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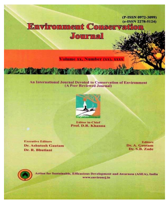

Water quality assessment of Kuwano River, Basti (U.P.) India, with reference to statistical analysis

Gopal Ji Kushwaha ✉

Department of Botany, Shivharsh Kisan P.G. College, Basti, (U.P.), India

Susmita Srivastav

Department of Zoology, Shivharsh Kisan P.G. College, Basti, (U.P.), India

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ABSTRACT

The present study analyses water quality parameters in the Kuwano River, Basti district, using correlation and regression analysis to establish relationships between variables and provide a comprehensive understanding of the factors influencing water quality. Kuwano is the main river that flows through Basti city. The water samples were collected at three locations. The values of different physicochemical parameters of the river water sample were found to be dependent on the hydrology of the area. The pH was strongly associated with TDS (r = 0.885), DO (r = 0.744), COD (r = 0.969), TH (r = 0.806), and Mg (r = 0.944). The biological oxygen demand (BOD) (-0.345), nitrate (-0.235), and calcium (-0.128) exhibited an inverse correlation with total dissolved solids (TDS), whereas nitrate and calcium had a positive correlation with all other physicochemical parameters. The mean TDS value of the river water sample (81.2) was within the permissible limit for drinking water. The total coliform counts established a negative correlation with most of the parameters studied, e.g., dissolved oxygen (-0.628), BOD (-0.983), chemical oxygen demand (-0.194), total hardness (-0.549), nitrate (-0.955), Ca (-0.918) and Mg (-0.279). The study's findings may provide practical information for decision making in river pollution management.

Introduction

Statistical investigations are a crucial part of science, helping to gather extra information and expand contextual knowledge in an area to make decisions under uncertainties. It is the dynamic science of collecting, analyzing, and interpreting data to make decisions, despite the possibility that the outcomes may differ from reality (Nemade and Shrivastava, 1997). Systematically applying correlation and regression coefficients to water quality variables permits a more comprehensive assessment of the waters as a whole, as well as a better understanding of the relative concentrations of different pollutants in the water, which is crucial for fast execution of initiatives aimed at improving the condition of the water (Khatoon *et al*., 2013; Tyagi *et al.,* 2020). Water is a core component of our economic and social institutions, and its availability is crucial to the maintenance of a vibrant and prosperous civilization (Murali *et al*., 2015; Bhutiani and Ahamad, 2018; Bhutiani *et al.,* 2021a&b; Ahamad *et al.,* 2022). The flowing waters of a stream are dynamic, metabolically rich ecosystem elements (Ouyang *et al*., 2006). It controls the quantity of nutrients as well as contaminants entering the water supply (Meera and Nandan, 2010; Bhutiani *et al.,* 2018; Ruhela *et al.,* 2019). In addition to reflecting their surroundings, the river additionally signifies the culture in which they find themselves and acts as a repository for the collective "sins" of mankind (Yogendra and Puttaiah, 2008). Scientifically supported decisions rely on accurate mathematical inference. Therefore, using adequate statistical methods and experiments is crucial for obtaining reliable results from the analysis of data (Schreiber *et al*., 2022). Quantitative observations of the sustainability of water are just a part of the massive datasets needed for analysis. By using statistical methods, these data

Corresponding author E-mail: gopalbot@gmail.com
Doi: https://doi.org/10.36953/ECJ.23222605

may be efficiently sorted, analyzed, and interpreted to find undetectable patterns of behavior, tendencies, and connections that would otherwise go unnoticed. Numerous factors, including human negligence and environmental variations, contribute to the inherent inaccuracy of water quality assessments. The variables of underground water quality could be easily correlated, which might provide for more efficient, real-time monitoring (Rao and Naga, 2005). Correlation is an effective method for predicting attributes with a specific level of precision (Chaubey and Patil, 2015).The paper statistically analyses the water quality parameters of the Kuwano River, Basti district, with the objective of quantifying uncertainties in a more precise manner and establishing relationships to infer the value of a variable from a set of other parameters. This is accomplished via the use of regression analysis (Rao and Naga, 2005). It facilitates the creation of prediction models, which may aid in proactive management as well as decision-making to prevent or minimize the effects of potential water quality concerns.Multivariate statistical interpretation of data has been demonstrated to be helpful in assessing riverine water quality variability and exposing temporal and geographical variations due to both natural and human influences in an array of publications (Gajendran *et al*., 2013; Ismail *et al*., 2014; Rizvi *et al*., 2015; Saxena and Saxena, 2015; Ling *et al*., 2017a; Bojago *et al*., 2023). The incorporation of multivariate statistical approaches for evaluating the health of rivers has been the focus of much research across the globe (Kuruppu *et al*., 2013; Khan *et al*., 2014; Tyagi *et al.,* 2020).This research points out the interdependence between inhabitants of Basti and the health of river waters and provides a first-hand report on water quality dynamics and pollutant load flows within the Kuwano River adjacent to Basti. This research also analyzed a correlation data matrix including the various variables.

Material and Methods

Study Area

The district of Basti, which is located in the middle Ganga plain, has a total area measuring 2,771.7 square kilometers. There are an estimated 2,780,683 people residing there as of 2021 (using Aadhar data), and its geographical coordinates are 260 23′ & 270 30′ N and 820 17′ & 830 20′ E. The Kuwano and Ghaghara are the two rivers with the greatest importance in the central and southern parts of the district. In addition to these waters, there are several nalas and ponds in the surrounding region. Within the Basti district, the Kuwano River travels approximately 55 kilometers from northwest to southeast, while it receives water from its numerous tributaries, including Bisuni, Manvar, and Kathinaya. The river serves as the city's main source of water. While passing through Basti, urban sewage, solid waste and industrial effluents are incorporated in it. The Kuwano River flows into Basti district from Siddharth Nagar and feeds the Rapti Zone in the Mid-Western Region. Using a systematic sampling design, we took water samples for analysis from three different locations along the river: upstream at Bandhuwa village near Chandokha (26° 81′ N & 82° 69′ E), in the middle of the district at Amhut (26° 77′ N & 82° 71′ E), and further down the river at Lalganj near the market (26° 65′ N & 82° 82′ E) (Figure 1). Due to the season-dependent nature of pollutant transport pathways, water samples were taken in September 2020, during the monsoon season, in January 2021, during the winter, and in May 2021, during the summer, at three sampling locations in triplicate. On-site measurements of pH, TDS, and EC were taken using digital portable devices; other variables were measured and analyzed in the research lab at Kisan P.G. College, Basti, in accordance with established laboratory protocols within twenty-four hours after collecting the samples. (APHA, 2005; Trivedi and Goel, 1984).

Statistical Analysis

Utilizing a spreadsheet in Excel, the authors determined the minimum, maximum, mean, median, standard deviation, standard error, range, count, confidence level, Pearson's correlation coefficient (r), and equation for regression for each potential combination of the water-related variables. The parameters of statistical significance were computed using the following standard equations:

$$\textbf{Standard Deviation}\ (\boldsymbol{\sigma}) = \sqrt{\frac{\boldsymbol{\Sigma(x-\bar{x})^2}}{\boldsymbol{(n-1)}}}$$

x = Sample mean (number1, number2)
n = Sample size

$$\textbf{Standard error} = \frac{\sigma}{\sqrt{N}}$$

σ = Standard Deviation
N = Total number of observations

$$\text{Pearson correlation coefficient (r)} = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \cdot \sum(y-\bar{y})^2}}$$

x and y = measurements of two variables
$\bar{x}$ and $\bar{y}$ = Means of two distributions of measurements

Regression Equation

The following formula is used to obtain the straight linear regression line:

$$\boldsymbol{Y = a + bX}$$

where X is the dependent variable, Y is the independent variable, 'a' is the angle of the slope to the line, and 'b' is the y axis intercept.

Empirical component values ('a' and 'b') may be determined using the formula:

$$\boldsymbol{b = \frac{\sum xy - \bar{X}\sum y}{\sum X^2 - \bar{X}\sum y}}$$

$$\boldsymbol{a = \bar{Y} - b\bar{X}}$$

Statistical analyses were performed to determine the importance of associations among a variety of variables. When the score of the coefficient of correlation (r) is substantial and close to one, there is a legitimate relationship between all of the variables. Predictions rely significantly on the concept of correlation, which describes the bond between two variables (Heydari *et al*., 2013). Further strongly linked variables allow for precise forecasting of conclusions. The parameters' associations were determined by regression analysis, which also serves as a framework for making predictions or forecasts (Ghildyal, 2018).

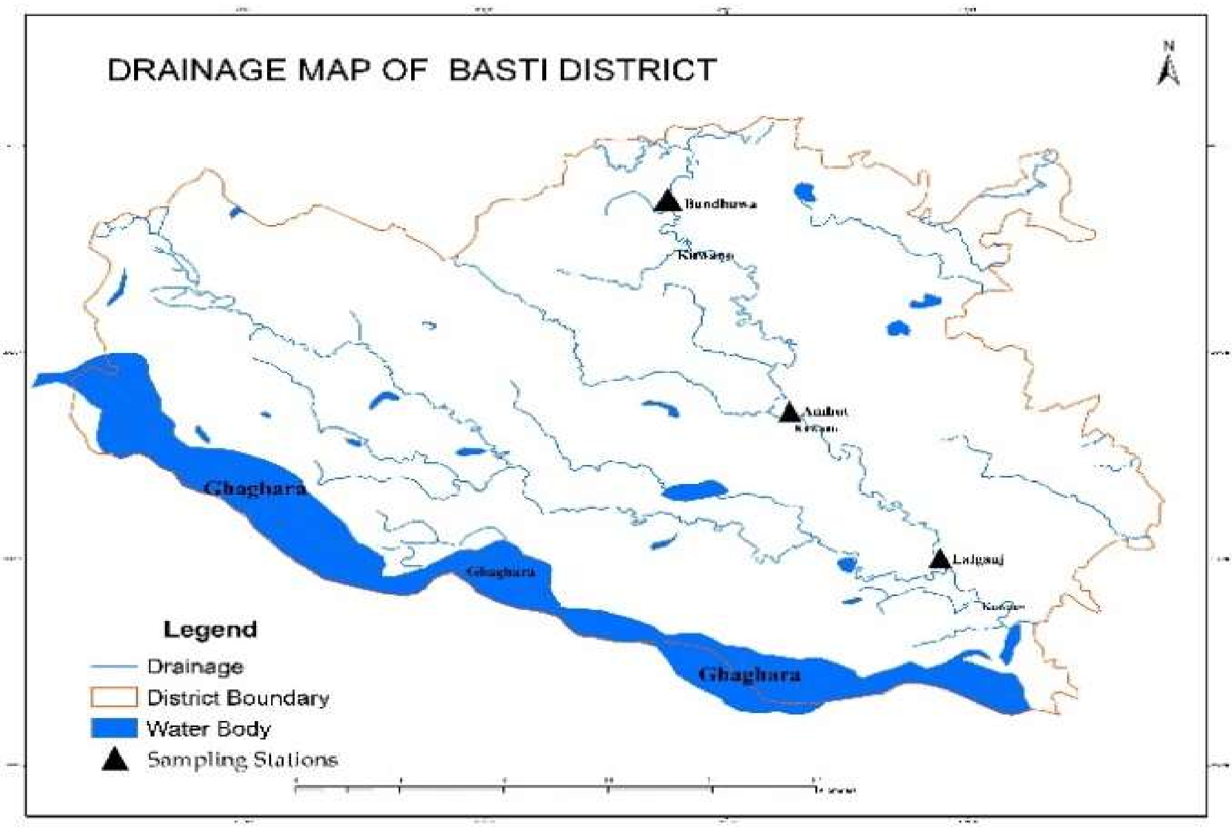

Figure 1: Map showing all three sampling sites in the study area

Results and Discussion

The hydrology of a particular region greatly influences the proportions of multiple physical and chemical variables investigated in the water sample from the Kuwano River. While ponds and lakes are closed systems, rivers are free-flowing structures where water is constantly being exchanged. A river's health may be assessed using a number of physical and chemical indicators. An essential indicator of the acid–base balance of water is its pH value. Animals' immune systems are taxed by the shift in pH of river water, and they also incur physical harm (Ismail *et al*., 2014), which renders them prone to illness. BIS recommends a pH range between 6.5 and 8.0 for water. The acidity level (pH) of Kuwano River water lies between 6.2 and 8.0 (Tables 1 & 2), while the 95% confidence interval (CL) mean value of 0.39 has a positive correlation with all the physical and chemical variables investigated. The pH and Chemical Oxygen Demand (COD) demonstrate a very strong positive correlation with an r value of 0.969. The regression equation suggests that pH increases by 0.0184 units for each unit increase in COD, and the pH value at zero COD is 2.7128. The total dissolved salts or ions in the river water influence the EC. Therefore, EC is a reliable predictor of TDS levels, the quantity of salt that influences the overall flavors of drinking water. The measured EC value for the stream water was between 108 and 186 µmhos/cm (Table 2). At the 95% confidence interval (CL), the mean of EC is estimated as 140.1±18.36. Excluding BOD, nitrate, and calcium, the EC was positively correlated with all other physical and chemical variables. A shift in electrical conductivity, whether increasing or decreasing, may be an indicator of contamination in a water body. In addition, chloride, phosphate, and nitrate ions that come from agricultural land (fertilizer wash) or sewage discharge will contribute to making the water more conductive (Pal *et al*., 2015). TDS, which stands for total dissolved solids, measures the sum of all solutes

Table 1: Seasonal variation in water quality attributes of Kuwano River (mean value)

Parameters	September 2020			January 2021			May 2021		
	Up stream	Mid stream	Down stream	Up stream	Mid stream	Down stream	Up stream	Mid stream	Down stream
pH	7.70	7.65	7.62	7.8	7.8	8.0	6.2	6.74	6.7
TDS	88	95	112	82	88	85	60	55	66
EC	171	171	186	145	136	122	112	108	110
DO	3.8	4.2	4.0	6.6	6.5	6.5	3.1	3.2	4.0
BOD	0.80	1.2	1.2	2.1	2.4	2.3	1.8	1.6	1.8
COD	3.0	3.4	3.4	3.4	3.5	3.8	2.8	2.5	3.2
Total Hardness (TH)	84	88	89	105	117	114	78	76	77
Nitrate	0.22	0.48	0.64	0.82	0.90	1.04	0.45	0.58	0.70
Ca	12.6	12.8	12.8	27.2	25.6	25.0	17.2	16.12	16.9
Mg	17.42	18.34	18.59	18.9	22.2	21.6	14.8	14.6	14.6
Total Coliform (T-coli)	340	384	468	302	312	322	258	378	388

Table 2: Statistical assessment of physical and chemical attributes of water from the Kuwano River

Statistical parameter	pH	TDS	EC	DO	BOD	COD	TH	Nitrate	Ca	Mg	T-coli
Mean	7.4	81.2	140.1	4.7	1.7	3.2	92.0	0.6	18.5	17.9	350.2
Standard error	0.2	5.7	9.4	0.5	0.2	0.1	5.0	0.1	1.9	0.9	19.4
Median	7.7	85.5	136.0	4.0	1.8	3.4	88.0	0.6	16.9	18.3	340.0
SD	0.6	17.0	28.1	1.4	0.5	0.4	15.1	0.2	5.6	2.7	58.1
Range	1.8	57.0	78.0	3.5	1.6	1.3	41.0	0.8	14.6	7.6	210.0
Standard variance	0.3	290.4	790.1	1.8	0.2	0.1	227.1	0.06	30.8	7.2	3378.1
Minimum	6.2	55	108.0	3.1	0.8	2.5	76.0	0.2	12.6	14.6	258.0
Maximum	8.0	112.0	186.0	6.6	2.4	3.8	117.0	1.0	27.2	22.2	468.0
Count	09	09	09	09	09	09	09	09	09	09	09
Confidence level (95%)	0.39	11.11	18.36	0.91	0.33	0.26	9.87	0.13	3.66	1.76	37.96
Upper confidence interval	0.99	28.11	46.46	2.31	0.83	0.66	24.97	0.33	9.26	4.46	96.06
Lower confidence interval	0.21	5.89	9.74	0.49	0.17	0.14	5.23	0.07	1.94	0.94	20.14

that occur in a given volume of water. It adds up all the ions that are less than 2 microns (0.0002 cm) in size. Aquatic creatures, especially fish eggs, may be affected by a surplus amount of overall dissolved solids, primarily due to the ionic attributes of the water. Dissolved substances have a crucial role in maintaining a healthy cell density, which is essential for aquatic organisms (Singh *et al*., 2017). High TDS levels usually imply that the water is fairly alkaline or hard. TDS levels in drinking water cannot exceed 500 mg/l. In this investigation, the average value of TDS with 95% CL was found to be 81.2±11.11. The TDS showed a negative correlation with BOD (-0.345), nitrate (-0.235), and calcium (-0.128) and a strong positive relationship with all other measured physical and biological attributes. The correlation study showed that TDS, EC, and TH are strongly correlated with each other and are likely influenced by the presence of minerals in the water. The significance of dissolved oxygen (DO) is not only from the perspective of addressing water quality issues (Agnieszka *et al*., 2014) but also for comprehending the mechanisms and causes that influence its dynamics in water bodies (Hondzo *et al*., 2013; Zhong *et al*., 2021). Reduced dissolved oxygen (DO) in rivers has a negative effect on physiological functions, leading to a decline in benthic fauna (Bu *et al*., 2021). Decreases in dissolved oxygen (DO) levels may impair pollutant degradation, natural water purification, and overall aquatic ecosystem wellness. The DO value in the current investigation varied between 3.1 and 6.6 mg/l (Tables 1 & 2). BOD was estimated to have a mean score of 4.7±0.91 at the 95% confidence level. The Pearson correlation coefficient analysis revealed a negative relationship between DO and total coliform count (-0.628), while positive interactions were observed for all other variables. DO-TH and DO-Mg show an extremely strong positive correlation with r values of 0.995 and 0.923, respectively (Table 4). The regression equation showed that DO decreased by 0.2054 units for each unit increase in TH and by 0.1369 units for each unit increase in Mg.

BOD (biological oxygen demand) or oxygen content (mg/L), which is used by microbes to breakdown organic materials in water bodies (Bhutiani and Ahamad, 2018). Microorganisms and decomposing biological waste in the water may pose a threat to the ecology of aquatics and human well-being. Dissolved oxygen levels decrease when organic material breaks down, threatening aquatic life by means of hypoxia and disrupting the delicate ecological equilibrium of the water. Therefore, BOD is an indicator of the degree of impurity of water due to organic matter. Based on the results of the current investigation, the BOD concentration was between 0.8 and 2.4 mg/l. The BOD was determined to have a mean score of 1.7 ± 0.33 at the 95% confidence level. In accordance with the results of the correlation analysis, BOD had a positive association with all other parameters investigated but a negative relationship with iron (-0.5) and total coliform (-0.983). The regression equation suggests that BOD decreases by 0.025 units for each unit increase in nitrate, and the BOD value at zero nitrate is 0.62. BOD and calcium also showed a strong positive correlation with an r value of 0.975 (Table 4).

The chemical oxygen demand (COD) is the amount of oxygen required for the breakdown of all bioavailable and non-biodegradable organic material directly into water, carbon dioxide, and other gases. Together, the BOD and COD tests may provide a rough estimate of the quantity of non-biodegradable organic compounds present in a given wastewater sample. The COD value is dependent on the condition of the river; if there is wastewater, the COD could be high, but if the river is clean, it must be low, but the value of COD is always higher than that of BOD. The BOD in the clean river was approximately 3 mg/l. The measured COD loads varied from 2.50 mg/l to 3.80 mg/l (Table 2). COD was determined to have a mean score of 3.2±0.26 at a 95% confidence interval. Although the existing investigation found a negative association between COD and total coliform (-0.194), it found significant correlations between COD and all other variables. The COD-TH pair had a strong positive correlation with an r value of 0.926 (Table 4). The regression equation found that COD increases by 1.2162 units for each unit increase in TH, and the COD value at zero TH is 73.5540. While evaluating the correlated oxygen-depletion impact of waste contaminants, the BOD and COD tests provide similar information. Therefore, both are used to assess the impact of contaminants in water (Prambudy *et al*., 2019;

Qiong, 2009; Sharma and Gupta, 2014). Under tropical climatic conditions, the BOD: COD proportions provide a useful measure of the relationship between BOD and COD concentrations in the water of rivers (Lee and Nikraz, 2015). In this study, BOD and COD were found to be strongly correlated, indicating that high levels of organic matter in the water can increase the amount of oxygen needed for degradation. The negative correlation between BOD and DO suggests that high levels of organic matter can deplete oxygen levels, leading to unfavorable conditions for aquatic life. Scientifically, water high in dissolved minerals, largely calcium and magnesium, is known as hard water. Dissolved metallic components such as aluminum, barium, strontium, zinc and magnesium, along with iron, may also contribute to hardness by generating bivalent or multivalent cations (Sengupta, 2013). The current investigation revealed that the TH levels detected in water samples collected from the Kuwano River varied from 76 mg/l to 117 mg/l, as indicated in Table 2. The 95% confidence interval for the calculated mean value of TH was 92.0 ± 9.87. Apart from the total coliform load (-0.549), all other physical and chemical variables examined correlated positively with TH (Table 2). Both magnesium and calcium compounds are significant contributors to water hardness ("total hardness"), although calcium is of greater significance in water. The hardness of calcium causes cloudiness in water. Scale, a hard and crusty grayish white substance, will form at the surfaces of pipes and other equipment if excessive calcium carbonate is present in water. The results showed that the concentration of Ca hardness varied between 12.6 mg/l and 27.2 mg/l, with a mean score of 18.5 ± 3.66 at a 95% confidence range. Calcium hardness was inversely related to TDS (-0.128), EC (-0.436) and total coliform (-0.918). The samples of water from the Kuwano River were analyzed and found to have a Mg hardness between 14.6 and 22.2 mg/l. With a 95% confidence interval (CL), the mean Mg hardness value was calculated to be 17.9 ± 1.76. While Mg hardness was found to be positively correlated with the remaining physical and chemical variables, it showed a negative correlation with the total coliform count (-0.279).The geological composition of the catchment region, soil class along with category, vegetation diversity, climate variables (precipitation-evaporation, periodical variations), terrain relief, sources of water type and magnitude (surface discharges and underground water inflows), and a number of other factors contribute to the quantities of both calcium and magnesium in rivers (Potasznik and Szymezyk, 2015). Variations in surface water chemistry are triggered by seasonal shifts in the movement of water and activity by organisms (Ling *et al*., 2017). Cations, such as calcium and magnesium in waters, show that environmental and human influences have an impact. Nitrate ions within aquatic systems are produced by both intrinsic and anthropogenic processes. Nitrate content is typically an indication of the nutritional status and extent of organic contamination within the water body; hence, measuring this parameter is an essential aspect of the evaluation of water standards (Maghanga *et al*., 2013). Nitrate nitrogen is essential for the synthesis of peptides and amino acids in all organisms (APHA, 2005). Both nitrite and nitrate are two different forms of nitrogen found in water, but at sufficiently excessive quantities, they may be harmful to human health, particularly to newborns and pregnant women (Panchagnula, 2016). Nitrate concentrations in freshwater are typically between 0.1 and 4 mg/L. Nitrate findings below 1 mg/L are indicative of safe drinking water.

Table 3: Correlation coefficient (r) for several indicators of water quality

Parameter	pH	TDS	EC	DO	BOD	COD	TH	Nitrate	Ca	Mg	T-coli
pH	1										
TDS	0.885	1									
EC	0.692	0.948	1								
DO	0.744	0.348	0.032	1							
BOD	0.132	-0.345	-0.625	0.760	1						
COD	0.969	0.744	0.493	0.885	0.371	1					
TH	0.806	0.437	0.130	0.995	0.693	0.926	1				
Nitrate	0.245	-0.235	-0.531	0.830	0.993	0.475	0.771	1			
Ca	0.349	-0.128	-0.436	0.885	0.975	0.568	0.836	0.994	1		
Mg	0.944	0.682	0.415	0.923	0.451	0.996	0.956	0.550	0.638	1	
T-coli	0.052	0.512	0.758	-0.628	-0.983	-0.194	-0.549	-0.955	-0.918	-0.279	1.000

The levels of nitrates found across various waters are mostly determined by their respective sources (Saha *et al.*, 1999). The concentration of nitrate in the water samples of the Kuwano River was determined to be within the limits of 0.2 mg/l and 1.0 mg/l, along with a mean value of 0.6 ± 0.13 when compared at the 95% confidence level. Nitrate showed a negative correlation with TDS (-0.235), EC (-0.531), iron (-0.397) and total coliform (-0.955). Other physicochemical parameters studied showed positive correlations (Table 3). Nitrate showed an extremely strong negative correlation with an r value of 0.994 (Table 4) with calcium (Ca).Total coliform (*T-coli*) bacteria is a total count or measure of the level of coliform bacteria in a water sample. Total coliform detection may be indicative of environmental contamination. *Escherichia coli* serves as a reliable marker of infestation in water supplies, either from humans or animals. Coliforms constitute an indicator of the water's overall hygienic condition and a potential source of waterborne infections (Sivaraja and Nagarajan, 2014). The total coliform count from the river water sample was found to be in the range of 258 to 468. The mean value of total coliforms at 95% CL was (350 ± 37.96). The total coliform count established a negative association (Table 3) with most of the parameters studied, e.g., DO (-0.628), BOD (-0.983), COD (-0.194), total hardness (-0.549), nitrate (-0.955), Ca (-0.918) and Mg (-0.279).Linear regression studies were performed for water-associated measures, with statistically significant correlation coefficients (R > 0.70). The regression analysis showed that the total coliforms and BOD are positively related, with a regression equation of y = 8081.573x (Table 4). The R square value of 0.2658 indicates that only 26.58% of the variation in total coliforms can be explained by BOD. The significance F value of 0.1554 suggests that the regression model is not significant, and the results should be interpreted with caution. Therefore, further research may be needed to explore other factors that could influence the total coliform count.The results of the statistical correlation study showed which combination of variables was most strongly related, as well as the trend of that link. The results indicate that pH is strongly associated with TDS (r = 0.885), DO (r = 0.744), COD (r = 0.969), TH (r = 0.806), and Mg (r = 0.944). TDS is closely related to EC (r = 0.948) and marginally associated with COD (r = 0.744). EC is strongly correlated with T. coli (r = 0.758). DO was closely linked to TH (r = 0.995) and showed a low degree of association with nitrate (r = 0.830), Ca (r = 0.885), and Mg (r = 0.923). BOD had a weak correlation with nitrate (r = 0.993) and a

Table 4: Linear correlation coefficient (r) and regression equation for some pairs of parameters that have significant correlation values

Pairs of Parameters	r value	Coefficient regression		Regression equation
		a	b	
pH - TDS	0.885	-0.2577	62.0206	pH = -0.2577 (TDS) + 62.0206
pH - DO	0.744	0.8689	-2.2552	pH = 0.8689 (DO) - 2.2552
pH - COD	0.969	0.0184	2.7128	pH = 0.0184 (COD) + 2.7128
pH - TH	0.806	-2.9823	96.5243	pH = -2.9823 (TH) + 96.5243
pH - Mg	0.944	-0.3829	17.1734	pH = -0.3829 (Mg) + 17.1734
TDS - EC	0.948	0.1648	100.0549	TDS = 0.1648 (EC) + 100.0549
TDS - COD	0.744	0.0637	-1.0120	TDS = 0.0637 (COD) - 1.0120
EC – T. coli	0.758	-30	3641.3330	EC = -30 (T. coli) + 3641.3330
DO - BOD	0.760	0.0958	1.4041	DO = 0.0958 (BOD) + 1.4041
DO - COD	0.885	0.6095	0.7404	DO = 0.6095 (COD) + 0.7404
DO - TH	0.995	-0.2054	77.7054	DO = -0.2054 (TH) + 77.7054
DO - Nitrate	0.830	0.2287	-0.2087	DO = 0.2287 (Nitrate) - 0.2087
DO - Ca	0.885	0.1684	16.1615	DO = 0.1684 (Ca) + 16.1615
DO - Mg	0.923	-0.1369	15.1369	DO = -0.1369 (Mg) + 15.1369
BOD - Nitrate	0.993	-0.025	0.62	BOD = -0.025 (Nitrate) + 0.62
BOD - Ca	0.975	4.65	8.68	BOD = 4.65 (Ca) + 8.68
COD - TH	0.926	1.2162	73.5540	COD =1.2162 (TH) + 73.5540
COD - Mg	0.996	-0.0270	14.7432	COD =-0.0270 (Mg) + 14.7432
TH - Nitrate	0.771	-0.065	5.5816	TH = -0.065 (Nitrate) + 5.5816
TH - Ca	0.836	0.54	-24.84	TH =0.54 (Ca) - 24.84
TH - Mg	0.956	0.1	6.9666	TH = 0.1 (Mg) + 6.9666
Nitrate - Ca	0.994	-1.2985	17.4888	Nitrate = -1.2985 (Ca) +17.4888

strong correlation with Ca (r = 0.975). COD is strongly correlated with TH (r = 0.926). Although the correlation analysis minimizes overall decision unpredictability, the regression equation can be used for predictive purposes (Shyamala *et al.*, 2008), and both can aid in the evaluation regarding the water's condition.

Conclusion

In the case of rivers, the quality of the water analysis along with the systematic application of correlation and regression techniques can help in ascertaining the overall condition of water and quantifying contaminants, which provides valuable information for decision-making in pollution management. The water flowing in the Kuwano River is suffering owing to the discharge of surrounding home sewage, agricultural runoff, and adjoining business and industrial activities. This study provides a baseline for monitoring the condition of water in the Kuwano River and has potential utility for devising strategies for managing and protecting this important aquatic ecosystem.

Conflict of interest

The authors declare that they have no conflict of interest.

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