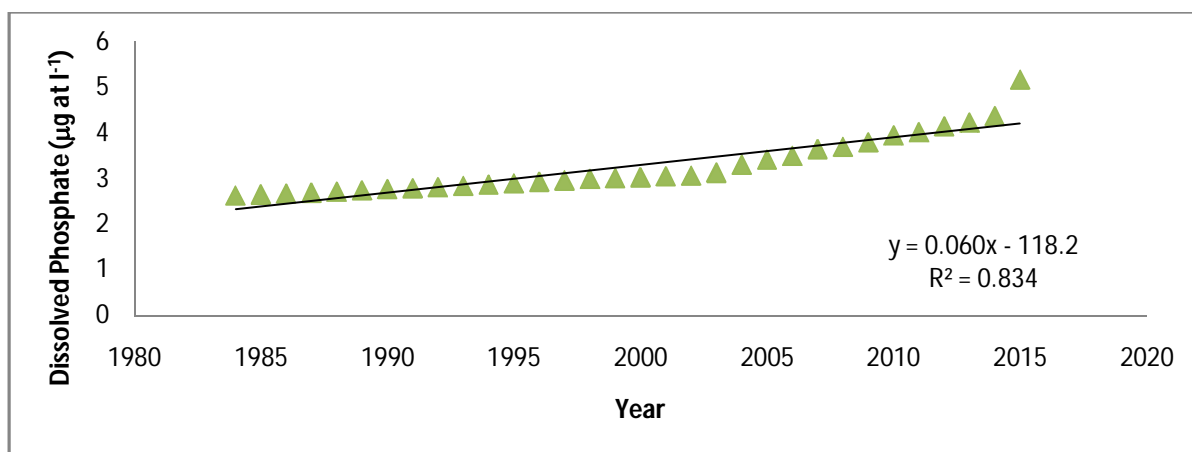


Fig.6 Trend line equation of dissolved phosphate during postmonsoon

C. Dissolved silicate

Dissolved silicate concentrations ranged from 71.98 µg at l⁻¹ (during premonsoon in 1984) to 95 µg at l⁻¹ (during monsoon in 1984). The trend line analysis reflects the equation to be $y = 0.0923x - 106.21$ ($R^2 = 0.0069$), $y = 0.2399x - 389.5$ ($R^2 = 0.102$) and $y = 0.1978x - 310.19$ ($R^2 = 0.0488$) during premonsoon, monsoon and postmonsoon respectively (Figure 7, 8 and 9). The oscillation of silicate in the aquatic phase is the result of churning action of the water column, which is again a function of weather condition. Windy days are frequent in the study site throughout the year. This causes ripples and small wave forms that churn the water mass resulting in the oscillation of dissolved silicate level. The least R^2 value during premonsoon is the Aila effect in the study area (Fig. 7).

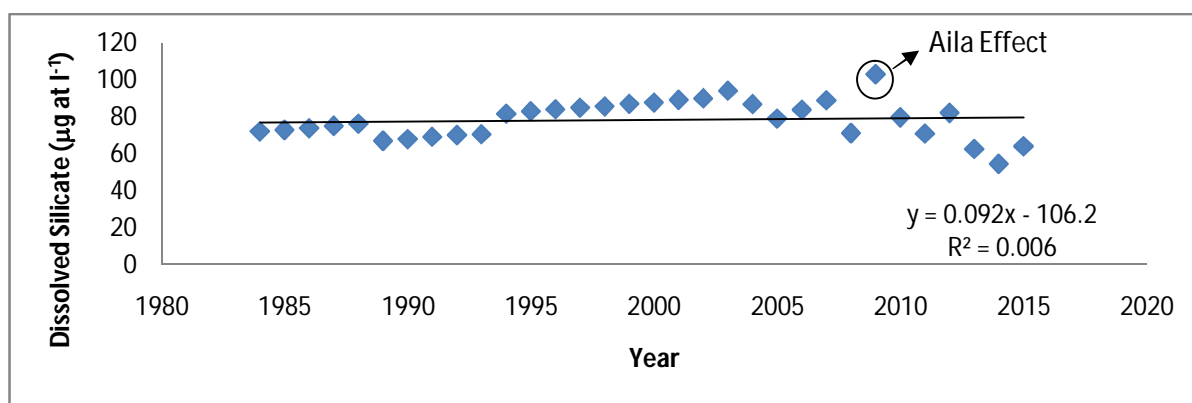


Fig.7 Trend line equation of dissolved silicate during premonsoon

The monsoon season is characterized by frequent wind actions that churn the bottom sediment with no definite pattern. This reflected through non-uniform trend line picture during monsoon in the study area (Fig. 8).

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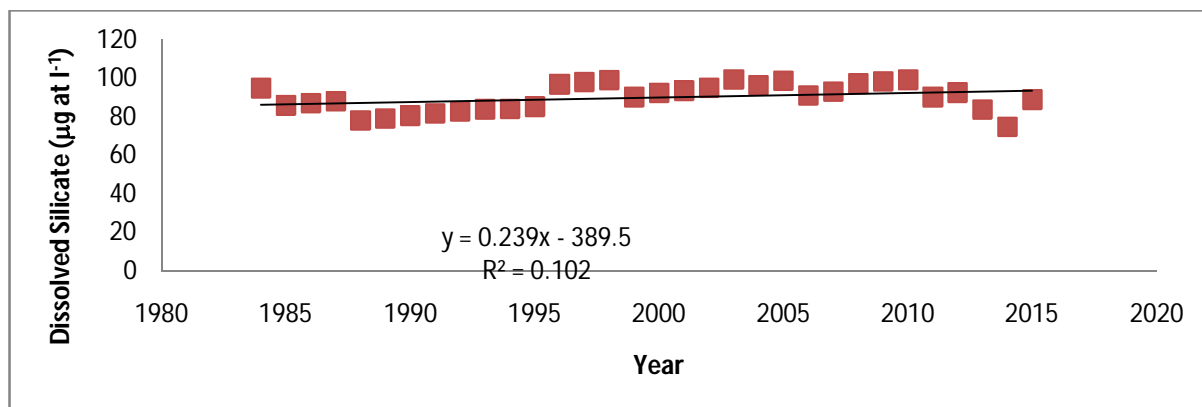


Fig.8 Trend line equation of dissolved silicate during monsoon

Silicate is not a major ingredient of waste water and its level is often controlled by biological processes like phytoplankton bloom, etc. The trend of silicate during postmonsoon (Fig. 9) with insignificant R^2 value may be the effect of this biological activities in the aquatic phase of the study site, which has not been studied in the present research programme.

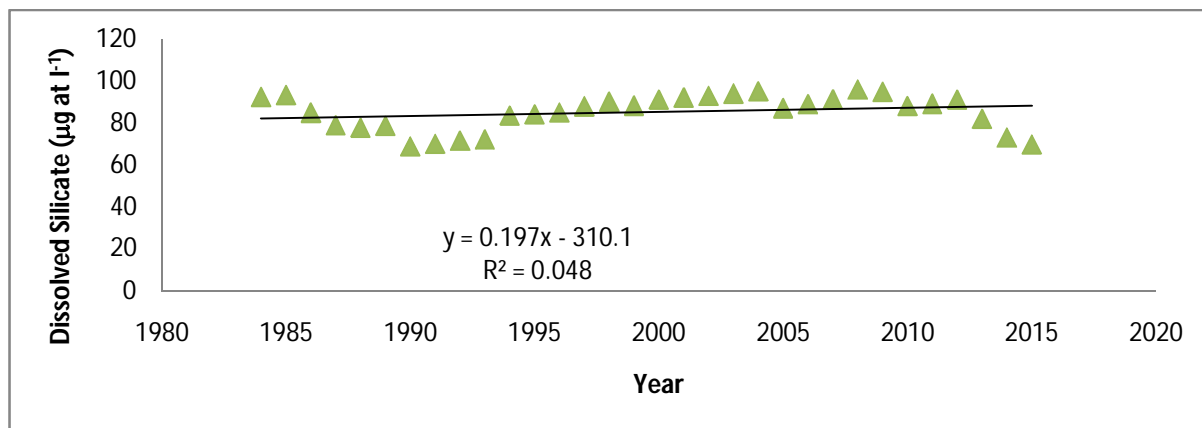


Fig.9 Trend line equation of dissolved silicate during postmonsoon

IV. DISCUSSION

The Kolkata Municipal Corporation area generates roughly 600 million litres of sewage and waste water every day and more than 2500 metric tonnes of garbage [10]. This is the primary source of nitrate and phosphate in the aquatic phase of EKW. Silicate originates in the system mainly from the soil.

A major portion of these nutrients is used up to promote the practices of sewage fed pisciculture and agriculture [11]. The surrounding areas of EKW have undergone a major change since the last few decades due to rapid pace of urbanization. This has altered the nutrient profile of the area and sometimes the carrying capacity of the sewage fed fisheries is also exceeded. Many industrial units have also been setup adjacent to the DWF and SWF canals which acts as the conveyor belt for transferring the waste materials from the city of Kolkata to

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Bidhyadhari River site. All these activities have made the EKW as one of the most threatened ecosystem in terms of water quality.

The present study clearly reflects the gradual increment of nitrate and phosphate in the aquatic phase of the selected sampling station which may be attributed to increase of municipal wastes and agricultural runoff. The trend line pattern of silicate is not uniform. The main sources of dissolved silicate in surface waters are chemical weathering of mineral silicates, the interactions of the hydrological cycles with soils, biological uptake and dissolution on land and in surface waters [12, 13, 14, 15]. The phytoplankton preferably diatoms use silicate to build their frustules [14, 16], consequently generating a pronounced temporal variation in dissolved silicate values. The non-significant R^2 values support the non uniform trend line of dissolved silicate in the study site. The present study also reflects an interesting finding related to natural disaster. The super cyclone AILA, that hit the lower Gangetic delta during 25th May 2009, significantly increased the level of nitrate, phosphate and silicate in the present study site. It can thus be concluded that, development of simulation model using long term data on environmental variables requires the input of natural disaster. It can also be concluded from the present study that there is an increasing trend of nitrate and phosphate level in the study site which may lead to cross the threshold level of these nutrients in the aquatic ecosystem of this important Ramsar site. Thus, control of waste generation at the point sources and recycling of the nutrients through pisciculture and agricultural activities may serve to suppress the increasing trend of nitrate and phosphate in the present geographical locale.

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BIOGRAPHY



Mr. Atanu Roy is currently Research Scholar in the Department of Biotechnology, Techno India University. He has publications in International journals of good repute and has attended several National and International seminars. Mr. Roy has experience in teaching subjects like Microbiology and Molecular Biology and was honoured with the Young Scientist Award in 2014 by the Centre for Ocean and Environmental Studies (COES), New Delhi, India. He is credited with 4 scientific publications. His present interest is studying the nutrients, water quality and phytoplanktons of East Kolkata Wetlands. He has also interests in bioremediation of heavy metals.



Ms. Anuradha Banerjee is a post-graduate student from the Department of Biotechnology, Techno India University. She is one of the meritorious students of her class and has tremendous interest in research work. She has attended several conferences and presented posters. She has done training on phosphate solubilising bacteria from Bidhan Chandra Krishi Viswavidyalaya (BCKV).



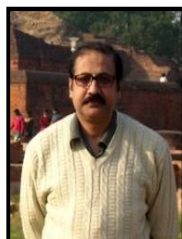
Ms. Rima Roy is a post-graduate student from the Department of Microbiology, Techno India University. Being a student of microbiology she has keen interest in micrographic study of microorganisms. She is also well versed with Microsoft office. Ms. Roy has presented posters in several science meets and has done training from Department of Microbiology, R. G. Kar hospital, Kolkata and from Central Institute of Fisheries Education, Saltlake, Kolkata.



Prof. (Dr.) Sujoy Biswas is a Chartered Engineer and is currently the Director & Chief Executive Officer of Techno India University and Techno India Group and also Professor in the Department of Civil Engineering in Techno India University. Dr. Biswas secured first position in his MBA examination and received the gold medal from Indian Institute of Social Welfare and Business Management under Calcutta University.



Dr. Madhumita Roy, M.Sc, PhD, is the assistant professor of Biotechnology Department of Techno India University. She has various research publications on different fields of Environmental Biotechnology and Environmental Microbiology. She is especially interested in bioremediation and biodegradation of different xenobiotic compounds.



Dr. Abhijit Mitra, Associate Professor and former Head, Dept. of Marine Science, University of Calcutta (INDIA) has been active in the sphere of Oceanography since 1985. He is a Gold Medalist in Marine Science (M.Sc.) and obtained his Ph. D as NET qualified scholar in 1994. Dr. Mitra is credited to have about 350 scientific publications in various National and International journals, and 28 books of postgraduate standards. Dr. Mitra also successfully guided 24 Ph.D students. Presently his research areas include environmental science, mangrove ecology, sustainable aquaculture, alternative livelihood, climate change and carbon sequestration.