Study of Seasonal Variation in Physicochemical Characteristics of Tlawng River, Aizawl, Mizoram

Lalnunthari Ngente
PhD Fellow, Department of Environmental Science, Mizoram University, Aizawl-796004, Mizoram, India.

Abstract:
Purpose: The current study aims to evaluate the water quality of the Tlawng river for both pre-treated and treated water. The Tlawng river is an important river to study since the residents of Mizoram's capital city, Aizawl, rely significantly on its discharge for drinking water. The Tlawng river also has significance for research because it transports biomedical effluents from Civil Hospital and Ebenezer Hospital. **Methodology:** Seasonal studies were conducted on a range of physico-chemical properties (pre-monsoon, monsoon, and post-monsoon seasons). The analysis was conducted using the procedure described in "Standard Methods for Examination of Water and Wastewater." The results were contrasted with scientific standards set by organisations like the World Health Organisation (WHO), the Indian Council of Medical Research (ICMR), the Bureau of Indian Standards (BIS), and the United States of Public Health (USPH). **Results:** With the exception of pre-treated turbidity and alkalinity, all of the physicochemical parameters tested during the study period were found to be within the acceptable range. Electrical Conductivity and Total Dissolved Solids levels were found to be higher during the pre-monsoon season, which could be attributed to inadequate water availability from sources, increasing salt concentrations, and the leaching of various pollutants and micronutrients from groundwater. Turbidity and acidity have higher values during the monsoon season, which is associated with heavy rainfall that washes adjacent fertilised agricultural fields, city waste, and other contaminants into river bodies of water. It was also found that the pre-monsoon season had increased total hardness and alkalinity. This might be attributed to a number of factors, including low water tables, water evaporation, and activities like bathing and cleaning along the bank using soap or detergent that contains alkalinity- and hardness-causing compounds. **Conclusion:** This study revealed the importance of taking serious management activities and methods to protect, conserve, and manage the Tlawng river. It is not recommended to drink water directly from the Tlawng river without treatment. It is vital to investigate the Tlawng river's water quality before an emergency occurs.

Keywords: Physico-chemical properties, pre-treated water, treated water, water quality, seasonal studies, scientific standards.

Introduction

Water quality refers to its chemical, physical, and biological qualities (Spellman, 2013) [1]. Water quality is a measure of the condition of a body of water based on the needs of various biotic species as well as any human usage or purpose. Water pollution is defined as the presence of unpleasant and hazardous substances in water in concentrations sufficient to render it unfit for use. It threatens the long-term survival of marine ecosystems and water quality (Banadda et al., 2009) [2].

Mizoram (the Land of the Mizos) is located in northeastern India, at the southernmost tip. Since all of Mizoram's rivers are monsoon-fed, their greatest flow occurs in the post-monsoon and monsoon seasons. The region contains a range of climate regimes that are primarily depending on the southwest monsoon of India. Surface water is scattered throughout the uneven landscape in the form of streams and rivers. In Mizoram, rivers, lakes, springs, and ponds are the primary sources of drinking water. However, due to the region's steep geography, there is very little water retention capacity, therefore most rivers and streams dry up during the dry season, resulting in a severe water deficit. A substantial amount of agricultural, domestic, and other pollutants are released directly or indirectly into surrounding rivers since the state lacks an effective drainage infrastructure (Lalparmawii and Mishra, 2012) [3]. Natural resources in the region are under threat due to fragmentation, unsustainable shifting farming techniques, degradation, and deforestation. During the summer, many localities have acute water shortages. Mizoram is very vulnerable to climate change and fluctuation, which is exacerbated by the region's poor infrastructure development (Lalthanpuia et al., 2022) [4].

In developing states like Mizoram, the majority of rural communities lack access to potable water that has been treated. The main supply of water for people is surface water, which is found scattered in many streams and rivers that run through the mountainous landscape because subsurface water is difficult to obtain because of the terrain's hills. In Mizoram, the availability of surface and groundwater varies greatly in both space and time. Human health and the health of other living things are impacted by poor water quality. Water quality is threatened by a rapid rise in human population and urban development, which results in a shortage of water supplies.

The Tlawng river, which flows through Mizoram, is the longest river in the country, measuring around 185.5 km inside the state. It is crucial for research because it transports biomedical effluents from Civil Hospital, the largest state hospital, and Ebenezer Hospital, the most renowned private hospital, which recently opened on the river's bank, along with domestic and municipal sewage from Aizawl's western suburbs. Buildings built into the side of mountains, municipal trash dumps, and untreated sewage poured straight into the river all cause significant pollution and destruction to the Tlawng river.

Methodology

Water samples were collected seasonally (in triplicate) from the specified locations over a year, from February 2022 to January 2023. The data was then categorised as pre-monsoon, monsoon, and post-monsoon seasons. The investigation followed the methodology specified in the American Public Health Association's (APHA) [5] 'Standard Methods for Examination of Water and Wastewater'. On-site measurements of electrical conductivity (EC) and Total Dissolved Solids (TDS) were taken with a potable EC and TDS metre. Turbidity was determined using a nephalometer. The total alkalinity, total hardness, and acidity were all determined using the titration method. The observed parameters were compared to drinking water standards established by scientific bodies such as the BIS [6], ICMR [7], WHO [8], and USPH [9] in order to safeguard public health.

Results and Discussion

1. **Electrical Conductivity (EC)**
   Pre-treated water had electrical conductivity values ranging from 165µS to 170µS, while treated water had values between 157µS and 161µS. (Figure 1). The EC was found to be lower during the monsoon season, which could be related to water dilution from rainfall and rising water levels. The pre-monsoon and post-monsoon periods were seen to have higher EC values, which could be attributed to the elevated concentration of salts and lower water table (Thasangzuala and Mishra, 2014) [10]. Throughout the seasons, the EC values remained within the ICMR/USPH permitted limit. (Table 1). The EC removal effectiveness of WTP ranged from 4.19% (post-monsoon) to 5.29% (pre-monsoon). (Figure 7).

2. **Total Dissolved Solids (TDS)**
The total dissolved solids values for pre-treated water ranged from 85mg/L to 89mg/L, while treated water ranged from 81mg/L to 84mg/L. (Figure 2). TDS levels were found to be greater during the pre-monsoon season, which might be related to limited water availability from sources, resulting in the leaching of various contaminants and nutrients from groundwater (Zahida and Rajendra, 2017) [11]. The results reveal that all values fall within the BIS/ICMR-established water quality range. (Table 1). The TDS removal effectiveness of WTP ranged from 4.5% (post-monsoon) to 5.6% (pre-monsoon). (Figure 8).
3. **Total Hardness (TH)**
The total hardness results for pre-treated water ranged from 60mg/L to 67mg/L, whereas those for treated water ranged from 54mg/L to 58mg/L. (Figure 3). The total hardness was found to be higher during the pre-monsoon season, which could be attributed to water evaporation, low water tables, and washing and bathing activities along the bank with soap or detergent containing hardness-causing agents such as calcium and magnesium (Lalbiakmawia anf Kumar, 2020) [12]. The data reveal that all values fall within the BIS/ICMR-established water quality range. (Table 1). The total hardness elimination effectiveness of WTP varied from 9.5% (post-monsoon) to 13.4% (pre-monsoon). (Figure 9).
4. **Total Alkalinity (TA)**
The alkalinity levels in pre-treated water ranged from 120mg/L to 128mg/L, while treated water ranged from 114mg/L to 119mg/L. (Figure 4). The alkalinity was found to be higher during the pre-monsoon season, possibly due to washing clothes in the reservoir with detergents containing dissolved carbonate and bicarbonates (Smitha et al., 2007) [13]. Pre-treated alkalinity readings were not within the ICMR/USPH permissible range throughout the pre-monsoon and post-monsoon season. (Table 1). The alkalinity removal effectiveness of WTP ranged from 4% (post-monsoon) to 7% (pre-monsoon). (Figure 10).
5. **Turbidity**
Turbidity levels for pre-treated water were between 8.8NTU and 9.7NTU, while treated water ranged between 4.4NTU and 5NTU. (Figure 5). Turbidity was found to be higher during the monsoon season and lower during the post-monsoon season, which could be attributed to heavy rainfall bringing sediment, organic and inorganic substance, suspended matter, and other contaminants into the water body from the area of catchment (Jehamalar et al., 2010) [14]. Because particles move more slowly throughout the winter, reduced turbidity in sample water could be due to solids sedimenting at the bottom. Throughout any season, pre-treated turbidity values exceeded the USPH/WHO-permitted standard. (Table 1). The turbidity elimination effectiveness of WTP ranged from 47.7% (pre-monsoon) to 50% (post-monsoon). (Figure 11).
6. **Acidity**
The acidity levels in pre-treated water ranged from 13.7mg/L to 15.5mg/L, while treated water ranged from 10.5mg/L to 12.3mg/L. (Figure 6). The acidity was found to be higher during the monsoon season, which could be attributed to an increase in organic debris that promotes microbial decomposition and carbon dioxide emission (Singh et al., 2010) [15]. Furthermore, rainfall is slightly acidic. Low rainfall and low organic loading may contribute to lower acidity levels during the post-monsoon season. The acidity removal efficacy of WTP varied from 20.6% (monsoon) to 23.3% (post-monsoon). (Figure 12).

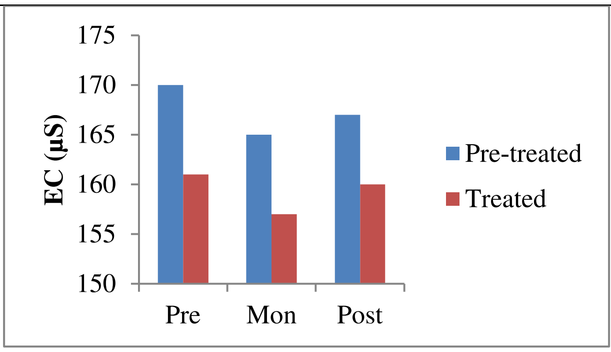

Fig 1. Seasonal variation in EC of river water

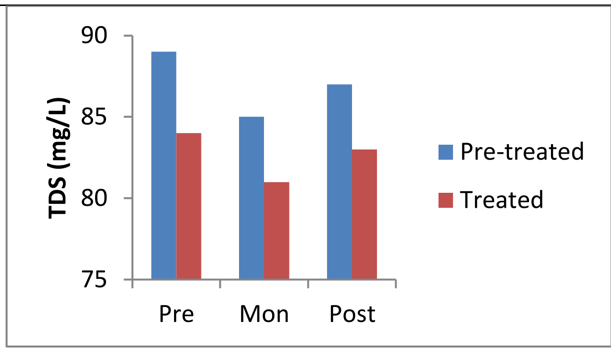

Fig 2. Seasonal variation in TDS of river water

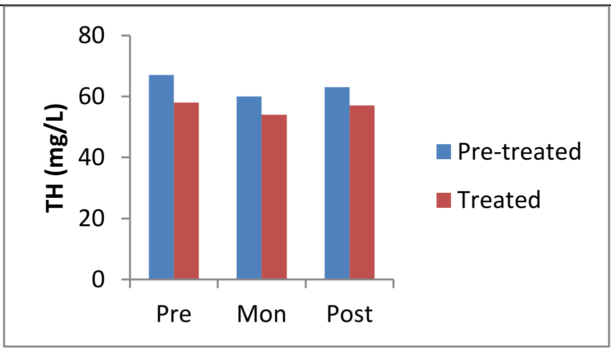

Fig 3. Seasonal variation in TH of river water

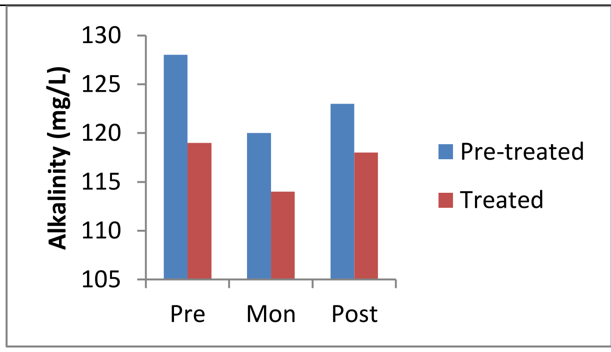

Fig 4. Seasonal variation in TA of river water

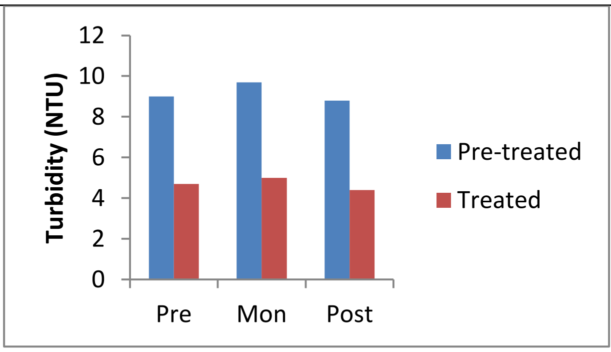

Fig 5. Seasonal variation in Turbidity of river water

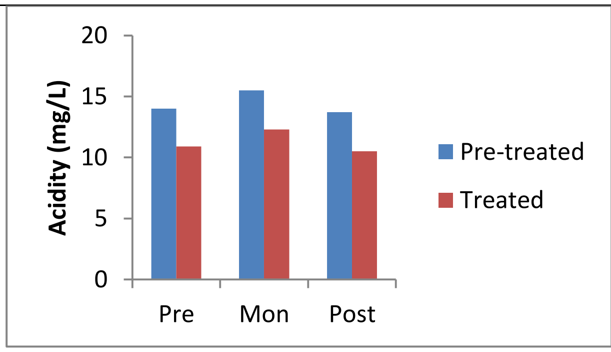

Fig 6. Seasonal variation in acidity of river water

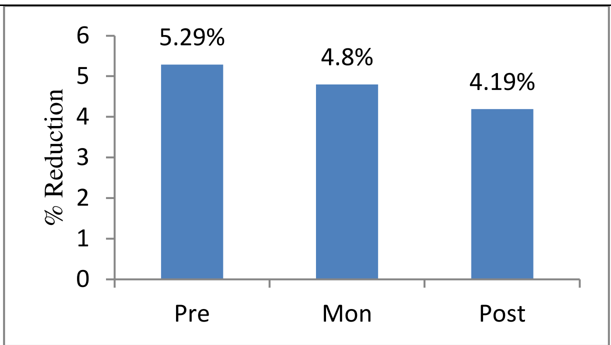

Fig 7. EC removal efficacy of river water

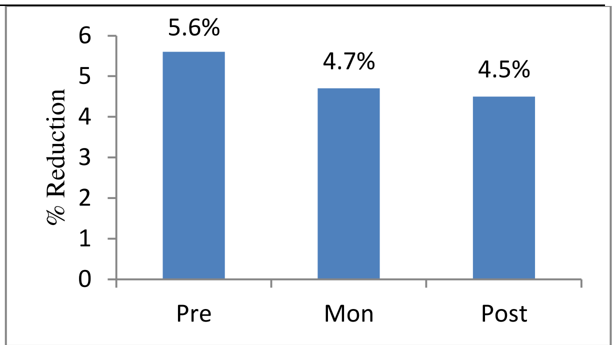

Fig 8. TDS removal efficacy of river water

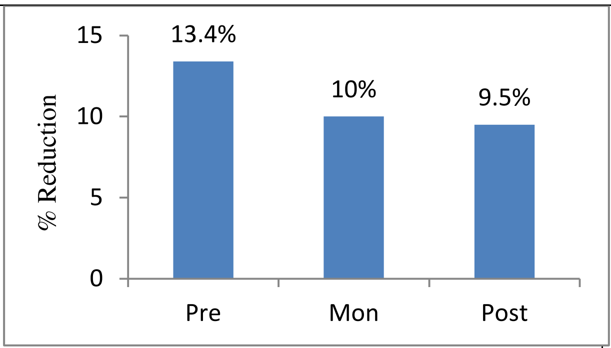

Fig 9. TH removal efficacy of river water

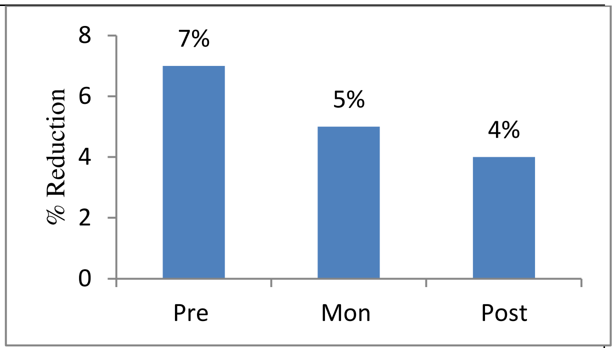

Fig 10. TA removal efficacy of river water

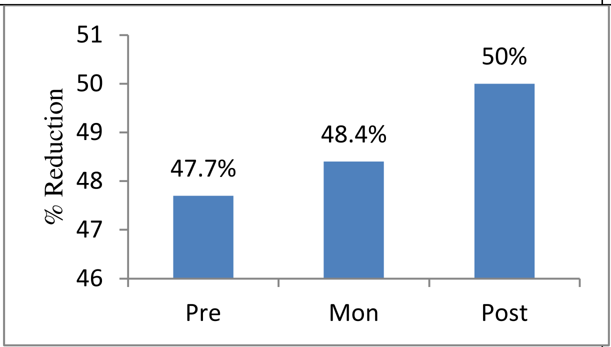

Fig 11. Turbidity removal efficacy of river water

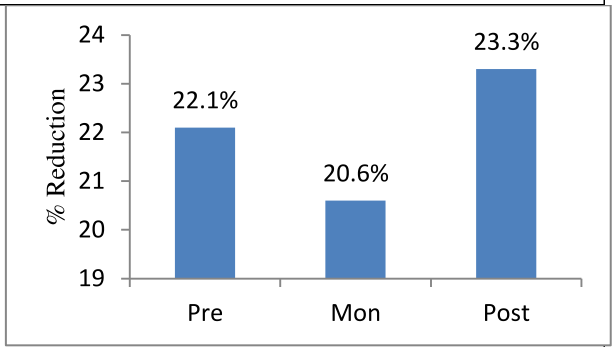

Fig 12. Acidity removal efficacy of river water

Table 1: Comparison of findings with water quality standards given by scientific agencies

Parameters	Standards				Water quality range during the study period	
	BIS	ICMR	USPH	WHO	Pre-treated	Treated
EC (µS)	-	300	300	-	165-170	157-161
TDS (mgL^{-1})	500	500	-	-	85-89	81-84
Turbidity (NTU)	-	-	5	5	8.8-9.7	4.4-5
Alkalinity (mgL^{-1} $CaCO_3$)	-	120	120	-	120-128	114-119
Total Hardness (mgL^{-1} $CaCO_3$)	300	300	-	-	60-67	54-58
Acidity (mgL^{-1})	-	-	-	-	13.7-15.5	10.5-12.3

Conclusion

The physicochemical parameters of all water samples obtained from the Tlawng river during the study period were compared to drinking water standards established by several scientific authorities. All of the physicochemical parameters examined throughout the study period were found to be within the permitted limit, with the exception of pre-treated turbidity and alkalinity. It is not advisable to drink water directly from the Tlawng river. The long-term usage of pre-treated water may have negative impacts on human health. Regular monitoring of the Tlawng river's water quality is recommended. Waste disposal and other human-caused activities that can jeopardise river water quality should be avoided and limited.

Water-polluting industries should be thoroughly identified, public involvement with watershed communities should be promoted, and all liquid waste-producing industries should be regulated to ensure effluent regulations are met. Sewage treatment plants need to be built in the homes within the catchment region, even if both hospitals have effluent treatment facilities that discharge their wastewater into the river. The study's findings may serve as a foundation for future research on how to maintain the water quality of the Tlawng river by developing appropriate management plans.

Acknowledgements

The author is grateful to the Public Health Engineering Department and the Mizoram Pollution Control Board for their assistance and support in carrying out this study work efficiently and effectively.

References

1. Spellman, F.R (2013). *Handbook of Water and Wastewater Treatment Plant Operations*. 3rd Edition. CRC Press. Boca Raton, 1-923.
2. Banadda, E., Kansiime, F., Kigobe, M., Kizza, M. and Nhapi, I (2009). Landuse-based non-point source pollution: a threat to water quality in Murchison Bay, Uganda. Water policy, 11(S1): 94-105.
3. Lalparmawii, S. and Mishra, B.P (2012). Seasonal variation in water quality of Tuirial river in vicinity of the Hydel project in Mizoram, India. Science Vision, 12(4): 159-163.
4. Lalthanpuia, Laldinpuii, H., Lalmalsawma, S. and Hrahsel J.L (2022). Assessment of District Level Climate Vulnerability of Mizoram, India: Water Resources Approach. Journal of Climate Change, 8(2): 21-29.
5. APHA, American Public Health Association (2012). Standards methods for the Examination of Water and Wastewater, Washington, D.C, USA, 22nd edition.
6. BIS, Bureau of Indian standards (2005). Indian Standards for Drinking Water Quality Specifications (IS 10500-1991).
7. ICMR, Indian Council of Medical Research (1996). Guidelines for Drinking Water Manual, New Delhi, India, 456-463.
8. WHO, World Health Organization (2004). Guidelines for Drinking Water Quality, Vol 1, 3rd edition. Geneva, Switzerland.
9. USPH, United States Public Health (1962). Drinking Water Standards. P.H.S. Pub. U.S. Department of Health, Education and Welfare, Washington D.C.
10. Thasangzuala, Z.R. and Mishra, B.P (2014). Physical characteristics of public drinking water in Aizawl city, Mizoram, India. International Journal of Engineering and Technical Research, 2(10): 56-60.
11. Zahida, B. and Rajendra, C (2017). Assessment of water quality of Upper Lake Bhopal. World Journal of Pharmaceutical Research, 6(7): 1384-1394.
12. Lalbiakmawia, F. and Kumar, S (2022). Status of hydrogeochemistry of water quality in Mizoram: A review. Water Scarcity, Contamination and Management, 5: 19-26.
13. Smitha, P.G., Byrappa, K. and Ramaswamy, S.N (2007). Physico-chemical characteristics of water samples of Bantwal Taluk, south-western Karnataka, India. J. Environ. Biol., 28(3): 591-595.

14. Jehamalar, E.E., Golda, D.B. and Das, S.M (2010). Water quality index and its seasonal variation on Thamiraparani river at Kanyakumari district, Tamil Nadu, India. Journal of Basic and Applied Science, 4(3): 110-116.
15. Singh, M.R., Gupta, A. and Beeteswari, K.H (2010). Physico-chemical properties of water samples from Manipur river system, India. J. Appl. Sci. Environ. Manage, 14(4): 85-89.