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Physico-chemical and bacteriological characteristics of Tuikual river in Aizawl, Mizoram

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ABSTRACT

The Tuikual river flows through Aizawl, also known as Tuithum Lui, before connecting with the Tlawng river, Mizoram's primary source of water supply. The study was carried out over a year, from October 2020 to September 2021, with samples collected at monthly intervals. The research area was divided into four sampling locations along the river, from upstream to downstream. Pollutants carried by the river include untreated municipal garbage, sewage discharges, and biomedical effluents. The upstream Site 1 sample, which contained biomedical effluents from Aizawl Civil Hospital (Mizoram's largest hospital), and the downstream Site 2 sample, which contained biomedical effluents from Aizawl Civil Hospital and Ebenezer Hospital (Mizoram's most popular state private hospital). The downstream Sites 3 (Khawhpawp) and 4 (Tuithum) are tourist attractions that eventually join the Tlawng river. Temperature, Dissolved Oxygen, Biochemical Oxygen Demand, Acidity, Sulphate and total coliform count are important water quality parameters that have been estimated for the study of the monthly variation of Tuikual river water quality. Except for DO, the monsoon (rainy) months had higher values in all of the studied parameters, which could be attributed to the flow of heavy rainwater, which carries a large amount of pollutants from the surroundings into the river body of water. Microsoft Excel was used for the statistical analysis of the correlation coefficient.

Key words : *Water quality, Parameters, Pollutants, Anthropogenic activities.*

Introduction

Water is a necessary element for life to exist on Earth. Even if the quantity of water is sufficient, the deteriorated water quality limits the uses that can be made of it. The majority of people in Mizoram rely on surface water bodies for their daily needs, as underground water is difficult to access in most parts of the state due to the state's hilly terrain. Because the state has yet to develop a proper drainage system, a large portion of domestic, agricultural, and other wastes are discharged directly or indirectly into nearby rivers (Lalparmawii and Mishra, 2012). Unplanned civilization and urbanisation have posed a significant threat to the quality of river water.

Pollutants in bodies of water pose a serious threat to the environment and human health. Large amounts of wastewater drains, sewage system leakage, domestic waste, city garbage, and other pollutants flow into the Tuikual river and its banks. It is now becoming more polluted and narrower, losing its identity as a result. Tuikual River is on the verge of disappearing; if it is not saved in time, it will be lost forever. It is critical to investigate the Tuikual River's water quality before it has disastrous consequences. The study's goal was to assess monthly variations in the water quality characteristics of the Tuikual River and compare them to standards set by various agencies.

Materials and Methods

The Tuikual River, which runs through Aizawl, is a beautiful river that has been tainted by anthropogenic activities. It is located in Aizawl's centre, also known as Tuithum Lui, just before the Tlawng River emerges. The study sites are approximately 9.45 kilometres long, carrying wastewater drains, domestic waste, city garbage, municipal waste, and other pollutants from various parts of Aizawl.

The first sampling site (Site 1) was chosen upstream of the river, near the source (sample containing biomedical effluents from Aizawl Civil Hospital, state biggest hospital).

The second sampling site (Site 2) was chosen to assess the impact of tributary water containing domestic waste from settlements and hospital discharges (after the confluence of samples containing biomedical effluents from Aizawl Civil Hospital and Ebenezer Hospital).

The third sampling site (Site 3) was chosen because it is near where the river receives sandstone quarry effluents (Khawhpawp river).

The fourth sampling site (Site 4) was chosen downstream of the river, where it joins the Tlawng river (Tuithum river).

Water samples were collected from the four research sites at monthly intervals (in triplicate) for a year, from October 2020 to September 2021. Temperature, dissolved oxygen, biochemical oxygen demand, acidity, sulphate, and total coliform count were among the physico-chemical and bacteriological characteristics examined in the collected water samples. A digital thermometer was used to determine the temperature at the point of collection. Following the methods outlined in APHA (2005) and Maiti, (2001) the remaining water samples were fixed immediately after collection and transported to the laboratory for further analysis. The findings were then compared to standards set by various organisations such as the USPH, BIS, WHO, and ICMR.

Results and Discussion

Temperature

The average water temperature was found to range between 18˚C at Site 1 to 30.5˚C at Site 4. Temperature was found to have a positive and significant correlation with BOD (0.923**), acidity (0.876**), nitrate-N (0.848**), sulphate (0.881**), and total coliform (0.854**), but a negative and significant cor-

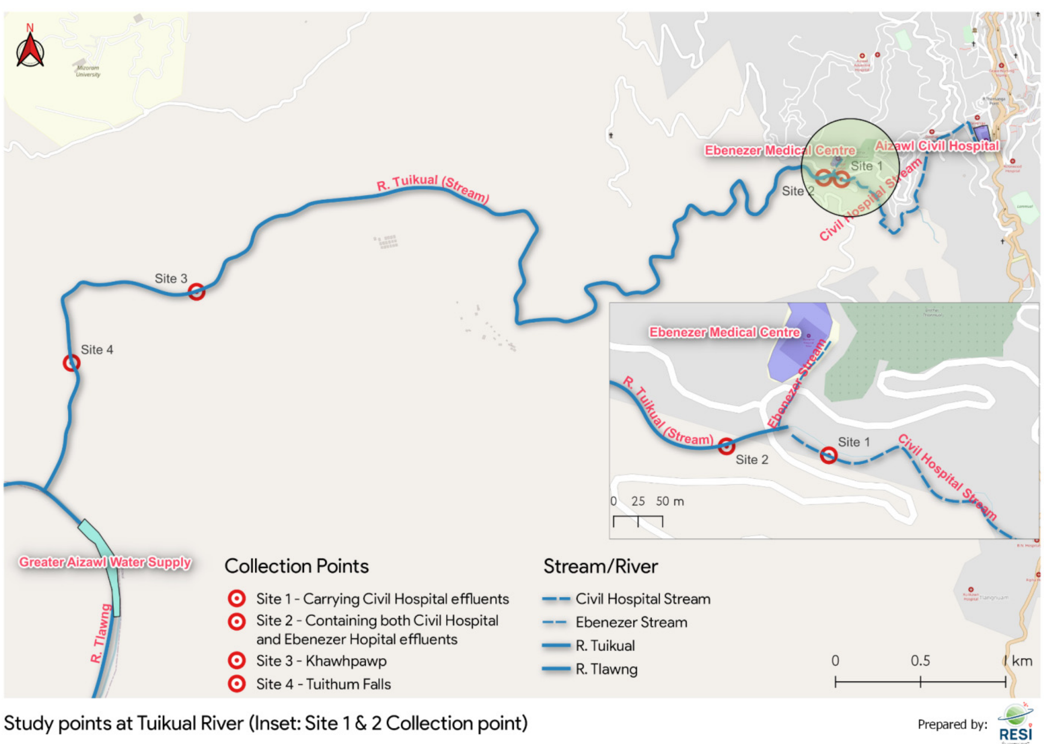

Fig. 1. The selected study sites are depicted on a map.

relation with DO (0.985**).

The average water temperature was found to be higher during the monsoon season, which could be due to a rise in ambient temperature that transfers heat to the surface or an increase in organic matter discharge through surface run-off. Water temperature varies according to the season, geographical location, ambient air temperature, and chemical reaction in the water body (Murthuzasab *et al.*, 2010).

Dissolved Oxygen

The amount of oxygen dissolved in a body of water that is essential for aquatic life is referred to as dissolved oxygen. The average DO ranged from 3.4 mgl^{-1} at Site 2 to 7.8 mgl^{-1} at Site 4. The results show that the DO values at Sites 1 and 2 exceeded the BIS and ICMR permissible limit.

DO was found to have a negative and significant relationship with temperature (0.985**), BOD (0.923**), acidity (0.917**), nitrate-N (0.900**), sulphate (0.910**), and total coliform (0.912**). The lower DO content discovered during the monsoon season could be attributed to an increase in aerobic microbial decomposition of organic matter, which results in high DO consumption (Rajiv *et al.*, 2012).

Biochemical Oxygen Demand

The average BOD ranged from 0.5 mgl^{-1} at Site 4 to 3.7 mgl^{-1} at Site 2. It was found that Site 2 BOD was found to have a positive and significant correlation with temperature (0.923**), acidity (0.878**), nitrate-N (0.912**), sulphate (0.909**), and total coliform (0.781**), but a negative and significant correlation with DO (0.923**). Higher BOD values during the monsoon season could be attributed to an increase in organic matter via surface runoff, which speeds up the microbial decomposition process at high temperatures (Lalparmawii and Mishra, 2012).

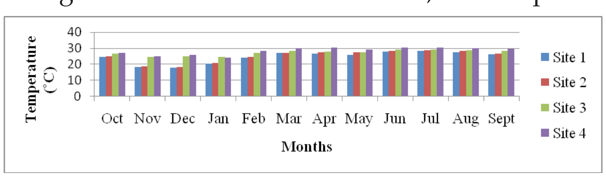

Fig. 2. Monthly variation in Temperature of river water at selected study sites

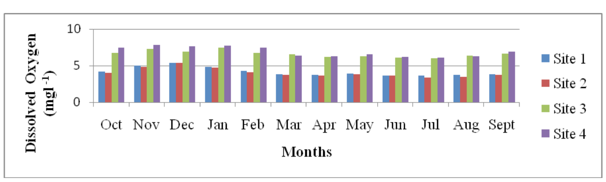

Fig. 3. Monthly variation in Dissolved Oxygen of river water at selected study sites

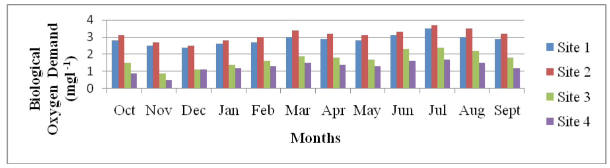

Fig. 4. Monthly variation in Biological Oxygen Demand of river water at selected study sites

Acidity

Water acidity is primarily caused by dissolved carbon dioxide gas. The water's acidity ranged from 17 mgl^{-1} at Site 4 to 90 mgl^{-1} at Site 2. Temperature (0.876**), BOD (0.878**), nitrate-N (0.967**), sulphate (0.923**), and total coliform (0.877**) were found to have a positive and significant correlation with acidity, while DO (0.917**) was found to have a negative and significant correlation. The acidity of water was found to be higher during the monsoon, which could be due to an increase in organic matter that supports microbial decomposition, resulting in the release of carbon dioxide (Singh *et al.*, 2010).

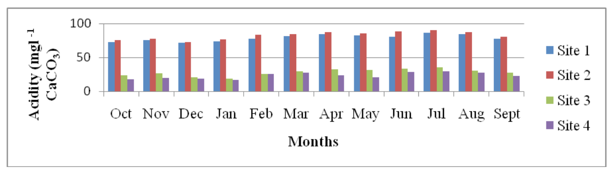

Fig. 5. Monthly variation in Acidity of river water at selected study sites

Sulphate

The average sulphate value ranged from 1.28 mgL^{-1} at Site 4 to 4.88 mgL^{-1} at Site 2 during the study period. Sulphate had a positive and significant correlation with temperature (0.881**), BOD (0.909**), acidity (0.923**), nitrate (0.965**), and total coliform (0.911**), but a negative and significant correlation with DO (0.910**). Higher sulphate content values during the monsoon may be due to an increase in

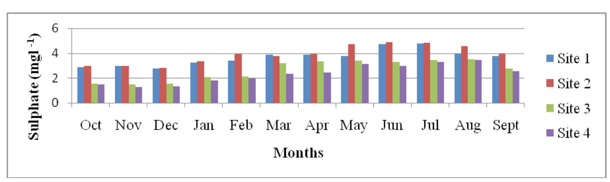

Fig. 6. Monthly variation in Sulphate content of river water at selected study sites

agricultural and sewage runoff containing sulphate minerals carried into the water body by heavy rainwater (Rizvi *et al*., 2015).

Total coliform

Because the number of bacteria present depends on the degree of contamination, total bacteria count can be a reliable indicator of water quality (Bilgrammi, 1998). Water had a total coliform count ranging from 93 to 2400 MPN/100 ml. The result indicates that total coliform counts exceeded the BIS permissible limit. Total coliform had a positive and significant correlation with temperature (0.854**), BOD (0.781**), acidity (0.877**), nitrate-N (0.888**), and sulphate (0.911**), but a negative and significant correlation with DO (0.912**). The investigation reveals that total coliform counts were typically high during the rainy season and in tributary waters, possibly due to high organic load, and low during the winter season, possibly due to cold climatic conditions that slow bacterial duplication (Maitera and Sudi, 2011).

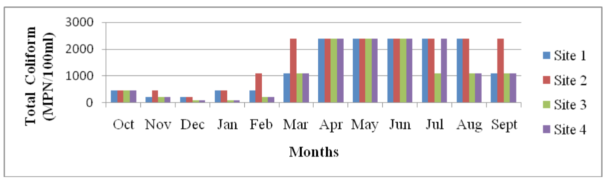

Fig. 7. Monthly variation in Total Coliform of river water at selected study sites

Conclusion

The results revealed that there was a significant variation in all of the physicochemical parameters studied. Because of the high pollution load from the catchment area, the upstream sites 1 and 2 had high parameter values. The river was heavily polluted during the monsoon season due to heavy rainfall that washed fertilised agricultural fields and other pollutants from the catchment area into the river water body. The DO and total coliform values were not within the prescribed limits set by various agencies. The correlation coefficient analysis revealed a strong and significant correlation between the variables under consideration. This study confirmed the need for serious management strategies and activities to protect, conserve, and manage the Tuikual River.

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Conflict of interest: The authors have no conflicts of interest.

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