

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(2): 226-231
www.biochemjournal.com
 Received: 01-11-2025
 Accepted: 06-01-2026

Rajib Lotion Roy
 Department of Zoology,
 Bhattadev University, Bajali,
 Pathsala, Assam, India

Hemen Das
 Department of Physiology &
 Biochemistry, College of
 Veterinary Sciences & Animal
 Husbandry, Central
 Agricultural University,
 Selesih, Mizoram, India

Physico-chemical assessment of water quality and primary productivity of the river Kaldiya, Assam (India)

Rajib Lotion Roy and Hemen Das

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2c.7447>

Abstract

The current study was carried out to assess the primary productivity and water quality of Kaldiya river of Assam. The period of the study was from the month of October to December, 2025. Various physico-chemical parameters such as temperature, pH, alkalinity, hardness, dissolved oxygen were analysed during the study. The Weighted Arithmetic Index method (WAWQI) was used to determine the water quality. Our study revealed that temperature of the river water decreased from a range of 21-24 °C in October to 16-20 °C by December, while pH levels remained alkaline (7.41 to 7.82). Dissolved oxygen, alkalinity and hardness were found to be at normal level. The Water Quality Index (WQI) for site-I was observed to be stable (59.94) across all three months; site-III showed lowest WQI value (49.99) in the month of October. However site-II showed highest value of WQI (69.46). The study also quantified the metabolic rates. The recorded Gross Primary Productivity (GPP) values were 103-117 mgC/m³/hr, 115-125 mgC/m³/hr and 88-93 mgC/m³/hr for site-I, site-II and site-III, respectively across all three months. Correlation analysis confirmed that WAWQI is strongly influenced by biological activity, showing a high positive correlation with Net Community Productivity (NCP) (r=0.765) and GPP (r=0.721).

Keywords: Kaldiya river, weight arithmetic index, pollution, primary productivity, TDS, pH

Introduction

Rivers are large, natural streams of flowing water. They help not only in facilitating nutrient cycling but also support a vast array of global biodiversity (Lim *et al.*, 2024) ^[1]. Besides, rivers are also useful for human civilization, providing essential ecosystem services such as fresh water for irrigation, industrial processes and domestic consumption, while also acting as a natural buffer for climate regulation (Lim and Do, 2023) ^[2]. In recent years, the pollution in river systems has increased significantly and has become a major environmental concern. The discharges of untreated sewage, solid waste, agricultural run-off etc. are the major contributors to water pollution (Dwivedi, 2017) ^[3]. Therefore, assessment of quality and primary productivity of the river water is a must for early detection of pollutants that will provide the empirical data necessary for legislative action and resource protection.

The Kaldiya is an important river of Assam. It originates from Bhutan, where it is locally known as 'Baga Noi'. It flows approximately 72 km through a mix of hilly terrain and plains. Upon entering India in the state of Assam, the river traverses several villages, Gondhaligaon, Jalaghat, Golagaon, Bhaluki, Kawaimari, Balapara etc. This river serves as a vital resource for local agriculture, irrigation, household needs and fishing-based livelihoods. Thus, it is considered to be the lifeline of rural households of a major part of lower Assam and hence, its physico-chemical assessment has become imperative (Kusre *et al.*, 2013) ^[4]. Thus, it is considered to be the lifeline of rural household of major part of lower Assam. However, no study has been carried out till date to evaluate the suitability of its water for various agricultural and house hold activities.

In view of the above, the present study was designed to determine the quality and gross primary productivity of water of the river Kaldiya in the state of Assam.

Materials and Methods

Location of the study

The study was conducted in three different sites of Kaldiya River spanning approximately 5.9 km. Site-I is located at 26°25'28"N and 91°08'59"E near the Balapara region. Site-II is at

Corresponding Author:
Hemen Das
 Department of Physiology &
 Biochemistry, College of
 Veterinary Sciences & Animal
 Husbandry, Central
 Agricultural University,
 Selesih, Mizoram, India

26°26'10"N and 91°11'12"E, which is situated near Kawaimari Village. Site-III is located at 26°26'56"N and 91°11'47"E near the Bangaon region. The Site-II is around 3.89 km upstream of Site-I, whereas Site-III is approximately 1.9 km upstream from Site-II.

Period of the study: The collection of water samples was conducted during the period from October to December, 2025. This specific time frame was selected as this period represents the post monsoon transition. In this period, the river flow decreases and actual pollutant level becomes clearer after monsoon dilution, which makes the monitoring essential.

Parameters studied: A total of twelve water quality parameters were selected for the analysis. The parameters were temperature, odour, TDS, conductivity, dissolved oxygen, pH, alkalinity, and hardness, Ca^{2+} and Mg^{2+} , Nitrate (NO_3^-) and Phosphate (PO_4^{3-}). Temperature was measured using a standard laboratory thermometer, for odour olfactory sense was used. TDS, pH and conductivity were determined using calibrated digital TDS meter, pH meter and Conductivity meter, respectively. Alkalinity, hardness, Ca^{2+} and Mg^{2+} were estimated using titrimetric methods. Nitrate and Phosphate concentration were determined using specific commercially available detection kits. The Dissolved Oxygen levels were determined using the modified Winkler's titrimetric method. Chemical parameters that fell below the detection limit (BDL) were treated as half the limit of detection (LOD/2) for statistical analysis following standard environmental data processing protocols (Hornung and Reed, 1990) [5].

For measurement of primary productivity, light bottle and dark bottle techniques were carried out as described by Gaarder and Gran (1927) [6]. Water samples were filled in three sets of bottles and designated as Initial, Light and Dark. The light and dark bottles were incubated for a designated period. Then the Dissolved Oxygen concentrations were determined using modified Winkler's method to calculate Gross Primary Productivity (GPP), Net Primary Productivity (NPP) and Net Community Production (NCP). The Primary productivity was calculated using the following equations:

$$\text{GPP} = \frac{(\text{LB} - \text{DB}) \times 0.375}{T \times PQ} \times 1000 \text{ mgC/m}^3/\text{hr}$$

Where;

- 0.375 = Conversion Factor
- RQ = Respiratory Quotient (1.0)
- PQ = Photosynthetic Quotient (1.2)
- T = Incubation time in hours.

$$\text{NPP} = \frac{(\text{LB} - \text{IB}) \times 0.375}{T \times PQ} \times 1000 \text{ mgC/m}^3/\text{hr}$$

$$\text{NCP} = \frac{\text{IB} - \text{DB}}{T} \times 0.375 \times \text{RQ} \text{ mgC/m}^3/\text{hr}$$

Calculation of Water Quality Index (WQI)

Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index Method, as proposed by Brown *et al.* (1970) [7]. Out of the twelve parameters analyzed, only ten, viz. TDS, Conductivity, DO, pH, Alkalinity, Hardness,

Ca^{2+} , Mg^{2+} , NO_3^- and PO_4^{3-} were selected for the WQI calculation. Parameters such as odor, though informative, are subjective and not quantitatively suitable for inclusion in the index.

The Weighted Arithmetic Water Quality Index (WQI) was calculated using the following formula:

$$\text{NPP} = \frac{(\text{LB} - \text{IB}) \times 0.375}{T \times PQ} \times 1000 \text{ mgC/m}^3/\text{hr}$$

$$\text{WQI} = \frac{\sum W_n Q_n}{\sum W_n}$$

Where, Q_n was the quality rating of nth water quality parameter, W_n is the unit weight of nth water quality parameter.

The quality of Q_n is calculated using the equation:

$$Q_n = 100 \left[\frac{V_n - V_i}{S_n - V_i} \right]$$

Here;

V_n = Observed Value

V_i = Ideal Value (0 for most of the parameters, but for pH:7, DO: 14.6)

S_n = BIS Standard permissible value.

Now the W_n can be calculated by

$$W_n = \frac{K}{S_n}$$

$$K = \frac{1}{\left(\sum \frac{1}{S_n} \right)}$$

Results

The data (Mean $\pm$ SD) recorded during the study for various physico-chemical parameters are presented in the table-1.

It was observed that the recorded values of different physico-chemical parameters in water samples of all the three sites of study were within the permissible limits recommended by Bureau of Indian Standards (BIS) for different day to day household chores including drinking.

The values of water quality indices and water quality standards for site-I, site-II and site-III are shown in Table-2. Figure-1 depicts the monthly variation of Weight Arithmetic Water Quality Index (WAWQI) at three sites of study during October-December.

The WAWQI across three sites were predominantly "Poor" water quality during the study period. For Site-I the water quality status remained stable at 59.9 across all three months. However Site-II consistently showed higher indices, peaking at 69.46 in the month of November. Site-III showed a "Good" water quality status of 49.99 in October before deteriorating to 59.78 and 59.76 in the subsequent months as illustrated in Fig.1. Although individually the parameters like pH, TDS, Conductivity, Alkalinity, Hardness, etc remained within permissible limit, their cumulative weight impacted the result in an overall index that necessitates conventional treatment of the water before domestic consumption.

Table 1: Parameters and their obtained values

Months	Parameters	SITE- I	SITE- II	SITE- III
October	Temperature	21-24 °C	21-24 °C	21-24 °C
	Odor	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy
	TDS	112 ± 4.2	100 ± 3.9	100 ± 3.9
	Conductivity	201 ± 6.5	200 ± 6.1	198 ± 6.3
	Dissolved Oxygen	7.5 ± 0.32	8.3 ± 0.28	7.7 ± 0.35
	pH	7.75 ± 0.08	7.78 ± 0.06	7.41 ± 0.08
	Alkalinity	135 ± 5.1	126 ± 4.4	123 ± 4.8
	Hardness	110 ± 3.5	108 ± 3.2	105 ± 3.9
	Ca ²⁺	24 ± 1.2	23 ± 1.1	23 ± 1.4
	Mg ²⁺	12 ± 0.8	12 ± 0.7	10 ± 0.9
	Nitrate (NO ₃ ⁻)	BDL (<0.5)	BDL (<0.5)	BDL (<0.5)
	Phosphate (PO ₄ ³⁻)	0.06 ± 0.01	0.07 ± 0.01	0.05 ± 0.01
November	Temperature	17-22 °C	17-22 °C	17-22 °C
	Odor	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy
	TDS	106 ± 3.9	105 ± 4.1	100 ± 3.7
	Conductivity	203 ± 6.1	201 ± 5.8	200 ± 6.4
	Dissolved Oxygen	7.4 ± 0.29	8.1 ± 0.31	7.6 ± 0.33
	pH	7.77 ± 0.07	7.79 ± 0.05	7.59 ± 0.11
	Alkalinity	130 ± 4.7	133 ± 4.9	128 ± 5.2
	Hardness	109 ± 3.2	110 ± 3.5	104 ± 3.1
	Ca ²⁺	23 ± 1.1	24 ± 1.2	22 ± 0.9
	Mg ²⁺	12 ± 0.8	12 ± 0.7	11 ± 0.8
	Nitrate (NO ₃ ⁻)	BDL (<0.5)	BDL (<0.5)	BDL (<0.5)
	Phosphate (PO ₄ ³⁻)	0.06 ± 0.01	0.07 ± 0.01	0.06 ± 0.01
December	Temperature	16-20 °C	16-20 °C	16-20 °C
	Odor	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy	No distinctive odor. Slightly earthy/muddy
	TDS	114 ± 4.3	112 ± 3.9	102 ± 3.5
	Conductivity	219 ± 5.8	211 ± 6.1	202 ± 5.4
	Dissolved Oxygen	7.7 ± 0.25	8.4 ± 0.30	7.7 ± 0.28
	pH	7.82 ± 0.06	7.71 ± 0.08	7.58 ± 0.07
	Alkalinity	139 ± 4.5	131 ± 3.8	126 ± 4.2
	Hardness	110 ± 3.3	109 ± 3.1	100 ± 2.8
	Ca ²⁺	24 ± 1.3	23 ± 1.0	24 ± 1.2
	Mg ²⁺	10 ± 0.7	12 ± 0.8	12 ± 0.7
	Nitrate (NO ₃ ⁻)	BDL (<0.5)	BDL (<0.5)	BDL (<0.5)
	Phosphate (PO ₄ ³⁻)	0.06 ± 0.01	0.07 ± 0.01	0.06 ± 0.01

[*All parameters are reported in mg/L, except TDS (ppm), Conductivity (µS/cm) and pH]

*Nitrate values below the detection limit (BDL) were substituted using LOD/2]

Table 2: Water quality indices and water quality standards of all three sites

Months	Sites	WQI	WQS
October	Site-I	59.94	Poor
	Site-II	69.41	Poor
	Site-III	49.99	Good
November	Site-I	59.97	Poor
	Site-II	69.46	Poor
	Site-III	59.78	Poor
December	Site-I	59.94	Poor
	Site-II	69.34	Poor
	Site-III	59.76	Poor

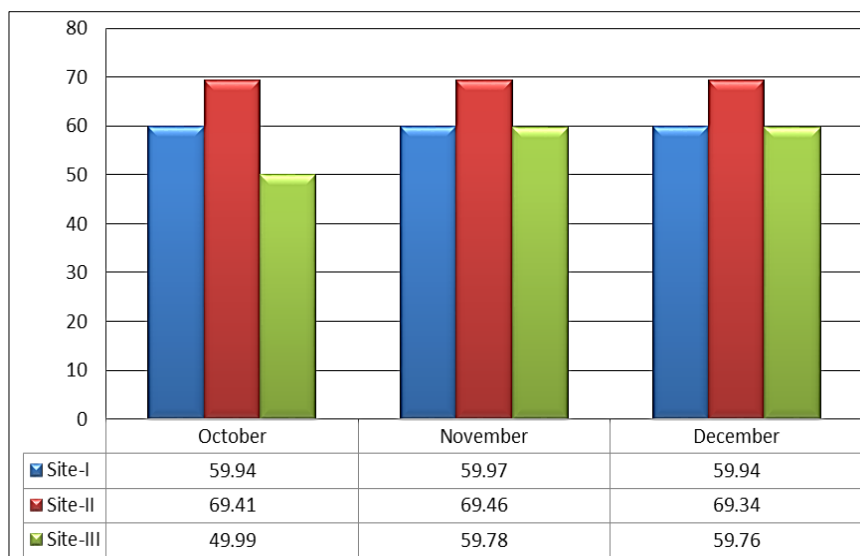


Fig 1: Monthly Variation of WAWQI at three sites during October-December

Table-3 reveals that site-I showed a declining trend of Gross Primary Productivity (GPP) from October (117.18 mgC/m³/hr) to November (103.42 mgC/m³/hr) with slight recovery in December. The Net Primary Productivity (NPP) also showed a similar trend of variation. Whereas, site-II showed an increase in GPP by December, reaching its highest value of 125.61 mgC/m³/hr. This site also

maintained the highest NCP value (0.071-0.078) indicating a higher rate of organic matter accumulation as compared to the other locations.

Site-III recorded the lowest overall productivity, with GPP declining steadily from 93.75 in October to 88.43 in December.

Table 3: Month wise summary of Primary Productivity values

Site-I	October	November	December
GPP	117.187	103.42	108.915
NPP	70.312	56.105	62.14
NCP	0.056	0.048	0.051
Site-II	October	November	December
GPP	117.187	115.442	125.61
NPP	54.687	53.91	63.105
NCP	0.075	0.071	0.078
Site-III	October	November	December
GPP	93.75	91.21	88.43
NPP	46.87	44.105	52.12
NCP	0.056	0.052	0.049

The results of statistical correlation of Primary Productivity and WAWQI are presented in table-4.

Table 4: Correlation between Primary Productivity and WAWQI

Parameters Compared	Correlation Value
WAWQI vs GPP	0.721
WAWQI vs NPP	0.305
WAWQI vs NCP	0.765

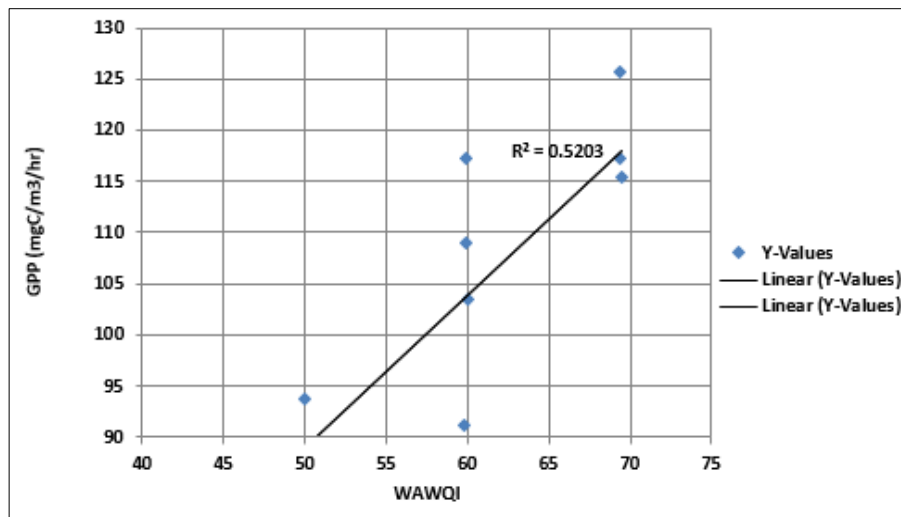


Fig 2: Scatter Plot Graph of WAWQI vs GPP

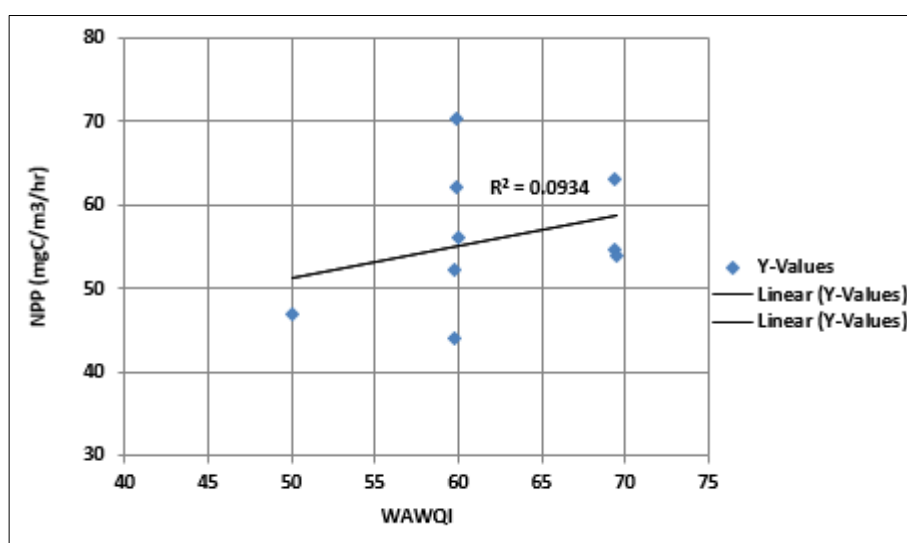


Fig 3: Scatter Plot Graph of WAWQI vs NPP

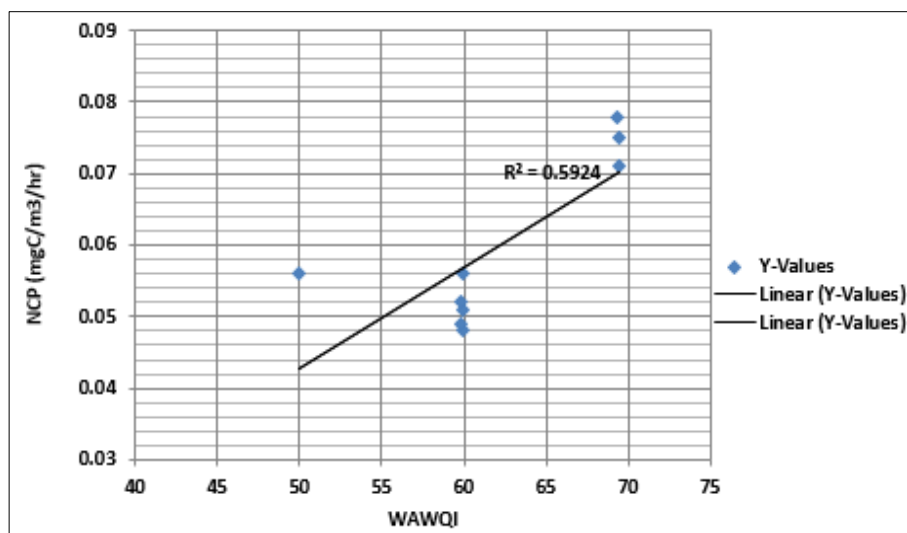


Fig 4: Scatter Plot Graph of WAWQI vs NCP

The statistical relationship between the WAWQI and Primary Productivity parameters was evaluated using Pearson Correlation coefficients (r). The result showed a strong positive correlation between WAWQI and GPP with an r value of 0.721 and R^2 of 0.520. An even stronger

correlation was observed for NCP which yielded an r value of 0.765 and an R^2 of 0.592. In contrast the correlation between WAWQI and NPP was notably weaker with an r value of 0.305 and R^2 of only 0.093. These findings are visualized in the scatter plots (Fig. 2, 3 and 4).

Discussion

Data generated during the study demonstrates a clear picture of environmental impact and natural recovery driven by human activity and seasonal transitions. Site-III is located upstream with very less human interference, which resulted in the best water quality among the all three sites. In contrast, Site-II showed high pollution due to high population density and domestic activities. These activities introduced organic waste and nutrients into the water, which is reflected in the high WQI values and the peak in GPP and NCP at this site. Moving downstream to Site-I, the water quality begins to show a signs of recovery. It might be due to the distance of 3.89 km from Site-II, reduced input of waste along the path and also the presence of vegetation which allowed for natural dilution and biological filtration, demonstrating the river's unique capacity for self-purification over distance (Fisenko, 2006) ^[8]. Across all the sites, a notable spike in both WQI and Productivity occurs during November. It might be ascribed to the seasonal change. As monsoon rain ceases, water level drops and flow velocity slows down (Jeba and Baskarasanjeevi, 2025) ^[9]. This causes the nutrients and pollutants to become more concentrated. However, by December these values begin to decline because the onset of winter brings lower temperature and shorter daylight hours, which results in slowing down of the metabolic rates of aquatic plants and thereby reducing photosynthesis (Rabaey *et al.*, 2021) ^[11]. The seasonal shift is also validated by correlation between WAWQI and NCP (0.765) and WAWQI and GPP (0.721), which signifies that biological activity is directly associated with the level of pollution. These high values prove that the pollution recorded at the sites selected for our study is primarily nutrient-based and triggers rapid organic growth. The correlation with NPP (0.305) is lower, which suggests that even though total production is high, the net energy stored is limited by environmental stress or increased plant respiration during these polluted phases (Kamali *et al.*, 2020) ^[10].

It may be concluded that the ecosystem of the river Kaldiya has undergone tremendous alteration in recent years due to intensification of activities with growing human population. Nonetheless, a comprehensive study is warranted to evaluate how water quality and productivity of the river has changed over the years. Further, regular monitoring of the river across multiple sites and periods is the need of the hour to understand the driving factors that significantly affects the water quality and primary productivity of the water of Kaldiya river.

Acknowledgements

The authors are highly grateful to Bhattadev University, Bajali, Pathsala for providing the necessary support and institutional facilities to carry out this research work.

References

1. Lim S, Woo DH, Do Y. Enhancing river health assessment: innovations and applications of the Aqua Shan Index. *Ecological Indicators*. 2024;160:111867. doi:10.1016/j.ecolind.2024.111867.
2. Lim SH, Do Y. Macroinvertebrate conservation in river ecosystems: challenges, restoration strategies, and integrated management approaches. *Entomological Research*. 2023;53:271-290.
3. Dwivedi AK. Researches in water pollution: a review. *International Research Journal of Natural and Applied Sciences*. 2017;4(1):118-142.
4. Kusre BC, Patra SC, Dutta B. Ex post performance evaluation studies of Kaldiya medium irrigation project in Assam, India. *Irrigation and Drainage*. 2013;62(5). doi:10.1002/ird.1761.
5. Hornung RW, Reed LD. Estimation of average concentration in the presence of nondetectable values. *Applied Occupational and Environmental Hygiene*. 1990;5(1):46-51.
6. Gaarder T, Gran HH. Investigations of the production of plankton in the Oslo Fjord. *ICES Reports on Plankton Production*. 1927;42. doi:10.17895/ices.pub.19272251.v1.
7. Brown RM, McClellan NI, Deininger RA, Tozer RG (1970) A water quality index—do we dare? *Water Sew Works*, 117:339-343.
8. Fisenko AI. Natural purification of rivers and creeks through froth formation process. *Research Journal of Chemistry and Environment*. 2006;10(1):24-29.
9. Jeba SN, Baskarasanjeevi S. Assessment of physico-chemical parameters in the River Cauvery, Tamil Nadu, India. *Advances in Bioresources*. 2025;1(1):92-102.
10. Kamali A, Khosravi M, Hamidianpour M. Spatial-temporal analysis of net primary production and its relationship with climatic factors in Iran. *Environmental Monitoring and Assessment*. 2020;192:718.
11. Rabaey JS, Domine LM, Zimmer KD, Cotner JB. Winter oxygen regimes in clear and turbid shallow lakes. *Journal of Geophysical Research: Biogeosciences*. 2021;126(3):e2020JG006065. doi:10.1029/2020JG006065.