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# A Study of Physicochemical Water Quality and Primary Productivity in Tekanpur Water Body

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***Abstract:*** **Present study has been carried out in Tekanpur Lake to study the physico-chemical water quality and primary productivity to assess its production potential. The study area was divided into 5 sampling sites to cover the whole lake area comprehensively. The parameters taken were pH, Conductivity (µmho/cm), Turbidity (NTU), Transparency (m), Total Hardness, TSS (mg/l), TDS (mg/l), Total Alkalinity , Free CO2(mg/l),DO (mg/l),BOD (mg/l), COD(mg/l), TN (mg/l), Nitrate-N (mg/l), Nitrite (mg/l), TKN (mg/l), TP(mg/l), Fluoride (mg/l),primary Productivity(mg C/m3(/d) & Chlorophyll-a microgram/l. Trophic Static Index of Tekanpur Lake was computed using regression equations and Carlson trophic status classification criteria was followed to know the status of the lake and The water quality criteria developed by CPCB have been used for classifying the lake water quality(class of water).The variations of each particular parameter across stations and that over seasons or years were calculated using the correlation and t-test.**

***Keywords:*** **Primary productivity, Phytoplankton, Trophic Static Index, correlation, regression equations.**

## 1. INTRODUCTION

The study of primary productivity and physico-chemical property of water, a part of Limnological studies which are based upon wetlands like lakes , reservoir provide a broad spectrum of assessment of status and their management implications. Its groundwork is typically accredited to F. A. Forel (Forel, 1892) and S. A. Forbes (Forbes, 1887). In recent times limnological studies are often related to fisheries, biodiversity conservation, pollution assessment and rejuvenation of degraded inland freshwater ecosystems (Arlinghaus *et al.*, 2008). Studies on limnology assess the functionality of a lake ecosystem on the basis of its productivity, nutrient balance and resource cycling. It estimates ecological carrying capacity of the system and indicates the sources and amount of pollutants in the form of nutrients and solids. The trophic status and water quality criteria, parts of limnological study reveal the success ional stage and point and non-point sources of pollution. As the natural and anthropogenic causes are identified, comprehensive conservation strategies could be chalked out to sustain the use of a lake ecosystem.. The study of primary productivity and physico-chemical property of water was carried out by various people like Mishra and Sakesena (1991) ,Kuashik and Saksena (1995). Patel et al., (2013), Vasanthkumar and Vijay Kumar (2011) , Garg et al., (2010). To conserve these anthropogenically valued, highly productive and biodiversity-rich areas, systematic study and monitoring is necessary In the present work, study on primary production, principal controlling factors and the effect on primary productivity of the Tekanpur Lake was conducted

## 2. MATERIAL AND METHODS

The Tekanpur Lake is a man made reservoir constructed on a small rivulet Chhochund of Sindh, a tributary of the Chambal River. In order to alleviate the sufferings of the common man, the Scindhias harnessed the water of various seasonal nallahs and constructed a 1875 mtrs long and 17.7 meters high dam with a catchment area of 64.75 square km situated near Tekanpur village in Pichhor Tahsil of Gwalior District.

The study area was divided into 5 sampling sites .Water samples were collected following sampling protocol as prescribed by Central Pollution Control Board (CPCB), Delhi and were measured using reference method of APHA.

The physico chemical parameters were pH, Conductivity (µmho/cm), Turbidity (NTU), Secchi Depth or Transparency (m), Total Hardness (mg/l), Calcium (mg/l), Total Suspended solids (mg/l), Total dissolve solids (mg/l), Total Alkalinity as CaCO3 (mg/l), Bicarbonate (mg/l), Free CO2(mg/l), Dissolved Oxygen (mg/l), Biochemical oxygen Demand (mg/l), Chemical oxygen Demand (mg/l), Total Nitrogen (mg/l), Nitrate-N (mg/l), Nitrite (mg/l), TKN (mg/l), Total Phosphorus (mg/l), Fluoride (mg/l), primary Productivity(mg C/m3(/d) & Chlorophyll-a microgram/1

Primary productivity was measured by "Light and dark bottle" method (Garder and Gran, 1927). For analysis of Chlorophyll-a, the pigments are extracted from the planktons, concentrated with aqueous acetone solution and the optical density of the extract is determined with a spectro-photometer

## 3. RESULTS

The range of pH was 7.32 to 8.28. Total Suspended Solids (SS) was recorded in between 16.74 mg/L to 56.07 mg/L with average concentration of 38.61 mg/L.The mean Secchi depth was found to be 1.29 ± 0.49 cm with a range of 0.52 cm to 2.16 cm. Turbidity was found in the range of 2.00 NTU to 21.00 NTU with mean value of 8.45 ± 4.00 NTU.Electrical Conductivity (EC) was recorded in between 244.96 µmho/cm to 625.06 µmho/cm, with mean value of 443.47 ± 97.38 µmho/cm.In Tekanpur Lake the total solids (TS) were in the range of 203.97 mg/L to 493.31 mg/L, with a mean value of 357.91 ± 74.32 mg/L.Total Dissolved Solids (TDS) was found in the range of 176.37 mg/L to 450.04 mg/L with a mean concentration of 319.30 ± 70.11 mg/L. Total Hardness (TH) was recorded in the range of 93.48 mg/L to 238.52 mg/L with a mean concentration of 169.23 ± 37.16 mg/L. The range of alkalinity in the Tekanpur Lake was 77.59 mg/L to 197.97 mg/L and the mean value was 140.46 ± 30.84 mg/L. The Dissolved oxygen in Tekanpur Lake varied in the range of 5.23 mg/L to 9.53 mg/L with a mean value of 7.77 ± 0.68 mg/L. The mean Biochemical Oxygen Demand was 3.92 ± 0.59 mg/L, with a range of 2.83 mg/L to 5.36 mg/L. The mean Chemical Oxygen Demand (COD) was 31.27 ± 5.29 mg/L, and the values ranged from 20.25 mg/L to 43.02 mg/L.The mean Total Nitrogen (TN) was 9.20 ± 1.50 mg/L. The TN ranged from 6.82 mg/L to 14.00 mg/L. The mean Nitrate-Nitrogen ($NO_3$-N) 9.20 ± 1.50 mg/L. The $NO_3$-N ranged from 6.82 mg/L to 14.00 mg/L. The mean Nitrite ($NO_2$-N) was 0.36 ± 0.04 mg/L. The $NO_2$-N ranged from 0.28 mg/L to 0.45 mg/LThe mean Ammoniacal Nitrogen ($NH_3$-N was 1.68 ± 0.19 mg/L. The $NH_3$-N ranged from 1.32 mg/L to 2.16 mg/L.The mean Total Kjeldahl Nitrogen (TKN) at Tekanpur Lake was 3.86 ± 0.57 mg/L, and the values ranged from 2.69 mg/L to 5.05 mg/L. The mean Total Phosphate ($PO_4^{2-}$) was 1.99 ± 0.47 mg/L, with a range of 1.05 mg/L to 2.96 mg/L.Tekanpur Lake the mean Bicarbonates ($HCO_3^-$) was 106.75 ± 23.44 mg/L, with a range of 58.97 mg/L to 150.46 mg/L. The mean Sodium ($Na^+$) was 19.63 ± 1.89 mg/L. The $Na^+$ ranged from 15.57 mg/L to 23.20 mg/L.The Potassium ($K^+$) was in the range of 1.28 mg/L to 2.15 mg/L, with a mean value of 1.65 ± 0.22 mg/L. Calcium ($Ca^{++}$) was found in between of 26.17 mg/L to 66.79 mg/L with a mean concentration of 47.38 ± 10.40 mg/L. The mean Magnesium ($Mg^{++}$) was 12.34 ± 2.71 mg/L. The $Mg^{++}$ values ranged from 6.81 mg/L to 17.39 mg/L.Free $CO_2$ of Tekanpur lake water was found in between of 0.15 mg/L to 0.39 mg/L with a mean concentration of 0.27 ± 0.06 mg/L. The mean Chloride ($Cl^-$) was 68.27 ± 6.24 mg/L. The $Cl^-$ concentration ranged from 56.34 mg/L to 82.32 mg/L. The mean Sulfate ($SO_4^{2-}$) was 4.16 ± 1.43 mg/L. The $SO_4^{2-}$ concentration ranged from 1.24 mg/L to 5.68 mg/L. The mean Fluoride ($F^-$) at Tekanpur Lake was 0.23 ± 0.20 mg/L. The $F^-$ concentration ranged from 0.01 mg/L to 0.50 mg/L.

**Biological Parameter:**

The mean Primary Productivity of Tekanpur Lake was 430.16 ± 144.51 mg C/$m^3$/d. The range varied from 162.00 mg C/$m^3$/d to 723.00 mg C/$m^3$/d. The mean Chlorophyll a of Tekanpur Lake was 83.83 ± 11.50 µg/L. The range varied from 58.08 µg/L to 103.42 µg/L.

**T-Test:**

Important parameters which mainly govern the lake chemistry were considered for the t-test and it is found that values and concentrations of Turbidity, EC, TDS, Hardness, Alkalinity, Nitrate, TKN, Chlorophyll a, Primary Productivity and Fluoride were significantly different ($p$<0.05) from 2011 values to 2014 values. Although, BOD and COD were not significantly change over the study period. Table 1: $p$-values of important parameters considered for t-Test

| Parameters | *p*-value for Tekanpur Lake from 2011 to 2014 |
|---|---|
| Turbidity | 0.000 |
| BOD | 0.082 |
| COD | 0.352 |

| | |
|---|---|
| EC | 0.000 |
| TDS | 0.004 |
| Hardness | 0.000 |
| Alkalinity | 0.000 |
| Nitrate | 0.000 |
| TKN | 0.005 |
| Chlorophyll a | 0.000 |
| Primary Productivity | 0.000 |
| Fluoride | 0.003 |

**Trophic State Index and Water Quality Criteria of Tekanpur Lake:**

Trophic State Index, Water Quality Index and best designated use of Tekanpur Lake water was assessed using water quality data for better understanding and interpretation of Lake Ecosystem.

**Trophic State Index of Tekanpur Lake:**

Trophic status of Tekanpur Lake was computed using regression equations of Reokhow and Chapra (1983). These equations (Eq. 1, 2, 3 & 4) were originally based on Carlson trophic static indices (1977).

TSI (SD) = 60.0 – 14.41 * ln (SD) = **56.33**

TSI (TP) = 14.42 * ln (TP) + 4.15 = **113.68**

TSI (TN) = 54.45 + 14.43 * ln (TN) = **86.47**

TSI (CHL) = 30.6 + 9.81 * ln (CHL a) = **74.05**

The obtained TSI values were compared with Carlson's trophic state classification criteria and results reveal that Tekanpur Lake was found in ***Eutrophic*** stage according to TSI assessed on the basis of mean Sechhi Depth (SD). However, all other parameters (TP, TN and CHL a) indicated a ***Hyper-eutrophic*** stage during the study period.

**Water Quality Criteria for Designated-Best-Use of Tekanpur Lake:**

Central pollution control board had developed criteria for the surface water body to designate the best water uses. Range of pH and DO is satisfying the criteria C but average concentration of BOD was higher in Lake water that is well above the standard value of 3 mg/L for the water quality Class-C (for drinking water source after conventional treatment and disinfection). So as a whole, due to high BOD concentration in lake water and Free Ammoniacal Nitrogen of >1.2 mg/L, the Tekanpur Lake water quality falls under Class C to D.

## 4. DISCUSSION AND ANALYSIS OF DATA

As observed during the present study the turbidity was correlated with organic nitrogen and sulfate. Organic nitrogen (TKN) provided algal growth that contributed to turbidity. pH was highly correlated with TDS and alkalinity. DO was negatively correlated with BOD, COD, TKN and TP as increase in organic load would reduce the DO level due to bacterial activity. BOD was highly correlated with COD and TKN as it represented biodegradable organic matters. On the other hand, COD highly correlated with TDS and some organics like TKN and TP, as it represented chemically ox disable organic and inorganic matter in the water. TDS was highly correlated with EC, hardness, alkalinity, bicarbonate, chloride and sulfate and vise versa, as TDS represent the total amount of soluble solids present in the water. TN had a high correlation with nitrate, nitrite and TKN. However, ammonia cal nitrogen was highly positively correlated with TKN, but negatively highly correlated with Sechhi depth. It also contributed positively with Chlorophyll production. Phosphate was highly correlated with Primary Productivity as it played a key role in nutrient input and enhanced growth of phytoplankton.

The t-test assesses whether the means of two groups are statistically different from each other. The seasonal variations for Turbidity, EC, TDS, Hardness, Alkalinity, Nitrate, TKN, Chlorophyll a, Primary Productivity and Fluoride were significantly different. As the season passed the solids, nutrients and organic input varied due to altered rainfall and surface runoff patterns. So, those parameters changed significantly. Although, BOD and COD were not significantly

change over the study period as these two parameters were balanced by algal bloom and nitrogenous and carbonate-bicarbonate compounds present in the Lake water.

Trophic level is the indicator of water quality for limnetic ecosystem. It shows the productivity of the system and biomass availability in that water body. The degree of nutrient enrichment is also classically indicated as trophic state of water bodies. It could vary between oligotrophic to hyper-eutrophic states. TSI (TP) was found greater than TSI (CHL a) which indicates the increasing phosphorous surplus in the water and TSI (SD) was found lower than TSI (CHL a) is the sign of smaller particulate dominated turbidity along with phytoplankton turbidity. Present interpretation was based on the similar findings reported by Carlson (1977). After assessment of computed results, it can be observed that phosphorous concentration along with organics dominated turbidity in Tekanpur Lake are critical elements for eutrophication and water quality is concerned during summer months.

**Biological status and Primary Productivity:**

The seasonal trends highlight that maxima of Chlorophyll a concentrations mainly occurred in either spring or autumn during the perio( Parvathi *et al*., (2014) . As per OECD (1982) classification of trophic state, 8 µg/L of Chlorophyll a concentration is the threshold for eutrophication and in the present study.

Primary productivity is the production of organic compound form atmosphere or aquatic carbon dioxide. It is greatly controlled by various physic-chemical characteristics of water body (Saksena *et al*., (2008), Mishra and Sakesena (1991), Kuashik and Saksena (1995), Patel *et al*., (2013) ,Garg *et al*., (2010) ,Vasanthkumar and Vijaykumar (2011). In the present study the primary productivity of the Lake is high in shallow zones and moderate in deeper sections. . The summer seasons (March-May) were highly productive due to longer day period and higher temperatures. Productivity during winter months (November-January)was low due to shorter day period and low temperatures. Chlorophyll a represents only a crude approximation of the algal biomass (Gasol and Duarte, 2000), and Khare and Chauraisia (2009)

**Table 2: Correlation matrix of physico-chemical parameters estimated at Tekanpur Lake during 2011 to 2014.**

| Parameters | Turbidity | pH | DO | BOD | COD | EC | TS | SS | TDS | Hardness | Alkalinity | Bicarbonate | Na | K | Ca | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Turbidity** | 1.000 | | | | | | | | | | | | | | | |
| **pH** | 0.188 | 1.000 | | | | | | | | | | | | | | |
| **DO** | -0.255 | -0.179 | 1.000 | | | | | | | | | | | | | |
| **BOD** | 0.186 | 0.042 | -0.646 | 1.000 | | | | | | | | | | | | |
| **COD** | 0.461 | 0.260 | -0.541 | 0.749 | 1.000 | | | | | | | | | | | |
| **EC** | 0.474 | 0.060 | -0.088 | 0.487 | 0.707 | 1.000 | | | | | | | | | | |
| **TS** | 0.472 | 0.042 | -0.071 | 0.447 | 0.701 | 0.993 | 1.000 | | | | | | | | | |
| **SS** | 0.199 | -0.116 | 0.093 | -0.097 | 0.266 | 0.393 | 0.398 | 1.000 | | | | | | | | |
| **TDS** | 0.374 | 0.660 | 0.088 | 0.487 | 0.707 | 0.840 | 0.993 | 0.393 | 1.000 | | | | | | | |

| Parameters | Turbidity | pH | DO | BOD | COD | EC | TS | SS | TDS | Hardness | Alkalinity | Bicarbonate | Na | K | Ca | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hardness** | 0.473 | 0.347 | -0.045 | 0.322 | 0.203 | 0.642 | 0.629 | 0.243 | 0.739 | 1.000 | | | | | | |
| **Alkalinity** | 0.299 | 0.760 | -0.062 | 0.284 | 0.062 | 0.502 | 0.607 | 0.303 | | | | | | | | |

## 5. CONCLUSION

During present study it was found that the Lake is in good condition in terms of pollution. Although biologically very active, the Lake water has very few inorganic and toxic pollutants. The organic load also diluted during monsoonal rainfall. The highly productive lake has thriving population of planktons and fishes. The Lake water could be used for anything from irrigation to drinking purposes provided the water is biologically treated before use. As no industrialization has taken place in the surrounding areas, menace of effluent discharge and subsequent pollution is not evident in the Lake. However, the Lake could face problems of eutrophication as organic load is very high. It may be avoided by plantation in the banks and subsequent reduction in the surface runoff and siltation. Agricultural activities should also be avoided in the near vicinity of the Lake to avoid input of toxic substances like pesticides and heavy metals through chemical fertilizers.

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