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LIMNOLOGICAL STUDIES RELATED TO PHYSICO-CHEMICAL CHARACTERISTICS OF MAYA SAROVAR (BODHGAYA POND) AT BODHGAYA, BIHAR, INDIA

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Abstract: - The present study deals with the seasonal limnological investigation related to physico-chemical characteristics of water of the Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India. Besides temperature and meteorological data, 11 limnological parameters were tested following standard methods at 5 sampling sites/stations of the lake. The physico-chemical parameters (pH, DO, BOD, HCO3, TDS, Chloride, Nitrate, TH, Ca, Mg and SO4 etc.) showed distinct variation in thesites. Keywords: Limnology, Physico-chemical parameters, Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India

Key Words :- Limnological, physico-chemical, Maya Sarovar (Bodhgaya Pond).

INTRODUCTION :- Wetland i.e., lakes, jheels, beels etc., have a variety of linkages for energy and nutrient exchange with surrounding watersheds and air sheds. The inland freshwater ecosystem both lentic and lotic, are being increasingly subjected to greater stress form various human activities (Wood and Gibson, 1974; Hemasundaram, 2003). The eutrophication of water means enrichment with nutrients and the resulting degradation of its quality accompanied by luxuriant growth of micro and macrophytes are recognized as a major problem in the developed as well as in developing countries. The enrichment of nutrients occurs due to the disposal of domestic and farm sewage, industrial effluents and from the runoff from surrounding areas. Vollenweider (1968) pointed out that the domestic sewage is a major source of eutrophication. With the constantly increasing eutrophication of surface waters more and more attention is being paid to investigations of the bottom sediments of wetlands (Kajak, 1979; Golterman and Qude, 1991; Freeman et al., 1993; Clair et al., 1996; Dortch, 1996; Craft, 1997; Ansari and Kumar, 2003). Although considerable investigations have been made by the researchers but a little information is known about the systematic limnological studies in Magadh University, Bodhgaya it is important to note that no qualitative, quantitative or ecological study on limnology was made so far from Maya Sarovar (Bodhgaya Pond). Maya Sarovar (Bodhgaya Pond) has received various types of sewage i.e., domestic sewage, cattle waste etc. Hence an attempt into the limnological investigation in relation to the different physicochemical characteristics of water of thewas taken up in the present investigation. Information about Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India : The Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar,India is situated in the heart of the city . The northern and southern boundaries are flanked by roads. Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar,India exists from many many decades. Since from early days thisis used for cattle rearing, for bathing, for fishing, and also women used to wash their household cloths. After few decades, the municipal administration joined the sewage drains from Ward A of Bodhgaya Nagar Panchayat . That's the point from which the got polluted & silted up. Incidences of fish kill happened 2 to 3 times. Very recently the City administration has taken up steps to added fresh water in it, apart from that they also constructed stone lining/pitching & fencing throughout the periphery of the lake. Now it is well protected from animals and anthropogenic hindrances. It is now being used for contractual recreational boating only.

MATERIALS AND METHODS: - Study Area: Bodhgayais a block head quarter of And also HQ and Campus of Magadh University, State University . It is situated on Delhi - Gaya – Kolkata Section of the Eastern Central Railway and is at a distance of110 Kms. from the capital of Bihar, the Patna. It is sufficiently developed in the field of education commerce,agriculture and industries. There are many educational institutes including Medical, Engineering, Arts, Science and Commerce Colleges. The city has all India Radio Broadcasting station and Television transmitting center. Bodhgaya is also a pilgrimage place of two religious centers and belongs from Budhism and also called the land of enlightment. The city is situated at latitude of 24°20' and longitude of 23°50'. It has a general slope of North-West to South-East. The town lies between the contours 1570m and 1460m and the average elevation above the mean sea level is about 458m. The ground level varies from 488m to 420m. Bodhgaya falls under one of the hottest regions. The climate is usually warm during most of the year. The maximum temperature in summer is 46°C during April to August and minimum temperature is 10°C during January average temperature is 36°C. The winds are generally light and moderate with some increase in force during the latter part of summer and monsoon. The rainy seasons occurs during June to October following by winter season from November to January. The average annual rainfall is 691.7mm. The mean annual maximum humidity observed in the morning is 60% and minimum in the evening is 40%. Geologically the area is composed of Deccan traps of tertiary period and shale and lime stones in Niranjana series. Deccan traps occupy ¾ of the area as horizontal flows of Basaltic lava. Different varieties of traps are present in the study area, (1) Hard massive trap (2) Jointed weathered trap (3) Zeolitic trap. The weathering of trap varies from place to place depending on the elevation. In a few places in between two trap flows bole beds (Inter trappings) are present, these are good aquifers. The jointed Zeolitic and weathered trap also act as good aquifers in the area. The location map of Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India.. The physico-chemical characteristics are analysed as per standard procedural methods. For statistical analysis viz., Correlation coefficients and Factor analysis MINITAB software is utilised. Correlation Coefficients (r): The degree of relationship between the variables is measured through the correlation analysis. The measure of correlation is called correlation coefficient, represented by symbol . The Karl Pearson's formula is Factor Analysis: Factor analysis is a very powerful technique which provides information on the meaningful parameters which describe the whole data set rendering data reduction with minimum loss of information . FA is a quantification of the significance of variables that explain the observed grouping and patterns of the inherit properties of the individual objects . FA allows the explaining of related parameters by only one factor . FA exposes the important factor responsible for variation in ground water quality and eventually leads to sources identification of ground water pollution. In this study, FA was applied to extract the most significant factors and to reduce the contribution of less significant variables to simplify even more of the data structure coming from factor analysis. The factors obtained were further subjected to varimax rotation according to well established rules to maximize differences between the variables and facilitate easy interpretation of the data . The rotating axis defined by factor analysis generates varimax factor which can further reduce the contribution of variable with minor significance. The classification of the factor loading as 'strong', 'moderate' and 'week' corresponds to absolute loading of > 0.75, 0.75-0.50 and 0.50-0.30, respectively (Liu. C.W. et. al,). Figure1: Location Map of Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar,India

RESULTS AND DISCUSSIONS :- The physico-chemical characteristics are analysed for all the sampling points and are presented in the table 1 to table5. Correlation coefficients are worked out for individual samples and are presented in the table 6 to table 10. Factor analysis also worked out for all the individual samples and is presented in table 11 to table 15. pH: Hydrogen Ion Concentration, DO: Dissolved Oxygen in mg/L, BOD: Bio-chemical Oxygen Demand in mg/L, TDS: Total Dissolved Solids in mg/L, TH: Total Hardness in mg/L, Ca: Calcium Hardness in mg/L, Mg: Magnesium Hardness in mg/L, NO3: Nitrate in mg/L, SO4: Sulphate in mg/L, Cl: Chloride in mg/L, Max: Maximum value, Min: Minimum value, SD: Standard deviation57 Correlation Coefficients (r): In all the sampling points, the highest positive correlation is found between Total dissolved solids & Alkalinity (TDS & HCO3), Chloride & Alkalinity (Cl & HCO3), Nitrate & Dissolved Oxygen (NO3 & DO), Sulphate & Dissolved Oxygen (SO4 & DO), Total hardness & Total dissolved solids (TH & TDS), Magnesium hardness & Total dissolved solids (Mg & TDS), Chloride & Total dissolved solids (Cl & TDS), Chloride & Total hardness (Cl & TH), Calcium hardness & Chloride (Ca & Cl), Magnesium hardness & Chloride (Mg & Cl), Nitrate & Chloride (NO3 & Cl), Nitrate & Sulphate (NO3 & SO4). Factor Analysis: In all the sampling points, almost following factor1 and factor2 gave the loadings. Factor 1: (1) Strong loading: It suggests that the quality of ground water is mainly controlled by strong loading parameters. The Strong loading on TH, Mg & Ca shows the permanent hardness of water. Alkalinity, Cl also suggests the hardness of water. High TDS shows that wash water from the water treatment are being added up in the fresh water of lake. Moderate loading: No loading at all. Weak loading: No loading at all. Factor Strong loading: Strong loading on DO suggests that water is being aerated in water treatment units of Magadh . NO3, & SO4 shows mild pollution and inherited quality of river water Moderate loading: Loading of Cl also indicates pollution & permanent hardness of water.

CONCLUSIONS :-The Physico-chemical characteristics are high at North-West corner (S1) where as South-East corner (S2), Centre (S3), and North-East corner (S4) are moderate & the South-West corner (S5) are low. Since receiving fresh cum treated water from Niranjana River, the water quality is good. All anthropogenic activities are barred in the water viz., bathing, swimming, Cattle's washing etc., since the well protected by pitching and fencing. The Physico-chemical Characteristics of Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India at different sampling points were analyzed and found all the values within the permissible limits except BOD which may be because of wash water from treatment unit. The pH in Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India is in between 7.45 to 8.77. The DO in Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India varies from 7.35 to 8.65 mg/L. The BOD in Maya Sarovar (Bodhgaya Pond) at Bodhgaya, Bihar, India varies from 96.65 to 113.70 mg/L. Factor analysis at all the sampling points has shown that DO is rich in water, NO3 and SO4 are present in the water is an inherent quality of Niranjana river water. Factor analysis for sampling points shown moderate high value in chloride, which shows permanent hardness of water. In all the sampling points, the highest positive correlation is found between Chloride & Alkalinity (Cl & HCO3), Chloride & Total hardness (Cl & TH), Calcium hardness & Chloride (Ca & Cl), Magnesium hardness & Chloride (Mg & Cl), Nitrate & Chloride (NO3 & Cl), Nitrate & Sulphate (NO3 & SO4) this shows the permanent hardness of water. Maya Sarovar

(Bodhgaya Pond) at Bodhgaya, Bihar, India is now being utilized only for boating, even fishing activities as been stopped by authorities..

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