

Impact of Anthropogenic Activities on the Hydro Biogeochemistry of lake *Taal Ratoi* a Fresh Water Lake

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Article Info

Volume 9, Issue 1

Page Number : 293-299

Publication Issue

January-February-2022

Article History

Accepted : 15 Feb 2022

Published : 21 Feb 2022

ABSTRACT

A fresh water lake the *Taal Ratoi* was chosen for present study situated near Fatehpur Mandaon village of Mau district in Eastern Uttar Pradesh. This lake is having an area of 1837 hectare and connected with River Ghaghara. Being a shallow water lake its hydro biogeochemistry was greatly affected by anthropogenic activities which include discharge of domestic waste, agricultural runoff, fisheries, boating, urbanization and use of recalcitrant materials. This results into eutrophication, acidification, siltation, and toxic contamination of the lake. For the present study physico-chemical properties of water analyzed from June to April 2019-2021 at ten sampling stations along the littoral and catchment area of lake. The statistical analysis of data revealed that the lake was eutrophic and the surface water contains high concentration of Nitrate 5.10mg/L and Phosphate 2.98mg/L. The mean value of pH 8.43, Electric conductivity 203.58 μ s/cm, Total Dissolve Solids 94.51mg/L, Dissolve oxygen 12.81mg/L, Salinity 212.74mg/L, and Total Dissolve Carbon 9.55mg/L were also analyzed. There were a positive correlation matrix found in between all physico-chemical parameters while a negative correlation was found between pH and Dissolve Oxygen. In this study a significant impact of anthropogenic activities were observed. It was found that the selected lake is being polluted and anoxic because the high anthropogenic activities such as fisheries and agricultural activities are taking place in the area. It was also found that littoral zone of the lake is total covered with the species *Eichhornia crassipes* and catchment area with *Hydrilla verticillata* and *Potamogeton crispus* [5].

Keywords- Anthropogenic activities, Fresh Water Lake, Eutrophication, Ecology, Littoral zone, Catchment area, Correlation matrix

I. INTRODUCTION

The lake *Taal Ratoi* is a shallow fresh water lake connected with River Ghaghara and land mass spread over in its catchment area inhabiting a population of

about twenty five thousand people which influence the lake. Up to 1950s the water of this lake was very clean and was the only major source of fresh water of the area for agricultural and domestic circulation [5]. Now this lake was grossly polluted due to use of

recalcitrant materials, recent year urbanization, agricultural runoff and discharge of domestic sewage. As a result its water quality has been changed. Therefore, present study was carried out to assess the physico-chemical properties of water which are under stress of anthropogenic activities.

A. Physico-chemical properties- A great number of anthropogenic activities that have a negative impact on water quality and ecological state of the fresh water ecosystem [14]. These anthropogenic activities are discharge of domestic waste, agricultural activities, fisheries, urbanization, boating and use of recalcitrant materials which are the main cause of poor water quality in rivers, lakes, and wetland [2]. As the population and development of economy increases the anthropogenic activities progressively increases [24]. Agriculture and urban activities are major source of Phosphorous and Nitrogen in the aquatic ecosystem [3]. Nitrogen loads are likely to increase through population growth, expanded land development and increased agriculture [10]. Nitrate concentration indicates the level of micronutrients which support growth of phytoplankton [16] and organic load of water and bottom sediments release Phosphate content which help in growth of weeds [17]. In spite of this household detergent, domestic sewage, leaching of phosphate fertilizers also increases the level of phosphate. The lake ecosystems have been greatly affected in the recent years due to horrific development of industries and agriculture [22]. Due to increased industrial and agricultural activities surface and ground water being contaminated. This contaminated water contains large number of chemical elements [7] which influence characteristic of water body. As a result change in the quality of water influencing the biota [21]. Due to more deposition of domestic sewage dissolve oxygen fluctuated in lake [11] and it is an important indicator of ability of a water body to support aquatic life. Chemical fertilizers, pesticides, herbicides, insecticides and improper disposal of

sewage are source of major pollutants which cause to change the water quality. The productivity of water body determine by their physico-chemical parameters and change in this aspect, a water body bring about a corresponding change in the relative composition and abundance of the aquatic organisms [1]. Lakes in highly populated or intensively cultivated areas have experienced high nutrient loading, resulting in turbid water and loss of biodiversity [23]. Where lakes and reservoirs are used for drinking water purposes, eutrophication and the development of undesired phytoplankton blooms may create huge problems [4]. Sewages loading have markedly negative impacts on biota and Oxygen levels and have constituted a major problem in many parts of the world [8]. Sediment composition and structure of water body may also affected by shoreline development [13]. Large effort has been made to reduce the external loading of nutrients, such as Phosphorus and Nitrogen which is the main factor controlling primary productivity of lakes [6]. Most of the lake of urban and rural area became hypereutrophic due to the heavy population density and blusterous human activities. As the population density increases the reclamation of lake for agriculture increases. It brings few economical benefits but the morphology and function of lake changed. The health of a lake ecosystem directly or indirectly related to the each component of the ecosystem [18]. The lake *Taal Ratoi* remain connected with river Ghaghara throughout the year which allow the free mixing of stagnant and flowing water, therefore exhibit physico-chemical and biological characteristic which support flora and fauna [9]. The objective of the present study is to find out the impact of anthropogenic activities on hydro biogeochemistry of lake. This study would certainly be helpful for coming researchers to assess the aquatic health of water body to design a model for sustainable utilization of lake.

II. METHODS AND MATERIAL

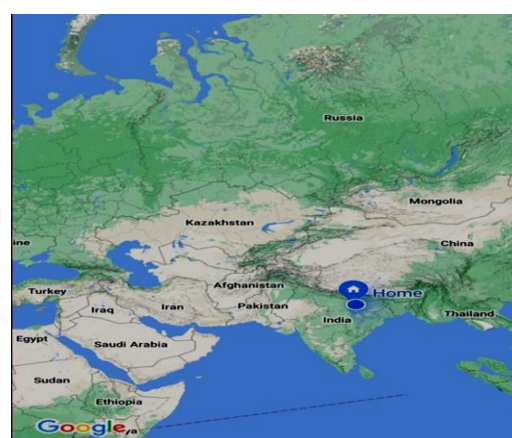
A. Study area-The *Taal Rato* is the largest shallow fresh water lake having an area of 1837 hectares and an average depth of 200 cm. It is placed near Fatehpur Mandao, a village of district Mau in Eastern Uttar Pradesh, India. The *Taal Rato* lies on North-East ($26^{\circ}09'46.6''\text{N}$ - $83^{\circ}44'16.8''\text{E}$) Coast of India and connected with River Ghaghara. Lake is influenced by monsoon, winter and summer season. The south and east basins of lake are deeper while north and west basins are comparatively shallow. The East, West and South basins are more affected through anthropogenic activities because these basins are direct interacting to the inhabitant. For analysis of the physical and chemical properties of water total ten sites were selected in the lake. An overview, location and specific site are given in Figure-1 (A) and (B).

B. Sampling and Analysis of surface water- Samples were collected from all the sites on monthly basis in 2L polyethylene bottles during morning hours from 8:30 to 12:00 noon. Before sampling all the sample bottles were washed with Laboline and distilled water. Separate samples were taken in 250 ml airtight bottles for the analysis of Dissolve Oxygen. All the samples were carried out to the laboratory settled in Botany department of Shibli National College for refrigeration. The samples were analyzed in the laboratory within 48 hours for different physico-chemical parameters through standard methods. Concentration of hydrogen ions (pH) and Electric Conductivity (EC) were analyzed on site by Hanna digital meter (HI-98107 and HI-99300), TDS in laboratory by evaporation method at 180°C (APHA). Dissolve oxygen estimated in laboratory by Winkler titration method and Salinity by Mohr-Knudsen (1856) titration method. Nitrate and Phosphate measured Spectrophotometrically using Ascorbic acid and mixed reagent at 880 nm and Carbon analyzed by Carbon Analyzer, untreated sample used for total Carbon where as H_2O_2 treated sample used for Inorganic

Carbon and the difference of both considered as Organic Carbon. For assessing the health and socio-economic status of the lake, investigations were made on monthly basis and the information was collected directly from the inhabitants.



Fig-1:(A) Overview of Taal Rato



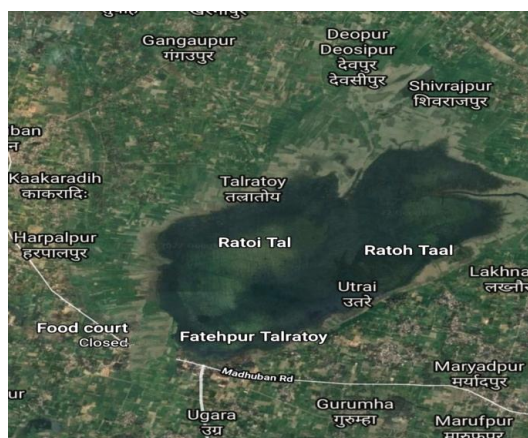


Fig-1:(B) Location and specific site of Taal Ratooi

III. RESULTS AND DISCUSSION

The *Taal Ratooi* is surrounded by many villages and about twenty five thousands of people inhabited around it. Through which lake has suffered numerous insults in the hand of man and as the results the lake is moving towards its definite end. Due to the ecological stresses from anthropogenic activities the lake is not only shrinking in surface but its water quality has deteriorated and the aquatic life is also badly affected. Large quantities of untreated sewage and garbage are received by lake from the villages as well as business establishment. Lakes usually become the recipient of waste water which severely pollutes their system and convey negative impacts on their physico-chemical parameters.

A. Effect on Physico-chemical properties- The physico-chemical properties of surface water of *Taal Ratooi* has been affected due to anthropogenic activities such as discharge of waste water, sewages and agricultural runoff. Eutrophication causes nutrient loading in water and sediments which influenced the water quality. From the present study and statistical analysis of data (Table-1) a significant changes have been found in the water chemistry. It was found that the lake is alkaline and during June to April pH value fluctuated from 7.61 to 8.97 with an average value 8.43. Maximum pH value (8.97) was

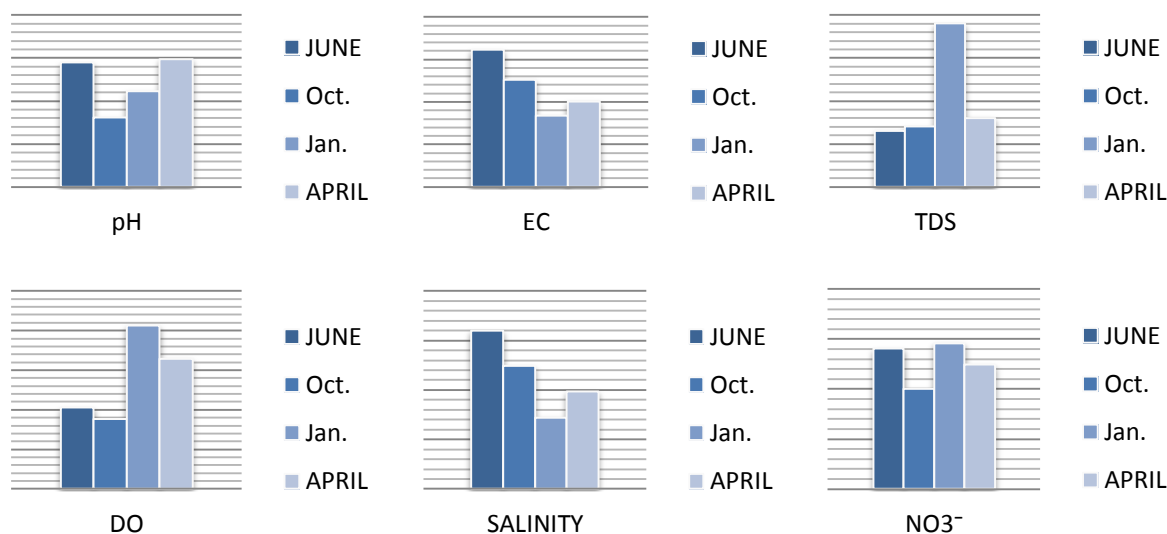
recorded in the month of April and minimum pH (7.61) in the month of October. Electric conductivity observed during June to April ranges between 196.75 to 212.23 μ s/cm. There was mean value of EC 203.58 μ s/cm while maximum Electric conductivity (212.23 μ s/cm) obtained in month of June in South and East basin of the lake whereas minimum Electric conductivity (196.75 μ s/cm) was estimated in month of January. An average value of Total dissolve solid was 94.51mg/L, ranged between 94.15 to 95.40mg/L during June to April. In month of January maximum TDS (95.40mg/L) and in June minimum TDS (94.15mg/L) was obtained. Maximum TDS was obtained at Fatehpur and Utrai sites in South-East basin of lake. Mean value of Dissolve oxygen 12.81mg/L fluctuated between 14.12 to 11.77mg/L during June to April. Maximum Dissolve Oxygen (14.12mg/L) obtained in month of January at Fatehpur site in southern basin and minimum Dissolve Oxygen (11.77mg/L) in month of October at Gangaupur site in northern basin. Salinity was estimated during June to April ranges between 204.40 to 221.95mg/L with average value 212.74mg/L. Maximum salinity (221.95mg/L) in the month of June while minimum salinity (204.40mg/L) was obtained in month of January. There was no significant change obtained in Salinity and Total Dissolve Solid (TDS). The mean value of Nitrate 5.10mg/L fluctuated between 3.99 to 5.83mg/L during month of June to April. Maximum Nitrate 5.83mg/L obtained in month of January at Fatehpur site in southern basin while minimum value of Nitrate 3.99mg/L in month of October at Doobari site in North-West basin of lake. Phosphate obtained during June to April fluctuated between 2.59 to 3.26mg/L with mean value 2.98mg/L. Maximum Phosphate 3.26mg/L was found in January at Fatehpur and Machariyahwa site in south-east basin while minimum Phosphate 2.59mg/L found in October at Gangaupur site in northern basin. Total Dissolve Carbon (Inorganic and Organic) during June to April ranged between 7.63 to 12.50mg/L with mean value 9.55mg/L. The maximum value of Total

Dissolve Carbon (12.50mg/L) analyzed in January at Fatehpur site in south basin but the minimum value (7.63mg/L) estimated in month of June at North basin of lake. There were a positive correlation matrix found in between Nitrate, Phosphate, Carbon, EC, TDS and Salinity. But a negative correlation matrix was found between pH and Dissolve Oxygen, as same correlation was also observed in Anchar Lake, Kashmir [19]. The Nitrate and Phosphate receive by the lake from household detergent, domestic sewage and fertilizers. The statistical analysis of data elucidated that the lake is eutrophic and being anoxic as well as the water is not in pristine condition. Important observation of this study was that the

Fatehpur, Machariyahwa, Maryadpur and Utrai sites in the South-East basin of lake was grossly polluted and insult with more anthropogenic activities because this basin direct interact to the inhabitant. In this study a significant impact of anthropogenic activities were observed. It was found that the selected lake is polluted because the high anthropogenic activities such as fisheries and agricultural activities are taking place in the area. The dissolution of pollutants in rainy season was also taking place because the lake connected with river Ghaghara.

Table-1: Analysis of physico-chemical parameters of surface water of Taal Ratoi in mg/L

PARAMETERS	JUNE	OCTOBER	JANUARY	APRIL	MEAN	SD	MAX.	MIN.
pH	8.89	7.61	8.23	8.97	8.43	±0.64	8.97	7.61
EC(µs/cm)	212.23	205.21	196.75	200.14	203.58	±6.73	212.23	196.75
TDS	94.15	94.2	95.4	94.3	94.51	±0.59	95.4	94.15
DO	12.05	11.77	14.12	13.28	12.81	±1.09	14.12	11.77
SALINITY	221.95	214.9	204.4	209.7	212.7	±7.49	221.95	204.4
NO ₃ ⁻	5.61	3.99	5.83	4.97	5.1	±0.83	5.83	3.99
PO ₄ ⁻	3.11	2.59	3.26	2.96	2.98	±0.29	3.26	2.59
DOC	7.54	6.29	9.96	6.15	7.49	±1.76	9.96	6.15
DIC	2.10	2.14	2.54	1.48	2.07	±0.44	2.54	1.48
TDC	7.63	8.43	12.50	9.64	9.55	±2.13	12.50	7.63



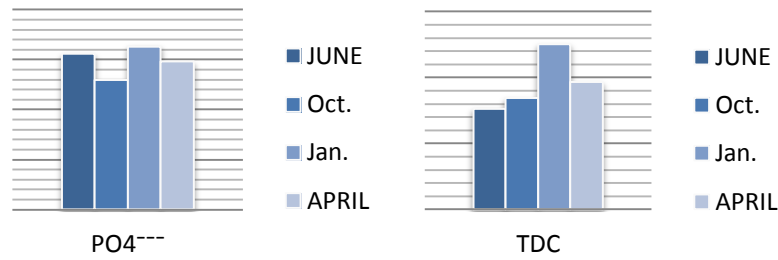


Fig-2: Graphical analysis of monthly basis value of physico-chemical parameters of *Taal Ratoi*

IV. CONCLUSION

In the present study it was observed that the lake is under stress of anthropogenic activities and suffered numerous insults in the hand of man and as the results the lake is moving towards its definite end. Due to the ecological stresses from anthropogenic activities the lake is not only shrinking in surface but its water quality has deteriorated and the aquatic life is also badly affected. The most striking observation was that the South-East basin of lake is grossly polluted because the high pH of the water due to the presence of Total Dissolve Carbon in the form of Carbonates and Bicarbonates while Nitrate was due to fertilizers used in agriculture. Due to the high population density, connection with river Ghaghara and intake of sewages from domestic wastage, the high organic pollution loading has been found. Presence of *Eichhornia species* confirmed that the lake is polluted and has high anthropogenic activities. There is a need to formulate proper ecologically benignant plan for the lake to embrace all the environmental components of the lake ecosystems and thus help to conserve the lake in a real ecological sense.

V. ACKNOWLEDGEMENTS

The authors are sincere thankful to Department of Botany, Shibli National College, Azamgarh Uttar Pradesh, India for providing necessary guidance, reform and research facilities.

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Cite this article as :

Mohammad Faizan, Abdullah, "Impact of Anthropogenic Activities on the Hydro Biogeochemistry of lake Taal Ratoi a Fresh Water Lake", *International Journal of Scientific Research in Science and Technology (IJSRST)*, Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 1, pp. 293-299, January-February 2022. Available at doi: <https://doi.org/10.32628/IJSRST229146>
Journal URL : <https://ijsrst.com/IJSRST229146>