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Efficiency of Water Treatment Plant in Tlawng River, Aizawl, Mizoram

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ABSTRACT
The current study investigated the water quality of the Tlawng river for a year (February 2022 to January 2023), using both pre-treated and treated water samples. The Tlawng river is an important river since the population of Mizoram's capital city, Aizawl, rely heavily on its flow for drinking water. The water physico-chemical parameters were compared with standards established by World Health Organization (WHO), the Indian Council of Medical Research (ICMR), the Bureau of Indian Standards (BIS), and the United States of Public Health (USPH). With an exception of DO and BOD in pre-treated water samples, all parameters measured during the study period were within acceptable limits.

Key words: Water quality, Physico-chemical parameters, Seasonally, Pre-treated water, Treated water, Scientific standards.

INTRODUCTION

Water is becoming a scarce resource due to pollution and improper utilization from human activities such land development, urbanization, farming, usage of fertilizers, and sewage disposal (Patil and Tijare 2001). The increasing population, agricultural output, and industrial growth have resulted in an increased demand for fresh water. Fresh water is thus becoming scarce. Consequently, the development of water-efficient technology for industry and agriculture, along with the introduction of a water price system, will prioritize the management of patterns of water consumption in the next decades. City sewage and industrial waste discharges are the main sources of river contamination. 10% of produced wastewater is treated before being discharged into our bodies of water (Anonymous 2011).

The north-eastern portion of India has extremely high rainfall. India's water resources are very variable in space, driven by precipitation patterns and orography. Because India's temperature is generally hot, evaporation rates are exceptionally high, influencing runoff significantly. Only 47% of all precipitation is turned into runoff. The summer's scorching temperatures and other weather conditions cause approximately 45% of rainwater to evaporate. Precipitation replenishes groundwater in only 8.5% of cases. India's water contamination has reached a stage of no return. Almost all of India's river systems are currently heavily polluted. Researchers at the National Environmental Engineering Research Institute (NEERI) in Nagpur estimate that about 70% of India's water is polluted (Martin 1998).

The principal water sources for drinking in Mizoram are rivers, lakes, springs, and ponds. However, due to the steep geography of the area, there is very little capacity for retaining water, which means that most rivers and streams dry up during the dry season, creating a serious water scarcity. Due to the state's inadequate drainage infrastructure, a significant amount of trash from households, farms, and other sources is dumped either directly or indirectly into adjacent rivers (Lalparmawii and Mishra 2012). Many places experience a severe water deficit in the summer. To check the significance and validity of the data on water quality analysis, statistical analyses, namely the correlation coefficient, was computed between various water quality attributes.

MATERIALS AND METHODS

Study area

The Tlawng river flows in Mizoram in northeastern India (Fig.1). The longest river in Mizoram is the Tlawng, which covers the state at a distance of roughly 185 km. The Tlawng river serves as the primary water supply source for the city of Aizawl. The river is vital to Aizawl City since it provides potable water. The Public Health Engineering Department (PHED) of the Mizoram Government is responsible of overseeing the programs' maintenance and service (Thasangzuala 2015). The primary

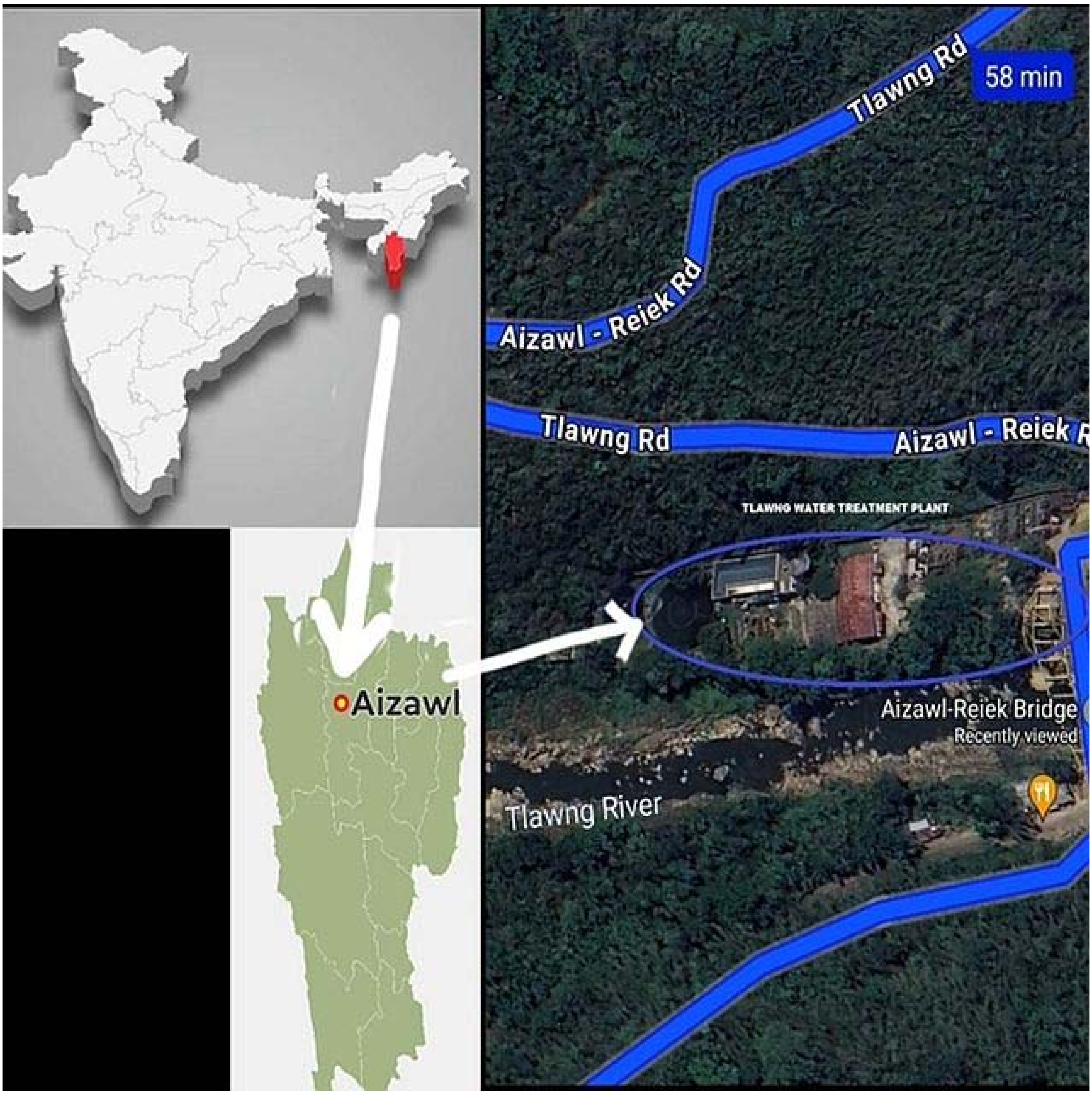

Figure 1. Location of the study area

processes used in the treatment of surface water include screening, sedimentation, coagulation, filtration, and disinfection (Vanlalhruaitluanga 2022).

Methodology

Water samples in triplicate were collected at seasonal intervals (pre-monsoon, monsoon and post-monsoon) from the locations specified over a year, from February 2022 to January 2023. A potable pH metre was used to take on-site pH measurements. The chloride content was determined using the modified Mohr's Argentometric titration method. The dissolved oxygen (DO) and biological oxygen demand (BOD) were determined using the Modified Winkler's Azide titration method. Nitrite-N (NO_2^-) and phosphate-P levels were determined using a spectrophotometric method (Anonymous 2005). In order to safeguard public health, the measured parameters were compared to drinking water standards set by scientific organizations such as Indian Council of Medical Research (Anonymous 1996), United States of Public Health (Anonymous 1962), World Health Organization (Anonymous 2008), and Bureau of Indian Standards (Anonymous

2003).

RESULTS AND DISCUSSION

pH

During the study period, the pH of pre-treated water ranged from 7 to 7.6, while treated water ranged from 7.2 to 7.8 (Fig. 2). The pH of the water was discovered to be higher during the post-monsoon season and slightly lower during the monsoon. Lower pH levels during rainy seasons may be attributable to increased turbidity and dilution of alkaline substances (Narain and Chauhan 2000). However all values are within the BIS/ICMR-established standards for water quality range (Table 1). A positive and significant correlation of pH was found with DO (0.99) and chloride (0.65) while a negative and significant correlation of pH was found with BOD (1), nitrite-N (0.96) and phosphate-P (0.96) (Table 2).

Chloride

During the investigation, the chloride concentration of pre-treated water ranged from 22 to 25mg/L, whereas treated water ranged from 24 to 28mg/L (Fig. 3). The chloride content of the water was higher in the pre-monsoon season and decreased in the monsoon season. Reduced river flow and a significant volume of sewage being carried into the river are further factors contributing to higher chloride concentrations during the pre-monsoon (Singh and Gupta 2010). The values are within the ICMR/USPH-established water quality standard (Table 1). A positive and significant correlation of chloride was found with DO (0.73) and pH (0.65) while a negative and significant correlation of chloride was found with BOD (0.65) and nitrite-N (0.83) (Table 2).

Dissolved Oxygen (DO)

For pre-treated water, the DO content value over the study period varied between 4.5 and 5 mg/L, and for treated water, it ranged between 5.5 and 6.5 mg/L (Fig. 4). The DO concentration of the water was higher in the post-monsoon season and lower in the monsoon season. High DO in the post-monsoon season could be attributed to enhanced oxygen solubility at low temperatures (Sabata and Nayar 1995). DO values of pre-treated water samples were consistently lower than the BIS/ICMR acceptable limit throughout the pre-monsoon and monsoon seasons (Table 1). A positive and significant correlation of DO was found with pH (0.99) and chloride (0.73) while a negative and significant correlation of DO was found with BOD (0.99),

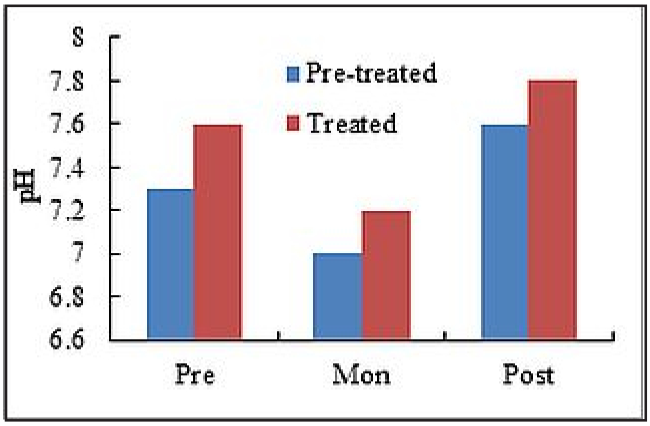

Figure 2. Seasonal variations in pH of river water

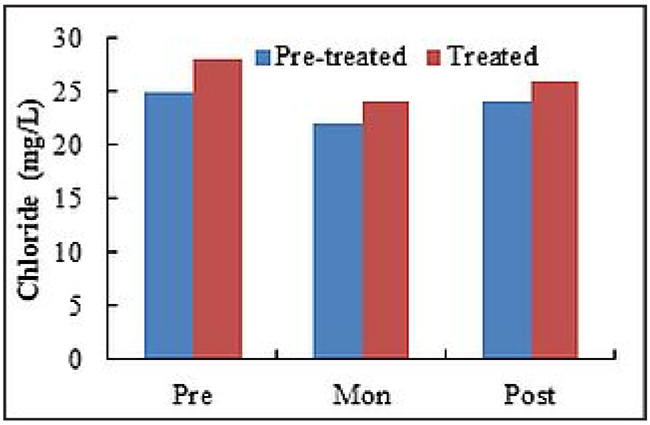

Figure 3. Seasonal variations in chloride of river water

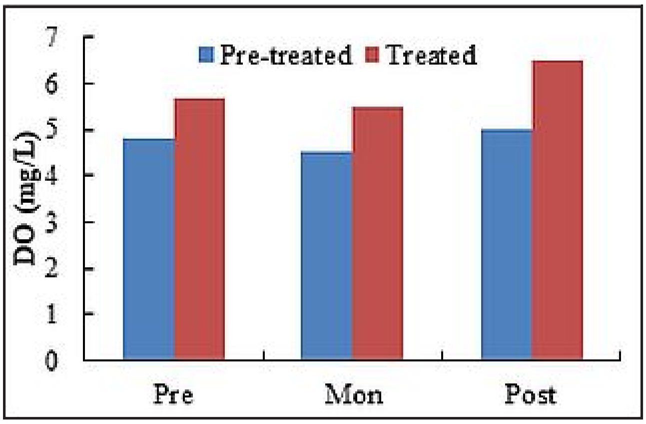

Figure 4. Seasonal variations in DO of river water

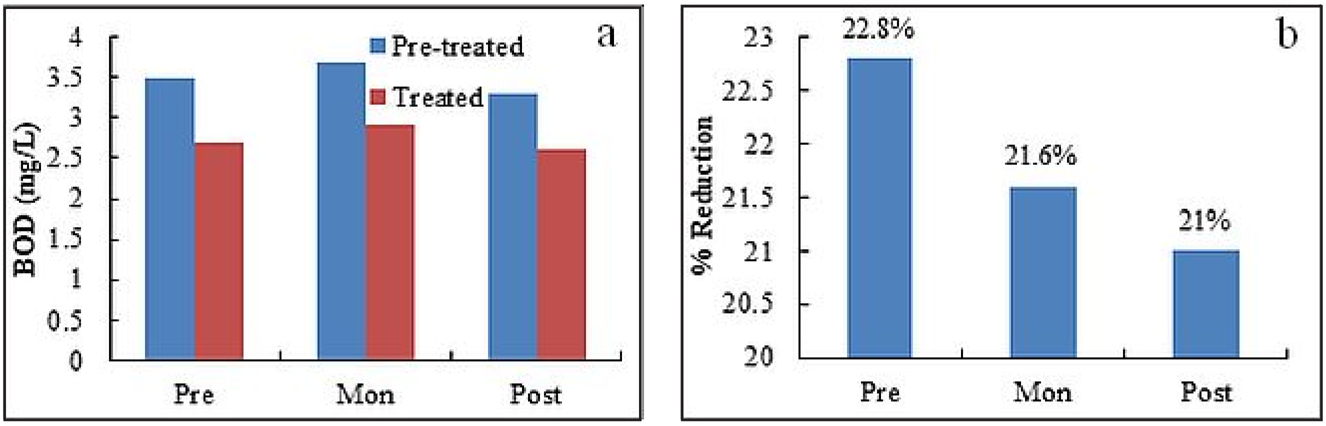

Figure 5(a). Seasonal variations in BOD of river water, (b). BOD removal efficacy

nitrite-N (0.98) and phosphate-P (0.92) (Table 2).

Biological Oxygen Demand (BOD)

During the study period, the BOD level in pre-treated water ranged from 3.3 to 3.7mg/L, while in treated water it ranged from 2.6 to 2.9mg/L (Fig. 5a). BOD level was greater during the monsoon season and decreased during the post-monsoon season. The massive inflow of soil and other organic matter into water bodies brought on by surface runoff during the monsoon season causes oxygen to be depleted, and the subsequent drop in temperature inhibits the growth of any microorganisms that could cause low BOD in the post-monsoon period (Vanlalhruaitluanga 2022). WTP's BOD removal efficacy (Fig. 5b) was between 21% (post-monsoon) to 22.8% (pre-monsoon). Throughout the season, BOD values of pre-treated water samples were consistently above the BIS permitted range (Table 1). A positive and significant correlation of BOD was found with nitrite-N (0.96) and phosphate-P (0.96) while a negative and significant correlation of BOD was found with DO (0.99), pH (1) and chloride (0.65) (Table 2).

Nitrite-N (NO_2^-)

Throughout the study period, the range of Nitrite-N concentration values for pre-treated water was 0.012 to 0.024 mg/L, whereas for treated water it was 0.01 to 0.019mg/L (Fig. 6a). Nitrite-N content increased during the monsoon season and decreased during the post-monsoon season. WTP's efficiency in removing nitrite-N (Fig. 6b) varied from 13.3% (pre-monsoon) to 20.8% (monsoon). Changes in ammonia oxidation, nitrate reduction, nitrogen recycling, and microbial decomposition of planktonic detritus could all be the cause of these changes (Asha and Diwakar 2007). The values are within the BIS-established quality of water range (Table 1). A positive and significant correlation of nitrite-N was found with BOD (0.96)

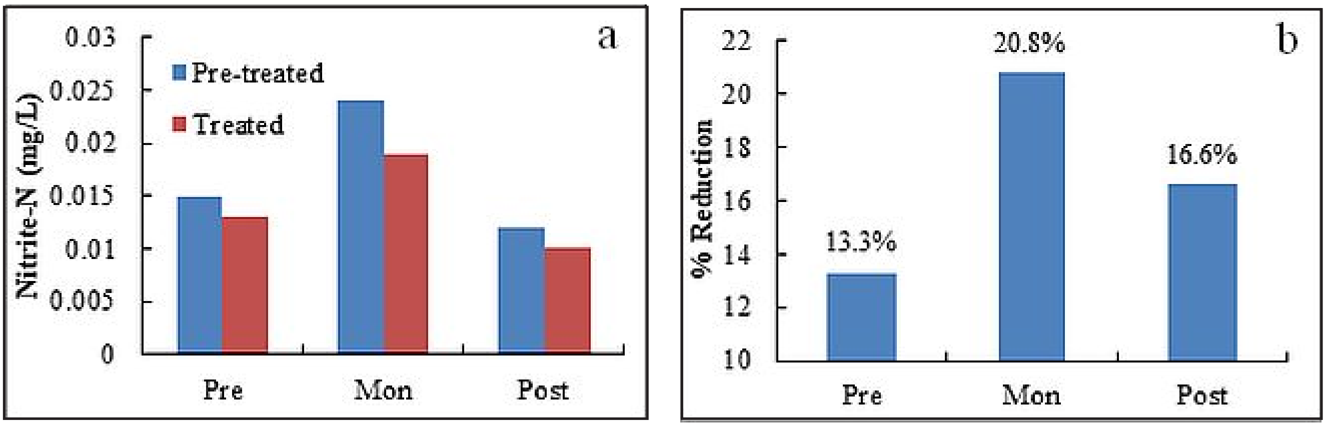

Figure 6(a). Seasonal variations in NO_2^- of river water, (b). NO_2^- removal efficacy

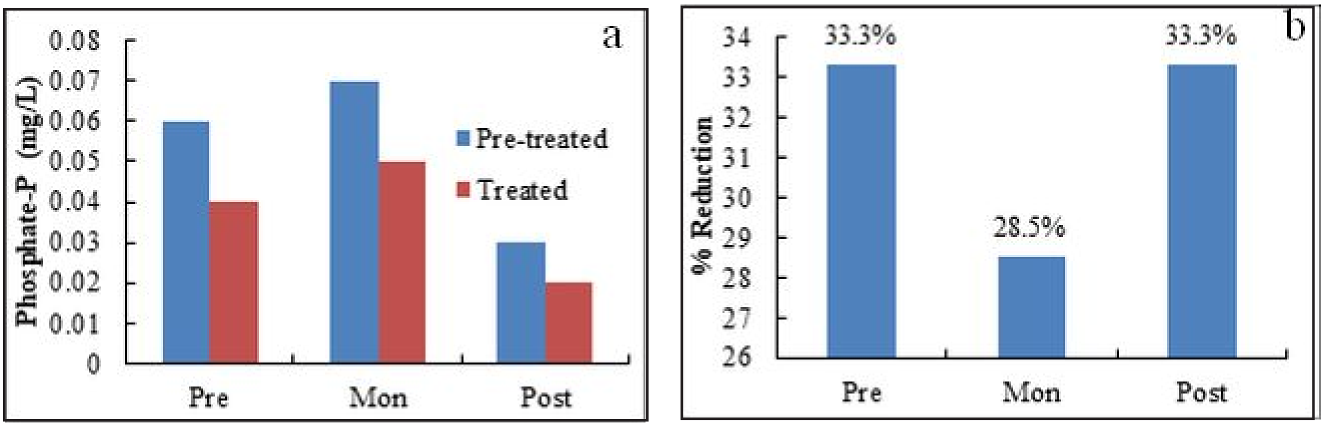

Figure 7(a). Seasonal variations in PO_4^{3-} of river water, (b). PO_4^{3-} removal efficacy

Table 1. Comparison of samples with the guidelines

Parameters	Standards				Water quality range	
	BIS	ICMR	USPH	WHO	Pre-treated	Treated
pH	6.5-8.5	6.5-8.5	-	-	7-7.6	7.2-7.8
Chloride (mg/L)	-	250	250	-	22-25	24-28
DO (mg/L)	>5	>5	-	-	4.5-5	5.5-6.5
BOD (mg/L)	3	-	-	-	3.3-3.7	2.6-2.9
Nitrite-N (mg/L)	1	-	-	-	0.012-0.024	0.01-0.019
Phosphate-P (mg/L)	-	-	0.1	-	0.03-0.07	0.02-0.05

Table 2. Correlation matrix

	DO	BOD	Nitrite-N	Phosphate-P	pH	Chloride
DO	1					
BOD	-0.99**	1				
Nitrite-N	-0.98**	0.96**	1			
Phosphate-P	-0.92**	0.96**	0.84**	1		
pH	0.99**	-1**	-0.96**	-0.96**	1	
Chloride	0.73*	-0.65*	-0.83**	-0.41	0.65*	1

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level.

and phosphate-P (0.84) while a negative and significant correlation of nitrite-N was found with DO (0.98), pH (0.96) and chloride (0.83) (Table 2).

Phosphate-P (PO_4^{3-})

During the study period, the phosphorus concentration of pre-treated water ranged from 0.03 to 0.07mg/L, whereas treated water ranged from 0.02 to 0.05mg/L (Fig. 7a). The phosphate-P level of the water was higher during the monsoon season and decreased during the monsoon season. The elevated Phosphate-P levels during the monsoon season could be attributed to the dissolution of phosphate ions from the soil as well as agricultural run-off carrying phosphate fertilizers in the water body carried excessive rainfall (Sunar 2018). The efficiency of WTP in removing phosphate-P (Fig. 7b) ranged from 28.5% (monsoon) to 33.3% (pre- and post-monsoon). The values are within the USPH-established water quality guideline (Table 1). A positive and significant correlation of phosphate-P was found with BOD (0.96) and nitrite-N (0.84) while a negative and significant correlation of phosphate-P was found with DO (0.92) and pH (0.96) (Table 2).

CONCLUSION

The physicochemical properties of all water samples collected from the pre-treated and treated Tlawng river during the study period were compared to drinking water standards specified by various authorities. With the exception of pre-treated DO and BOD, all of the physico-chemical parameters tested during the study period were found to be within the permissible ranges. Long-term use of pre-treated water may have detrimental consequences for human health. It is not recommended to drink water directly from the Tlawng river without treatment. Regular monitoring of the Tlawng river's water quality is advised. Waste disposal and other anthropogenic activities that damage river water quality should be avoided and reduced. The optimization and upgrade of the current operational unit will significantly improve the effectiveness of treated water. Experimenting with linear correlation provides an accurate estimate of river water quality based on a few parameters.

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Conflict of interest: Author declares no conflict of interest.

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