To Estimate The Quality Biological Activities And Total Dissolve Solids From Different Water Sources Near Raipur

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ABSTRACT

The impact of Total Dissolved Solids (TDS) on concrete properties is examined in this study as it relates to water samples from areas close to Raipur. Because elevated TDS in mixing water may have an impact on the quality of concrete, it is limited. The detection of TDS in water quality parameters (WQPs) depends on co-occurring mechanisms, even though TDS is optically inert. Significant vertical and regional variations were observed in the study's findings of elevated TDS in contaminated locations. Ecosystems, human health (affecting several organs), and domestic appliances are at risk from high TDS levels (>500 ppm) because of scaling. A key component of risk communication is the study's appeal for public understanding of the possible adverse consequences of prolonged water use from various geographic areas. People can be empowered to advocate for improved water quality management in their communities and make educated decisions about their water sources by sharing the research's findings with the local populace. This demonstrates how applicable and significant the scientific study is to society.

Keywords

- Total Dissolve Solids
- Raipur
- Concrete Properties
- Human Health Impacts
- Water Contamination

INTRODUCTION

Water is a basic and vital resource that is necessary for all living things to survive. Protecting human health and maintaining the ecosystem depend heavily on the quality of the water. However, fresh water is becoming more and more scarce in many areas due to the rising demand for water worldwide. Desalination becomes a dependable and efficient method for supplying an adequate supply of fresh water in regions with lower natural fresh water availability, hence overcoming the water scarcity (Ghaffour et al., 2013). These include total suspended solids (TSS) and total dissolved solids (TDS) (Adjovn et al., 2023; Adjovu et al., 2023; Khan et al., 2018). The fractional components of the same sample's "total solids" that are separated by filtration are TDS and TSS (American Public Health Association et al., 2017)."The material residue left

in the vessel after a sample evaporation and subsequent drying in an oven at a defined temperature" is what is meant by total solids (Wilder et al., 2023). Because highly resistive petroleum compounds partially replace conductive soil and pore water, it was previously widely believed that hydrocarbon-impacted sediments could only be imaged effectively by their higher (De Ryck et al., 1993; et al., 1990; Schneider and Greenhouse,1992).

The geological and microbiological literature contains a wealth of information indicating that native micr obes may physically and chemically modify hydrocarbons in polluted sediments (e.g., Cozzarelli et al., 1 990; Cozzarelli et al., 1994; Cozzarelli et al., 2001). TDS is the percentage of both organic and inorganic materials that go through the same filter (Rice et al., 2012). Although there are few studies looking at the connection between TDS and TSS in watersheds affected by mining, the relationship has been examined in relation to erosional processes and rates of land denudation (Einsele 1992; Milliman 1997; Milliman and Farnsworth 2011; Ran et al. 2015). Einsele (1992) There aren't many studies looking at the relationship between TDS and TSS in watersheds affected by mining, but t ET ALhose that have looked at the relationship between erosional processes and land denudation rates point out that there isn't a direct correlation between TDS and TDS loads, but that there are some broad patterns for areas with varying topography and climate (Ran et al., 2015). It is hypothesized that the greater ratios in smaller highland river basins result from less chemical weathering than mechanical weathering, possibly as a result of storage capacity constraints (Milliman and Farnworth 2011). The effectiveness of the desalination process and the caliber of the final product are significantly influenced by the quality of the water used (Ghaffour, N. et al., 2013; Azadi et al., 2019). Scaling and fouling issues in the desalination system can be brought on by high concentrations of organic matter and other pollutants, including suspended and dissolved particles. Higher operating expenses and lower product quality can arise from these fouling and scaling phenomena, which can also increase energy consumption, diminish process efficiency, and perhaps damage equipment (Matin et al., 2021; Ghaffour N. et al., 2013; Azadi et al., 2019). Specifically, desalination facilities, especially those that use Reverse Osmosis (RO) technology, depend heavily on the amount of total dissolved solids (TDS) in seawater (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021; Saeed et al., 2019). To remove TDS, this sophisticated method forces feedwater across a semi-permeable membrane. The amount of TDS in the feedwater has a major effect on the desalination plant's performance (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021; Saeed et al., 2019; Younos, T., 2005). TDS. The amount of TDS in the feedwater has a major effect on the desalination plant's performance It is more difficult to remove salts and other materials when TDS levels are higher because it takes more energy to pressurize the water flow through the membranes (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021; Saeed et al., 2019; Younos, T., 2005; Pushpalatha, N. et al., 2021). Therefore, to guarantee the efficacy and efficiency of water production, it is essential to fully comprehend, continuously monitor, and properly manage the TDS levels of the feed water supply. In regular operations, the electric conductivity (EC) ratio method is usually used to report the TDS level (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021; Saeed et al., 2019; Younos, T., 2005; Pushpalatha, N. et al., 202; Walton, A.F.,2018). (Houatmia et al., 2016) revealed that the GW quality in the northeastern region of Tunisia is significantly impacted by the interaction between evaporation and rock water. According to (Li et al., 2016), rock-water interaction has an impact on GW chemistry. Furthermore, it has been observed that the rock-water interaction affects the quality of GW (Adimalla and Venkatayogi, 2017). Therefore, for monitoring purposes, an effective method of GW quality evaluation must be found. Numerous research had attempted to use deterministic, stochastic, and numerical models to assess a broad variety of water quality metrics. To describe the GW quality, total dissolved solids (TDS) are widely utilized. To preserve freshwater, research on accurate TDS estimation is essential. At high TDS concentrations, GW turns saline. High TDS concentrations in GW are typically seen to be harmful for irrigation and agriculture. Hydrological and agricultural management research also requires modeling and, as a result, TDS concentration prediction (Kisi et al., 2013). Water quality modeling has made extensive use of deterministic and numerical models (Zounemat-Kermani et al., 2019). In addition to providing essential ions like calcium, magnesium, potassium, and sodium, the amount of total dissolved solids (TDS) in water is one of the most critical elements influencing its taste

(Islam, M. R.., 2016; United Nation Environmental Protection Agency 2018; World Health Organisation 2017). However, water with high TDS levels typically indicates human activity contamination, including nitrate-based fertilizer overuse, uncontrolled animal grazing and wildlife impacts, soil and agricultural runoff from irrigation, and environmentally harmful farming practices like slash and burn agriculture (Wei Z. et al., 2013; Rosca O. M. et al., 2020). When temperature is measured, heat acts as a natural tracer of groundwater movement. In addition to being over-used, freshwater aquifers—particularly those with little recharge from meteoric water—may attract non-potable water from hydraulically related aquifers to surface water bodies, contingent on the hydrogeology of the area. Mineral toxins like arsenic can pollute groundwater in particular places (Chouvelon et al., 2017). Water quality is impacted by chemical processes that take place as it moves through streambed sediments, changing its composition. Mineral dissolution causes an increase in dissolved materials. The relative quantity of materials in solution is altered via exchange and other processes. As water continues to move through geologic strata, alterations in its chemical may intensify until it reaches saturation. The chemical makeup of the stream is impacted if groundwater finally finds its way into it (Constantz, Cox, & Su, 2003b). Water chemistry along flow channels can occasionally be used to track water exchanges. Watershed scales and smaller scales such as stream banks, sand bars, and local reaches of a stream can be used to trace flow pathways (Bencala, Kennedy, Zellweger, Jackman, & Avanzino, 1984). Water quality studies frequently use geographic information systems (GIS) and standard physicochemical parameters, however evaluating and interpreting all of the parameters can be expensive and time-consuming. Electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), and turbidity are the only four primary parameters that need to be examined in order to evaluate the drinking water quality in non-chemically damaged watersheds more quickly and economically. These factors can give a thorough picture of the state of the water and are essential for assessing its quality. Furthermore, having accurate data on one or two of these parameters—such as the linear relationship between TDS and electrical conductivity—can make it easier to evaluate the water quality in a particular basin and interpret overall water quality results. TDS is equal to $k \times EC$, where k is either 0.55 or 0.75. Nonetheless, the constant's value typically varies with placement. Furthermore, temperature and ionic composition have little bearing (Allan et al. 2021; Spellman, 2015). Since minerals like calcium, magnesium, and potassium are good for many body processes, it is crucial to remember that having no dissolved minerals in drinking water is not good for human health. Public health depends on maintaining high-quality drinking water, and measuring important metrics including turbidity, TDS, EC, and TH can provide important information about water quality. Communities can guarantee the safety and cleanliness of their sources of drinking water by adhering to set standards and norms. Magnesium helps prevent cardiovascular illness, potassium is necessary for muscles and the neurological system, and calcium is crucial for the growth of bones (Islam et al., 2016). Guidelines for permissible TDS levels in drinking water are provided by the World Health Organization.

LITERATURE REVIEW

Water quality stands as a cornerstone of both ecological health and human well-being, necessitating rigorous monitoring and assessment. Among the suite of parameters employed to characterize water quality, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) are pivotal indicators. TDS, defined as the non-volatile residue remaining after water evaporation and oven drying (Wilder et al., 2023), encompasses a spectrum of dissolved substances, including organic and inorganic constituents. In contrast, TSS refers to the particulate matter suspended in water that can be separated through filtration (American Public Health Association et al., 2017). The interplay between these two metrics provides crucial insights into the overall solid content and its distribution within aquatic systems. TDS, comprising both organic and inorganic substances that pass through a filter (Rice et al., 2012), is inherently influenced by the water's origin and prevailing environmental conditions. While natural waters typically exhibit a dominance of inorganic ions such as calcium, magnesium, sodium, potassium, chloride, sulfate, and bicarbonate,

anthropogenic activities, including mining, agriculture, and industrial processes, can significantly alter its concentration and composition. Given its direct ramifications for various water uses, ranging from drinking water palatability to the suitability for aquatic life, industrial applications, and irrigation, TDS emerges as a critical parameter in water quality evaluation. Understanding the sources, distribution, and ecological and practical effects of TDS is therefore paramount for effective water resource management and environmental stewardship.

The origins of TDS in water bodies are broadly classified into natural and anthropogenic sources. Natural sources primarily involve geological processes such as the weathering of rocks and minerals, soil erosion, and atmospheric deposition. These processes gradually release dissolved ions into water systems over extended periods. However, the most significant and often rapid alterations in TDS levels are attributed to anthropogenic activities. Urban runoff, carrying a complex mixture of pollutants from impervious surfaces, contributes dissolved solids to surface waters. Mining operations, particularly coal mining, are well-documented for their substantial contribution to elevated TDS concentrations in watersheds, often characterized by high sulfate levels that can severely impact aquatic ecosystems, particularly benthic macroinvertebrate communities (Bodkin et al., 2007; Mount et al., 1997; Pond et al., 2008). Agricultural practices, including uncontrolled livestock grazing and the excessive use of nitrate-based fertilizers, also contribute significantly to increased TDS levels through the transport of dissolved salts via irrigation runoff and soil erosion (Wei Z. et al., 2013; Rosca O. M. et al., 2020). Environmentally damaging agricultural methods like slash and burn agriculture can further exacerbate this issue. Industrial discharges from sectors such as textile, pharmaceutical, and synthetic industries are another major source of TDS contamination, often releasing a diverse array of dissolved salts, organic compounds, and other contaminants into receiving waters (Rajasulochna et al., 2016).

Elevated TDS concentrations exert a wide range of adverse effects on both ecological and human systems. In aquatic environments, high TDS levels can alter the water's salinity and chemical composition, leading to habitat degradation and impacting the physiological processes of aquatic organisms (Mount et al., 1997; Pond et al., 2008). For human consumption, high TDS levels can impair the taste, odor, and aesthetic quality of drinking water, potentially leading to consumer dissatisfaction and, in some cases, posing health risks. Furthermore, the use of high-TDS water for irrigation can negatively affect soil salinity, ultimately reducing agricultural yields and impacting food security (Wei Z. et al., 2013).

The challenge of water scarcity has led to the increasing reliance on desalination technologies, particularly reverse osmosis (RO). However, the efficiency and cost-effectiveness of RO are significantly influenced by the TDS levels in the feedwater (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021; Saeed et al., 2019). Higher TDS concentrations necessitate greater energy inputs to overcome osmotic pressure, resulting in increased operational costs (Younos, T., 2005; Pushpalatha, N. et al., 2021). Additionally, high TDS levels, often accompanied by elevated concentrations of organic matter and suspended particles, can lead to scaling and fouling of RO membranes, reducing process efficiency, increasing energy consumption, and potentially damaging equipment (Ghaffour N. et al., 2013; Azadi et al., 2019; Matin et al., 2021).

Electrical conductivity (EC) is a widely adopted surrogate parameter for estimating TDS levels in water. The correlation between TDS and EC is based on the principle that dissolved ions conduct electricity, with higher ion concentrations resulting in increased EC. This relationship can often be approximated by a linear equation (TDS = k × EC), where the conversion factor 'k' is influenced by temperature and the ionic composition of the water (Allan et al. 2021; Spellman, 2015; Hem, J. D. 1992). EC measurements offer a rapid and cost-effective alternative to direct chemical analysis for TDS determination, making it a valuable tool for monitoring TDS in various water bodies (J. Barthel et al., 1998; Carlson, G. 2005; Hayashi, M. 2005; Janardhana 2007; Y. Shirokova et al., 2000; F. Visconti Reluy et al., 2004). However, the TDS-EC relationship can become less reliable at very high TDS concentrations (above 50,000 mg/L), necessitating direct TDS measurements in such cases (Hem, J. D. 1992).

Effective management of TDS levels is crucial for ensuring the sustainability of water resources. Various technologies are employed for TDS removal, including temperature gradient-based methods, ion exchange, and membrane-based processes like RO (Rajasulochna et al., 2016). Reducing TDS loading in receiving waters relies heavily on efficient wastewater recycling and treatment (Kumar et al., 2015). Advanced modeling approaches, such as deterministic, stochastic, and numerical models, can be valuable tools for forecasting and controlling TDS concentrations in water resources (Kisi et al., 2013; Zounemat-Kermani et al., 2019). Continuous monitoring and evaluation of TDS levels in impacted watersheds, utilizing techniques like remote sensing and GIS (Allan et al. 2021; Spellman, 2015), are essential for developing successful management strategies.

Emerging research highlights the complex interactions between TDS and other water quality parameters. In high-TDS waters with elevated NOM, the formation of disinfection byproducts (DBPs) during chlorination poses a significant concern (Richardson & Postigo, 2012). Advanced oxidation processes (AOPs) are being investigated as potential solutions to break down NOM and minimize DBP formation (Crittenden et al., 2012). Understanding the speciation of TDS components, such as iodide and bromide, is also crucial as they can influence DBP formation (Hua & Reckhow, 2007). In industrial water management, high TDS levels contribute to corrosion, scaling, and operational inefficiencies. While membrane technologies like RO and EDR are effective for TDS removal (Greenlee et al., 2009), the management of the resulting concentrated brine remains an environmental challenge, driving research into sustainable brine management strategies like resource recovery and zero liquid discharge (ZLD) systems (Mickley, 2012). Furthermore, the impact of anthropogenic activities on groundwater TDS levels, including contamination by heavy metals, nitrates, and sulfates, and the exacerbation of saltwater intrusion in coastal aquifers, necessitates the development of effective remediation and management strategies (Foster & Chilton, 2003; Werner et al., 2013; Fetter, 2018; Clark & Fritz, 1997). Integrating chemical analysis, bio-indicators, and citizen science initiatives, along with remote sensing and GIS, is crucial for comprehensive TDS monitoring and ecosystem health assessment (Metternicht, 2003; Rosenberg & Resh, 1993; Bonney et al., 2016). Finally, the intricate relationship between nanoparticles (NPs) and TDS in aquatic environments and its implications for water treatment is an area of growing interest (Nowack & Bucheli, 2007; Li et al., 2016; Choi & Dionysiou, 2003). Future research should continue to explore these complex interactions to optimize water purification technologies and assess the environmental fate of both natural and engineered nanoparticles in the presence of varying TDS levels. The ionic makeup of TDS also holds promise as an indicator for tracing water sources and understanding underlying geochemical processes in watersheds (Freeze & Cherry, 1979).

Total Dissolved Solids (TDS) stands as a critical parameter in the assessment of water quality, wielding significant influence over both ecological integrity and human well-being. Its sources are diverse, encompassing both natural geological processes and a wide array of anthropogenic activities. Elevated TDS levels can trigger a cascade of adverse effects, impacting aquatic habitats, drinking water quality, agricultural productivity, and the efficiency of essential water treatment technologies like desalination. Effective monitoring strategies, often employing electrical conductivity as a surrogate measure, are crucial for understanding TDS distribution and temporal trends. Furthermore, the development and implementation of robust management and removal technologies are essential to mitigate the negative consequences of high TDS concentrations. Emerging research continues to unravel the complex interactions between TDS and other water quality parameters, as well as the implications for advanced water treatment processes and the fate of emerging contaminants like nanoparticles. Ultimately, a comprehensive understanding of the sources, impacts, and control of TDS is indispensable for ensuring the sustainable management of our precious water resources and safeguarding both environmental and human health.

MATERIALS AND METHORD

Study Area: Raipur - Geographical and Hydrological Context

This research focused on the city of Raipur, the capital of Chhattisgarh, situated in the central part of the state, India. Raipur holds significant urban and commercial importance within Central India and is geographically located around 21.25° North latitude and 81.63° East longitude. Often referred to as the "rice bowl of India," Raipur lies within the fertile Chhattisgarh plain. The landscape is characterized by the Mahanadi River, which flows eastward through the city, and the densely forested southern regions of the district. To the north, the terrain gradually ascends towards the Chota Nagpur Plateau, while the northwest exhibits a gentle rise towards the Maikal Hills. Raipur's connectivity is robust, with well-established road, rail, and air networks, including Swami Vivekananda Airport and the crucial Raipur Junction railway station on the Mumbai-Howrah route.

The water resources within Raipur exhibit a nuanced interplay with the city's geography and daily life. While the Mahanadi River and its tributaries serve as primary water sources, variations in water quality and usage exist across different areas. Regions proximate to the river may exhibit distinct mineral concentrations compared to areas relying more heavily on groundwater sources like borewells. Traditional wells, still present in older parts of the city, often possess unique water characteristics influenced by local aquifers and surrounding soil composition. The prevalence of treated municipal water supplies increases towards the suburbs and newer developments, ensuring a degree of uniformity but potentially differing in taste and hardness from natural sources. Total Dissolved Solids (TDS) concentration, representing the sum of positively charged cations and negatively charged anions, serves as a qualitative indicator of the total dissolved ion content. While elevated TDS is generally considered an aesthetic concern rather than a direct health hazard (classified as a secondary drinking water standard), it can lead to scale formation, corrosive or brackish tastes, and reduced efficiency of hot water heaters. Furthermore, high TDS levels can sometimes indicate the presence of elevated concentrations of specific ions like nitrate, arsenic, aluminum, copper, and lead, which may exceed primary or secondary drinking water standards.

Data Collection and Sampling Methodology

To assess the spatial variability of water quality, a total of fourteen distinct sampling locations were strategically selected across Raipur city. These locations were chosen to represent different water usage patterns and were geographically dispersed to capture potential variations in water characteristics. The sampling sites included Arang (Pandiri Talab) (A1), Abhanpur (Motit talab) (A2), Mahadev Ghat (A3), Sendh lake (A4), Palod (A5), Kalinga (Girls Hostel) (A6), Mayfair (A7), Marine Drive (A8), Indravati Colony (Raja Talab) (A9), Sector 29 (Tap water) (A10), Bhatagaon (near bus station) (A11), Kurud Dam (A12), Sarona (Dabri Talab Khasara) (A13), and Zora (A14). Water samples were collected over a period from mid-March to mid-April 2025, with a total of 144 samples obtained using well-sterilized 100 ml water bottles. The research primarily focused on surface water quality parameters.

The determination of TDS in the collected water samples followed a meticulous gravimetric analysis conducted indoors under controlled temperature conditions. Prior to each experimental set, water samples were tested for initial temperature and TDS. All equipment was thoroughly cleaned with purified water before and after each measurement to ensure accuracy and prevent contamination.

The gravimetric analysis commenced with the preparation of a clean evaporating dish (typically made of borosilicate glass, porcelain, or platinum due to their inertness and heat resistance). The dish was washed with lab-grade detergent, rinsed with tap water, and finally rinsed with distilled or deionized water. To ensure complete dryness and eliminate any volatile residues, the cleaned dish was placed in a laboratory oven at 180 ± 2 °C for at least one hour. After drying, the dish was carefully removed using heat-resistant gloves or tongs and immediately placed in a desiccator containing a desiccant (such as silica gel or anhydrous calcium sulfate) to cool to room temperature, preventing moisture reabsorption. Once cooled,

the empty, dry dish was precisely weighed using a calibrated analytical balance (sensitivity of 0.1 mg or better), and this initial weight (W1) was recorded.

To separate dissolved solids from any potential suspended particulate matter, the water samples were thoroughly mixed. A known volume (typically 100 ml, adjusted based on anticipated TDS content) of the well-mixed sample was then filtered through a glass fiber filter with 1-2 μm pores using a filter funnel and a vacuum source (or gravity filtration for samples with minimal particulate matter). The filtered water (filtrate), containing the dissolved solids, was collected in a clean flask or beaker, and its precise volume (V) was recorded.

The next step involved isolating the dissolved solids by evaporating the water. The measured volume of the filtrate was carefully transferred to the pre-weighed evaporating dish. The dish was gently heated on a hot plate below the boiling point of water to initiate evaporation, with the heat reduced as the water concentrated to prevent splattering and loss of solid material. Once most of the water had evaporated, the evaporating dish was transferred to the laboratory oven, again set at $180 \pm 2\ °C$, to ensure complete removal of residual moisture. The drying process continued until a constant weight was achieved, defined as a variation of no more than 0.5 mg between two successive weighings (with at least one hour of drying between weighings). After reaching a constant weight, the dish containing the dried residue was carefully removed from the oven using proper heat protection and immediately placed in a desiccator to cool to room temperature, preventing hygroscopic residue from absorbing atmospheric moisture. Once fully cooled, the evaporating dish with the dry residue was weighed precisely (W2) using the analytical balance.

The mass of the total dissolved solids (W_TDS) was calculated using the formula:

$$WTDS\ (mg) = (W2(g) - W1(g)) \times 1000\,mg/g$$

Finally, the TDS concentration in milligrams per liter (mg/L) was determined using the following equation:

$$TDS\ (mg/L) = V(L)\ WTDS\ (mg)$$

where V is the precise volume of the filtered water evaporated, expressed in liters (obtained by dividing the volume in milliliters by 1000).

By meticulously following these procedures, the research aimed to accurately measure the amount of total dissolved solids in water samples collected from the fifteen different locations across Raipur city during mid-March and mid-April 2025, providing insights into the spatial variability of this key water quality parameter.
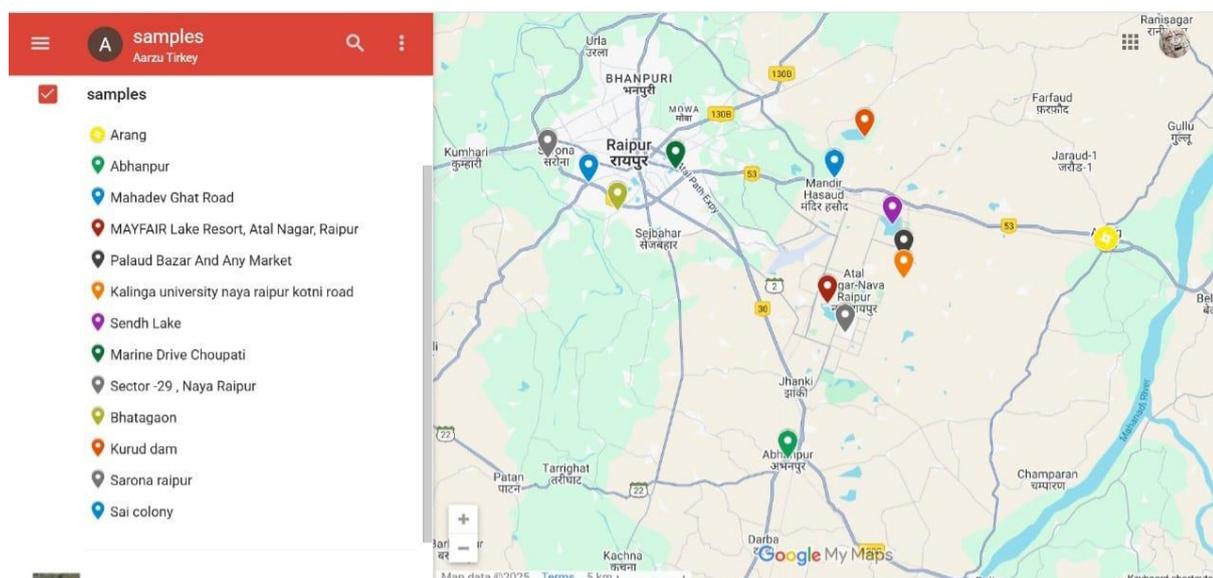
(Figure 1. Representing the sampling location)

RESULT AND DISCUSSION

The present study aimed to assess the physical characteristics—specifically pH, Total Dissolved Solids (TDS), and temperature—of water samples collected from various locations in and around Raipur District. These parameters are critical indicators of water quality, particularly for evaluating suitability for drinking and household use. The data collected have been represented both in **Table 1** and through graphical visualizations (see **Figure 1**) to illustrate spatial variations and compliance with permissible standards.

SAMPLE ID	LOCATION	pH Value	TDS	TEMP
A1	Arang, Raipur	6.7	660 mg/L	25.9 °C
A2	Abhanpur	7.34	558 mg/L	25.3 °C
A3	Mahadev Ghat,	7.65	599 mg/L	26°C
A4	Sendh Lake	8.9	1108 mg/L	25 °C
A5	Palod	7.58	624 mg/L	25.8°C
A6	Kaling Girls Hostel	7.2	716.66 mg/L	25°C
A7	Mayfair	8.85	1100 mg/L	25.9°C
A8	Marine Drive	9.6	1200 mg/L	24.8°C
A9	Indravati Colony	7.4	692 mg/L	24°C
A10	Sector 29	7.8	629 mg/L	25.4°C
A11	Bhatagaon	7.69	588 mg/L	25.7°C
A12	Kurud Dam	7.65	234 mg/L	24.3°C
A13	Sarona	7.1	520 mg/L	25.6°C
A14	zora	7.81	655 mg/L	25.1°C

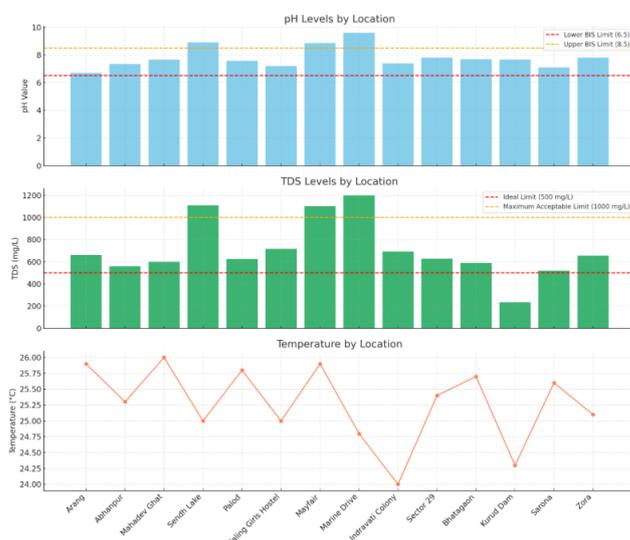TABLE 1: Physical parameters of Water samples of Raipur District

FIGURE 1: Graphical Representation of samples

Across the 14 sampling locations, pH values ranged from 6.7 to 9.6. Most locations, including Abhanpur, Mahadev Ghat, Palod, Indravati Colony, and Kurud Dam, fell within the **Bureau of Indian Standards (BIS)** acceptable range of 6.5 to 8.5, suggesting water that is chemically balanced and safe for consumption. However, some sites exceeded this limit, indicating elevated alkalinity: Sendh Lake (8.9), Mayfair (8.85), and Marine Drive (9.6). These anomalies may be attributed to industrial runoff, urban waste, or naturally occurring carbonates in the region's geology. In contrast, Arang recorded the lowest pH at 6.7, still within permissible levels but suggestive of slightly acidic water, potentially influenced by organic matter or acid rain.

TDS levels showed even greater variability, spanning from 234 mg/L to 1200 mg/L. The **lowest TDS** was recorded at Kurud Dam (234 mg/L), indicating excellent water quality with minimal mineral content. Several locations, including Abhanpur, Mahadev Ghat, and Sector 29, had TDS values slightly above the **optimal level of 500 mg/L**, yet remained under the **maximum BIS permissible limit of 1000 mg/L**. However, samples from Marine Drive, Mayfair, and Sendh Lake recorded TDS values above 1000 mg/L, with Marine Drive reaching **1200 mg/L**, suggesting significant mineral enrichment. Such elevated TDS levels are likely due to anthropogenic influences such as urban runoff, agricultural discharge, or sewage contamination and may pose long-term health risks if left untreated.

Temperature across all samples ranged narrowly between 24°C and 26°C, showing a relatively stable thermal profile. This consistency indicates no signs of industrial thermal pollution and aligns with expected ambient water temperatures for Central India. The highest temperature was noted at Mahadev Ghat (26°C), while the lowest was observed in Indravati Colony (24°C).

The findings reveal a complex water quality profile for Raipur, with variations likely stemming from both natural and human-induced factors. While most samples fall within acceptable limits for pH and TDS, the presence of highly alkaline and high-TDS samples raises concerns. Alkaline water can lead to scaling in pipes and appliances, whereas acidic water may corrode plumbing systems, potentially introducing heavy metals into the supply. From an environmental standpoint, deviations in pH can also impact aquatic ecosystems by altering pollutant solubility and affecting aquatic life survival.

In conclusion, Raipur's water resources demonstrate a need for ongoing, comprehensive monitoring. A mean pH of **7.73** suggests a general tendency toward neutrality, but localized anomalies highlight the importance of identifying pollution sources and applying targeted water treatment solutions. Future research should focus on understanding the underlying causes of these fluctuations—whether geological, environmental, or anthropogenic—to ensure both public health and ecological integrity are preserved. Sustainable water management practices, informed by continuous data collection and analysis, are essential for securing the region's water quality in the long term.

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