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Water Quality Assessment of Tuikual River Water in Aizawl, Mizoram, India

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Abstract

Objectives: To evaluate the water quality of the Tuikual River in order to determine the impact of human activities on the river's water quality. **Methods:** The present study examined the water quality of the Tuikual River over a year (i.e., from October 2020 to September 2021). Four sampling points were chosen along the river from upstream to downstream. The method outlined in 'Standard Methods for Examination of Water and Wastewater' was used for the analysis. The results were computed and expressed on a seasonal basis, i.e., winter (October-January), summer (February-May), and rainy (June-September). **Findings:** The findings reveal that the river water gets polluted due to the discharge of unwanted substances and the intensity of pollutants. It transports wastewater drains, household waste, city garbage, municipal waste, and other pollutants from a variety of locations around Aizawl. The Tuikual River also receives biomedical effluents from Aizawl Civil Hospital and Ebenezer Hospital. All of the parameters under study showed a strong and significant ($p<0.01$) correlation, according to the analysis of correlation coefficients. The findings were compared to scientific standards established by organisations such as the Bureau of Indian Standards (BIS), the World Health Organisation (WHO), and the United States of Public Health (USPH). **Novelty :** Most of the investigated metrics have higher values during the monsoon season, which is linked to significant rainfall that rinses nearby fertilised agricultural areas, city trash, and other pollutants into river bodies of water. This study proved the significance of serious management actions and strategies for the Tuikual River's protection, conservation, and management. It is critical to investigate the water quality of the Tuikual River before it has disastrous consequences.

Keywords: Pollutants; Anthropogenic activities; Tuikual River; Water quality standards; Correlation

1 Introduction

Water is essential for life, so researching its quality is crucial. Physical, chemical, and biological structural changes in water are caused by a variety of anthropogenic activities, resulting in damaged water resources[1]. Anthropogenic activities include urban development (municipal wastes, cemeteries, transportation, livestock production, land use practices, and others), industrial processes (solid and liquid wastes, chemicals, mining processes, spills, and leaks), agricultural practices (pesticides, fertilisers, and others), and rapidly expanding populations[2]. Urban rivers may have been associated with poor water quality as a result of industrialization and population growth, and there has been a serious concern about discharging untreated domestic and industrial waste into the watercourse[3].

Most rural areas in developing states such as Mizoram lack access to treated water for consumption. Because underground water is not easily accessible due to the hilly terrain, surface water is found distributed in numerous streams and rivers flowing through the hilly terrain, which is the primary source of water for the people. Surface and groundwater availability in Mizoram is highly uneven in both space and time. Management of water resource development is required for domestic and agricultural purposes. Poor water quality has an impact on human and other life forms' health. The rapid increase in human population and urban sprawl causes a scarcity of water resources and threatens water quality. The use of synthetic fertilisers, insecticides, and a wide range of human activities gradually contaminate various water sources[4].

The Tuikual River is important for research because it carries domestic and municipal sewage from Aizawl's western suburbs as well as biomedical effluents from Civil Hospital, the biggest state hospital, and Ebenezer Hospital, the most well-known private hospital, which recently opened on the bank of the river. The Tlawng River, the main water supply for Aizawl and several neighbouring villages, also receives significant tributaries, which include the Tuikual river. The Tuikual River is seriously harmed and polluted by mountainside building, municipal rubbish dumping, and untreated sewage dumped directly into the river's water. A nearby piece of land is also used as a dumping place, which contributes significantly to river pollution.

2 Study Area

The Tuikual River is a river that runs through Aizawl, Mizoram, and has a lot of sentimental meaning associated with it. Tuithum Lui is the name given to the area where it meets the Tlawng River. It is one of the primary tributaries of the Tlawng River, which provides water to Aizawl, Lunglei, and a number of adjacent communities. Figure 1depicts the study area's sampling locations. The research area is approximately 9.45 km long and runs east-west, with pockets of mountain forest and siltation in various areas. It transports municipal and domestic sewage from a variety of Aizawl neighbourhoods.

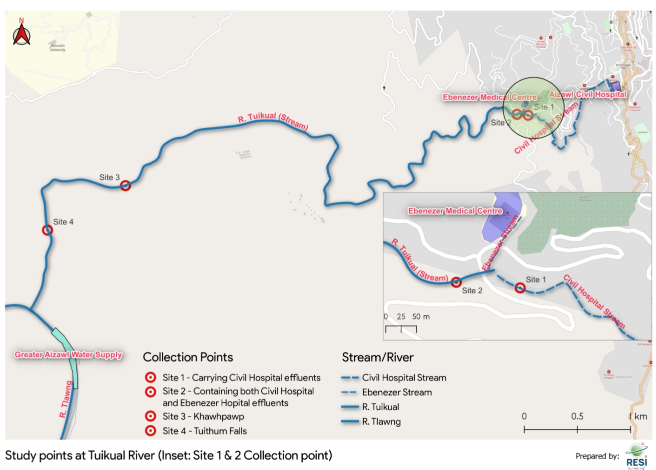

Fig 1. Locations for water quality sampling in the Tuikual River in Aizawl, Mizoram, India

The sampling area is divided into four sections:

Site 1 is located near the river's headwaters (containing Aizawl Civil Hospital discharges).

Site 2 is located near the confluence of a tributary and a river in order to assess the influence of tributary water containing domestic waste from settlements or hospital discharges (after the confluence of Aizawl Civil Hospital and Ebenezer Hospital discharges).

The river that receives sandstone quarry effluents was designated as Site 3 (Khawhpawp River).

Site 4 is located downstream of the river's confluence with the Tlawng River (Tuithum Lui).

3 Methodology

Water samples were taken at monthly intervals (in triplicate) from the specified sites for a year between October 2020 and September 2021. The data was then classified into the winter, summer, and rainy seasons. On-site measurements of pH, EC, and TDS were made using a potable pH, electrical conductivity (EC), and TDS metre. TSS was calculated using the evaporation method. The dissolved oxygen (DO), biological oxygen demand (BOD), and total alkalinity (TA) were all measured using the titration method. By using a spectrophotometric method, phosphate-P (PO_4^{3-}) and nitrite-N (NO_2^-) were estimated.

The method outlined in the American Public Health Association's (APHA)[5] 'Standard Methods for Examination of Water and Wastewater' has been used for the analysis. It includes all of the requirements and standards needed for water and wastewater analysis. Titration and spectrophotometric methods are used for the majority of the parameters studied because they aid in determining the concentration of a substance in a sample and are more accurate and precise methods. The measured parameters were compared to drinking water standards established by scientific organisations such as BIS, WHO, and USPH in order to protect public health.

4 Results and Discussion

4.1 pH

The pH levels were found to be lower during the rainy season (Figure 2), which could be due to heavy rainfall, which increases contamination of water bodies from the surface and agricultural runoff, or to a rapid rate of organic matter decomposition, which results in the release of humic acid. Kumar and Kumara[6] have reported similar findings. TSS, BOD, NO_2^-, and PO_4^{3-} had a negative and statistically significant ($p<0.01$) correlation with pH. The correlation between pH and DO was found to be positive and significant ($p<0.01$).

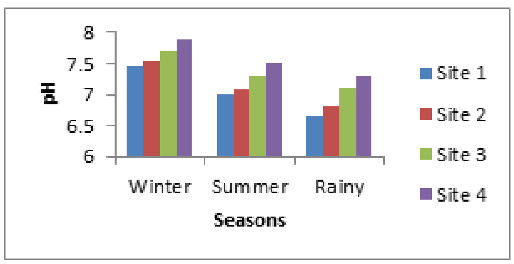

Fig 2. Seasonal changes in water pH

4.2. Electrical Conductivity

EC values were observed to be greater during the summer season (Figure 3), possibly as a result of increased salt concentrations from runoff sources and a low water table. Ranjith *et al*[7] made similar observations. TDS and TA had a positive and significant ($p<0.01$) connection with EC and are not within the USPH allowed limit.

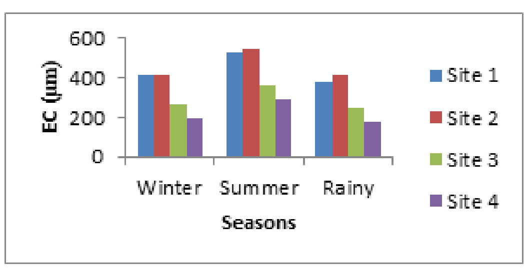

Fig 3. Seasonal changes in water EC

4.3. Total Dissolved Solid s

TDS levels were found to be higher during the summer season (Figure 4), which could be attributed to limited water availability from the sources, resulting in the leaching of various pollutants and nutrients from the groundwater. Vanlalhruaitluanga and Mishra[8] observed similar findings. TDS had a positive and significant ($p<0.01$) correlation with TA and EC.

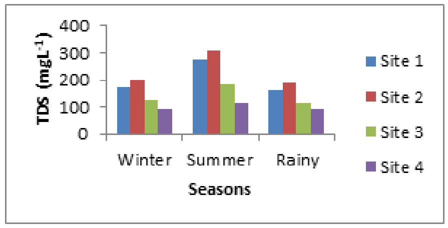

Fig 4. Seasonal changes in water TDS

4.4 Total Suspended Solids

Because of the heavy flow of precipitation that conveys organic and inorganic contaminants, pollutants, sediments, and suspended particles from surrounding topographical extremities, buildings, and mining, TSS values were observed to be greater during the rainy season (Figure 5). Sunar *et al*[9] discovered similar findings. TSS was found to have a positive and substantial ($p<0.01$) connection with BOD, NO_2^-, and PO_4^{3-}. On the other hand, pH ($p<0.01$) and DO ($p<0.05$) showed a negative and significant correlation with TSS.

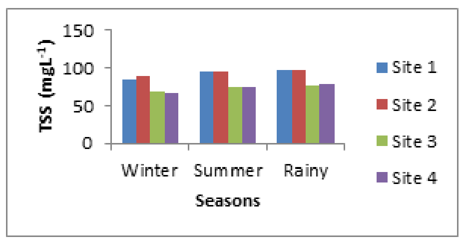

Fig 5. Seasonal changes in water TSS

4.5. Dissolved Oxygen

Due to the heavy discharge of organic debris that was degraded by microorganisms, DO levels were low during the rainy season (Figure 6). The microorganisms use a substantial amount of DO during the decomposition process, lowering the amount of DO in the water body. Laskar *et al*[10] offered similar reports. DO was found to have a positive and significant ($p<0.01$) correlation with pH. In contrast, a negative and significant ($p<0.01$) correlation with BOD, NO_2^-, PO_4^{3-} and TSS ($p<0.05$) was found. The DO values were not within the BIS permissible limit.

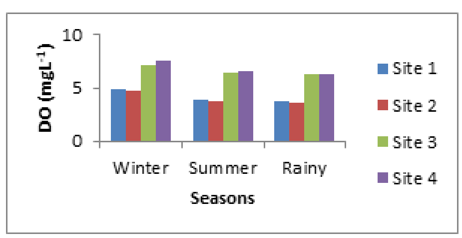

Fig 6. Seasonal changes in water DO

4.6. Biological Oxygen Demand

Due to an influx of untreated organic waste discharged directly into water bodies by anthropogenic activities and surface runoff brought by heavy rains, BOD readings were high throughout the rainy season (Figure 7). Laldinpuii and Mishra[11] have offered similar reports. BOD was found to have a positive and significant ($p<0.01$) connection with TSS, NO_2^-, and PO_4^{3-}. With pH and DO, on the other hand, a negative and significant ($p<0.01$) correlation was found. The BOD levels were likewise over the BIS's permissible range.

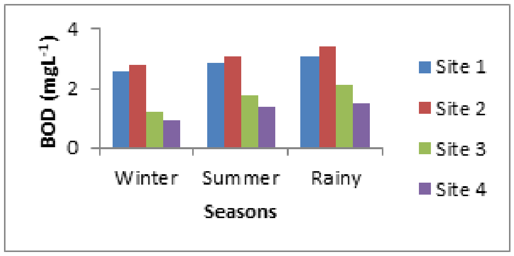

Fig 7. Seasonal changes in water BOD

4.7. Total Alkalinity

TA values were high during the summer season (Figure 8), which could be attributed to washing clothes in the reservoir with detergents containing dissolved carbonate and bicarbonates. Tleipuii *et al*[12] discovered similar results. A positive and significant ($p<0.01$) correlation of TA with EC and TDS was found, and the TA readings were not within the USPH's permitted limit.

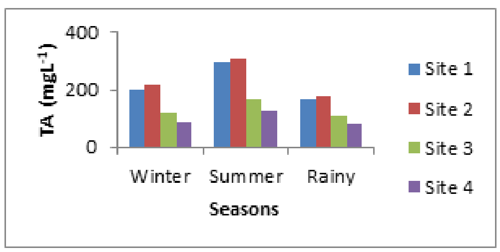

Fig 8. Seasonal changes in water TA

4.8. Nitrite -N

Due to heavy runoff of fertilisers, sewage, septic systems, chemicals from industries, and nitrite-containing food preservatives, NO_2^- levels were high throughout the rainy season (Figure 9). Sinha *et al*[13] discovered similar results. NO_2^- was found to have a positive and significant ($p<0.01$) connection with TSS, BOD, and PO_4^{3-}. With pH and DO, on the other hand, a negative and significant ($p<0.01$) correlation was found.

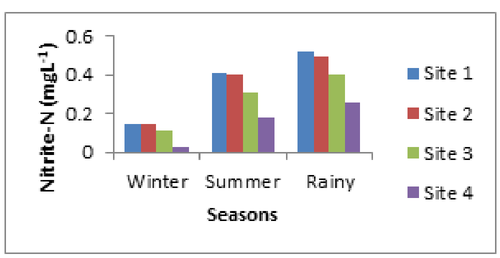

Fig 9. Seasonal changes in water nitrite-N

4.9. Phosphate -P

PO_4^{3-} readings were high during the rainy season (Figure 10) due to the presence of the bank soil erosion, which transports phosphate-P from river banks and urban runoff into the water body by heavy rainfall. Maansi *et al*[14] discovered similar findings. PO_4^{3-} was found to have a positive and significant (p<0.01) connection with TSS, BOD, and NO_2^-. pH and DO, on the other hand, showed a negative and significant (p<0.01) correlation. The measured PO_4^{3-} values were found to be higher than the USPH-recommended limit.

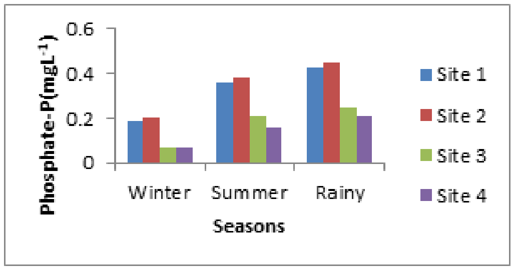

Fig 10. Seasonal changes in water phosphate-P

4.10. Statistical analysis

The statistical analysis was done using Microsoft Excel. All of the parameters studied had a strong and significant (p<0.01) relationship, according to the correlation coefficient analysis. The two-way ANOVA reveals a significant variation (p<0.01) in all the concentrations of the studied water quality parameters between seasons and between sites.

5 Conclusions

Figures 2, 3, 4, 5, 6, 7, 8, 9 and 10 shows how severely the disturbed regions (sites 1 and 2) have been polluted by significant anthropogenic activities such as dumping sewage, detergents, rubbish, faulty drainage systems, waste disposal, bathing, and clothes washing directly into water sources. The worst water quality was observed at sites 2 and 1, followed by site 3 and site 4. Lower DO concentrations, higher BOD, and most of the other investigated characteristics suggest a larger pollution load in the reservoir, according to the research. During the monsoon season, most of the examined metrics have higher values, which are linked to significant rainfall that washes nearby fertilised agricultural fields, city trash, and other contaminants into river water bodies.

The EC, DO, BOD, TA, and PO_4^{3-} values were all above the prescribed limits set by various agencies. The correlation coefficient analysis revealed a strong and significant (p<0.01) relationship between all of the parameters studied. According to the two-way ANOVA, the interaction between seasons and sites has a significant (p<0.01) effect on all of the studied parameters. Hence, management strategies and treatment of water are highly required to be developed in order to save the Tuikual River. This research could lead to more in-depth water resource studies as well as the development and execution of effective water management plans. The state government must initiate a water treatment plant for all effluents and discharges from industry and municipal waste before releasing their waste directly into the river body, including recycling and reuse of treated waste water.

6 Declaration

Presented in 4th Mizoram Science Congress (MSC 2022) during 20th & 21st October 2022, organized by Mizoram Science, Technology and Innovation Council (MISTIC), Directorate of Science and Technology (DST) Mizoram, Govt. of Mizoram in collaboration with science NGOs in Mizoram such as Mizo Academy of Sciences (MAS), Mizoram Science Society (MSS), Science Teachers' Association, Mizoram (STAM), Geological Society of Mizoram (GSM), Mizoram Mathematics Society (MMS), Biodiversity and Nature ConservationNetwork (BIOCONE) and Mizoram Information & Technology Society (MITS). The Organizers claim the peer review responsibility.

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References

1) Deka S, Singha LB, Tripathi OP. Determining water quality index using the physico-chemical attributes for groundwater and spring in vicinity of Kawasing reserve forest, Assam, Northeast India. *Journal of Global Resources*. 2021;7(1):41–48. Available from: https://www.researchgate.net/publication/348920143.
2) Akhtar N, Ishak MIS, Bhawani SA, Umar K. Various Natural and Anthropogenic Factors Responsible for Water Quality Degradation: A Review. *Water*. 2021;13(19):1–35. Available from: https://doi.org/10.3390/w13192660.
3) Sangani K, Manoj K. Water quality index for surface water quality assessment: Tapi river, Gujarat, India. *International Journal of Advanced Research*. 2020;8(7):1528–1534. Available from: http://dx.doi.org/10.21474/IJAR01/11420.
4) Lalbiakmawia F, Kumar S. Status of hydrogeochemistry of water quality in Mizoram: A review. In: Current Directions in Water Scarcity Research;vol. 5. 2022;p. 19–26. Available from: https://doi.org/10.1016/B978-0-323-85378-1.00002-7.
5) Lipps WC, Braun-Howland EB, Baxter TE. Standard Methods for the Examination of Water and Wastewater. 24th ed. Washington DC. American Public Health Association Press. 2023.
6) Kumar KMV, Kumara V. Seasonal variation in the physico-chemical analysis of Mangrove water, Kundapura, Karnataka, India. *Journal of research in Environmental and Earth Sciences*. 2021;7(8):2348–2532. Available from: www.questjournals.org.
7) Ranjith S, Anand VS, Shiva K, Chandrashekarayya GH, Santhosh D. Water Quality Assessment of River Tungabhadra, India. *Nature Environment and Pollution Technology*. 2020;19(5):1957–1963. Available from: https://doi.org/10.46488/NEPT.2020.v19i05.020.
8) Vanlalhruaitluanga B, Mishra BP. Seasonal Variation in the Physical Characteristics of River Tuipui, Champhai District- Mizoram, India. *Journal of Emerging Technologies and Innovation Research*. 2021;8(3):2134–2136. Available from: https://www.jetir.org/papers/JETIR2103265.pdf.
9) Sunar S, Tripathi OP, Mishra BP. Water Quality and Pollution Indices Application in Monitoring Water Quality of Serlui River Impacted by Serlui-B Dam, Mizoram, North East India. *Current Science*. 2020;119(10):1685–1689. Available from: https://doi.org/10.18520/cs/v119/i10/1685-1689.
10) Laskar N, Singh U, Kumar R, Meena SK. Spring water quality and assessment of associated health risks around the urban Tuirial landfill site in Aizawl, Mizoram, India. *Groundwater for Sustainable Development*. 2022;17:100726–100726. Available from: https://doi.org/10.1016/j.gsd.2022.100726.
11) Laldinpuii H, Mishra BP. Assessment of the chemical characteristics of river Serlui-A in Aizawl, Mizoram, North East, India. *Environment and Ecology*. 2019;37(4):1141–1146. Available from: http://www.environmentandecology.com/.
12) Tleipuii RVL, Lalruatkimi C, Sellate IL. Assessment of Drinking Water Quality from Open Sources, Mizoram, Northeast India. *Journal of Environment Pollution and Human Health*. 2022;10(1):23–30. Available from: http://pubs.sciepub.com/jephh/10/1/4.
13) Sinha E, Michalak AM, Balaji V, Resplandy L. India's Riverine Nitrogen Runoff Strongly Impacted by Monsoon Variability. *Environmental Science & Technology*. 2022;56(16):11335–11342. Available from: https://doi.org/10.1021/acs.est.2c01274.
14) Maansi, Jindal R, Wats M. Evaluation of surface water quality using water quality indices (WQIs) in Lake Sukhna, Chandigarh, India. *Applied Water Science*. 2022;12(2):1–14. Available from: https://doi.org/10.1007/s13201-021-01534-x.