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PHYSICOCHEMICAL AND BIOLOGICAL ASSESSMENT OF DRINKING AND SURFACE WATER SOURCES IN KOPPAL CITY OF KARNATAKA, INDIA

Chemistry

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ABSTRACT

This study evaluates the physicochemical and biological characteristics of water from seven representative sites in Koppal City, India. We assessed crucial water quality parameters including pH and conductivity, TDS, hardness, major ions, DO, BOD, and residual chlorine using standard APHA procedures. Although most samples passed BIS/WHO suitability tests, spatial variations exposed localized concerns. Elevated dissolved solids and hardness at residential and religious sites indicate intensified groundwater-rock interactions. The study highlights the need for continuous surveillance to ensure sustainable water governance in northern Karnataka. This baseline assessment provides critical data to support environmental monitoring and management.

KEYWORDS

Water Quality Assessment; Physicochemical Parameters; Groundwater-rock Interaction; Dissolved Oxygen Depletion;

1. INTRODUCTION

Water is a vital natural resource that sustains human health, agricultural productivity, industrial development, and ecological stability [1]. Despite its abundance, only a small fraction of water is readily available as freshwater suitable for human consumption [2], increasing urbanization, industrialization, population growth, and climate variability have placed enormous pressure on freshwater resources worldwide, resulting in deterioration of water quality and increasing challenges in water resource management [3]–[5].

Contaminated drinking water remains one of the leading causes of waterborne diseases, particularly in developing countries [2]. Unsafe water contributes to the transmission of pathogens responsible for diarrhea, cholera, typhoid fever, dysentery, hepatitis A, and several parasitic infections [6]. Excessive dissolved salts, hardness-producing minerals, nutrients, and heavy metals can cause severe health consequences alongside microbial contamination [7], [8].

The physicochemical characteristics of natural water are controlled by complex interactions among geological formations, climatic conditions, hydrological processes, and anthropogenic activities. [8]. Parameters such as pH, electrical conductivity, total dissolved solids, total hardness, calcium, magnesium, chloride, dissolved oxygen, and biochemical oxygen demand are widely recognized as reliable indicators of water quality [9].

In India, the Bureau of Indian Standards (BIS) has issued guidelines for drinking water quality [9]–[11], while the World Health Organization's (WHO) Guidelines for Drinking-water Quality provide internationally recognized standards. [1], [2], [4], [8], [9].

This study aims to assess the physicochemical characteristics of water in Koppal City, Karnataka, and evaluate its suitability for domestic use and leisure activities [5]. The obtained results were subsequently interpreted in light of established guidelines provided by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO).

2. MATERIALS AND METHODS

2.1 Study Area and Sampling Locations

The study area, Koppal City, is located in a semi-arid tropical zone with distinct climatic patterns [12]–[14] The region's geology is dominated by granitic gneisses, schists, and younger sedimentary formations, which influence groundwater chemistry through mineral weathering and dissolution processes [14]–[17]. Seven sampling locations were selected to represent various categories of urban water use, including institutional, residential, recreational, religious, and surface water environments. Sampling took place in May 2025, during the pre-monsoon season, when groundwater mineralization is typically at its highest [5].

Table 1. Description of Water Sampling Locations

Sample Code	Sampling Location	Source Type	Purpose
S1	Government District Hospital	Municipal Drinking Water	Institutional
S2	Eshwar Park	Municipal Drinking Water	Recreational Area
S3	Shri Gavimatha	Drinking Water	Religious Institution
S4	Hullikere Lake	Surface Water	Environmental Assessment
S5	Male Malleshwara Temple	Drinking Water	Religious Institution
S6	Padaki Layout (Location 1)	Residential Water Supply	Domestic
S7	Padaki Layout (Location 2)	Residential Water Supply	Domestic

2.2 Physicochemical, Biological Analysis

Water samples were collected and transported to the laboratory for analysis. Physicochemical parameters measured included temperature, pH, electrical conductivity, total hardness, calcium concentration, magnesium concentration, chloride ion concentration, acidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), and residual chlorine [5], [11], [18]. Temperature measurements were obtained using a calibrated laboratory thermometer, while pH was measured immediately upon collection using a digital pH meter. Electrical conductivity was measured using a calibrated digital conductivity meter [19]. Total hardness, calcium concentration, magnesium concentration, and chloride ion concentration were determined through complexometric titration, EDTA titration, and argentometric titration, respectively. Acidity was determined through titration against standardized sodium hydroxide [20]. Dissolved oxygen (DO) levels were measured using the modified Winkler iodometric method [21], while biochemical oxygen demand (BOD) values were estimated by measuring the reduction in dissolved oxygen following a five-day incubation at 20°C under dark conditions. Residual chlorine was determined through iodometric titration [5].

2.3 Statistical Analysis

Descriptive statistics, including minimum, maximum, mean, and standard deviation, were calculated for each physicochemical parameter. Calculated BOD values were assessed against permissible limits set by the Bureau of Indian Standards (BIS) and World Health Organization (WHO) drinking water guidelines [11] [2].

3. RESULTS

3.1 Overview of Water Quality Characteristics

A comprehensive assessment was conducted on seven water samples collected from representative locations within Koppal City in May 2025. The parameters measured included temperature, pH, EC, TS, TDS, TSS, TH, Ca^{2+}, Mg^{2+}, Cl, DO, BOD, RC, and CD. The results were compared to established limits by the Bureau of Indian Standards (IS 10500:2012) and World Health Organization (WHO) guidelines to evaluate water quality suitability for domestic use [2]. Spatial variation was observed among sampling locations, with most physicochemical parameters within acceptable limits, but dissolved oxygen and total hardness exhibiting site-specific variations. The findings highlight the influence of local geological condition Physicochemical and Biological Assessment of Drinking and Surface Water Sources in Koppal City of Karnataka, India s, water source characteristics, and anthropogenic activities on urban water quality. Temperature remained constant at 25°C, pH values ranged from 6.0 to 8.0, and electrical conductivity varied between 385.5 and 757.1 µS cm^{-1}[14].

3.2 Total Solids, Total Dissolved Solids and Total Suspended Solids

Total solids exhibited spatial variation among sampling sites, with residential Padaki Layout points showing highest concentrations (1400 mg L^{-1}). Total dissolved solids ranged from 200 to 1000 mg L^{-1}, also peaking at residential sites. Elevated TDS indicates mineral dissolution during groundwater movement through geological formations. Total suspended solids were relatively low across all sites, except for Hullikere Lake, which reflected expected particulate matter in surface water. Although elevated TDS affects taste and scaling, measured concentrations generally remained within drinking water limits.

Total hardness varied widely (112-342 mg L^{-1}), with the Male Malleshwara Temple sample showing highest hardness due to calcium and magnesium ions derived from geological weathering of carbonate-bearing minerals. While hard water doesn't pose significant health risks, prolonged use may contribute to scaling in plumbing, reduced soap efficiency, and increased maintenance of water distribution systems.

3.3 Calcium and Magnesium

Calcium concentrations reached a maximum of 96 mg L^{-1}, while magnesium concentrations ranged up to 24.78 mg L^{-1}. These ions collectively explain the observed hardness of groundwater samples. Higher concentrations in temple and residential locations indicate longer groundwater residence time and increased mineral dissolution. Measured concentrations remained within permissible limits specified by national drinking water standards. Chloride concentrations remained comparatively low throughout the study, with the highest value (127.46 mg L^{-1}) recorded in the Government District Hospital sample.

The measured concentrations were substantially below the BIS[11] permissible limit of 250 mg L^{-1}, indicating minimal contamination from sewage intrusion, industrial discharge, or agricultural runoff. The low chloride concentrations demonstrate that salinity-related deterioration is not presently a major concern within the investigated water supply network.

3.4 Dissolved Oxygen (DO) and BOD (Biochemical Oxygen Demand)

Dissolved oxygen showed significant variability, with undetectable levels suggesting localized stagnation or high organic consumption, contrasted by higher surface water DO due to aeration. Biochemical oxygen demand was generally low, but elevated values at specific sites indicate localized organic pollution.

The chlorine measurements confirm operational municipal sanitation; residual chlorine ranged from 1.06 to 3.90 mg L^{-1}. Furthermore, consistently low chlorine demand suggests efficient use of applied disinfectant. This combination reveals variability in aquatic status and confirms that disinfection standards were maintained across the sampled sites [22].

4. DISCUSSION

Crucially, these levels remain within permissible limits, posing no immediate public health threat. Overall, water sources are chemically suitable for domestic use, meeting BIS/WHO standards [11] [2]. Residential areas show elevated Total Dissolved Solids and conductivity due to groundwater-geology interaction, indicating natural mineral dissolution within hard-rock aquifers [14].

4.1 Hardness and Major Cations

Furthermore, total water hardness varied substantially across the sites. The highest hardness was observed at the Male Malleshwara Temple sample. This confirms that high levels of dissolved calcium and magnesium are primarily sourced from natural geological weathering of carbonate and silicate-bearing minerals, rather than direct anthropogenic pollution.

4.2 Dissolved Oxygen and Organic Pollution

Dissolved Oxygen (DO) showed the most variability, with undetectable levels at several sites suggesting localized stagnation or high organic consumption. Conversely, the Hullikere Lake sample exhibited higher DO due to natural aeration [21], [23], [24].

The absence of DO indicates oxygen consumption exceeded replenishment, possibly from trapped organic matter or biofilms. While these findings highlight potential environmental stress factors requiring monitoring, they were not accompanied by extremely high chloride concentrations, indicating sewage intrusion was unlikely. These observations underscore the vital need for incorporating DO into routine municipal [5], [25].

4.3 Biochemical Oxygen Demand

Elevated BOD and correspondingly low DO were found at certain sites, indicating localized organic contamination. This strong inverse relationship suggests accumulating biodegradable matter reducing water quality. Regular monitoring is vital to prevent these areas from becoming major sources of pollution.

Table-3: Detailed Physico-chemical Water Quality Analysis Data - Koppal City Sites (S1-S7)

Sample	pH	Conductivity (µs/cm)	TS (mg/l)	TSS (g/l)	TDS (g/l)	Acidity (mg/)	Cl-(mg/l)	Total Hardness (mg/l)	Ca Hardness (mg/l)	Mg Hardness (mg/l)	Ca (mg/l)	Mg (mg/l)
S1	8	726.3	0800	0.4	0.4	054	127.46	200	090	110	36.0	26.73
S2	7	508.6	0600	0.4	0.2	042	030.99	120	076	044	30.4	10.69
S3	6	533.3	1000	0.6	0.4	044	037.48	148	080	068	32.0	16.52
S4	8	385.5	1000	0.8	0.6	056	017.49	112	058	054	23.2	13.12
S5	8	707.5	1000	0.2	0.8	120	012.49	342	240	102	96.0	24.78
S6	8	757.1	1400	0.0	1.0	096	037.48	128	056	072	22.4	17.49
S7	7	545.5	1400	0.4	1.0	046	029.99	142	090	052	36.0	12.63

Table-04: Detailed Physico-chemical Water Quality Analysis Data - Koppal City Sites (S1-S7)

Sample	DO (mg/l)	BOD Final DO (mg/l)	BOD (mg/l)	Residual Chlorine (Sodium thiosulphate Used (ml)	Residual Chlorine (mg/l)	Chlorine Demand
S1	0.00	1.510	2.880	1.10	3.9	0.0
S2	2.40	0.890	4.694	0.50	1.77	0.0
S3	0.00	1.189	3.600	0.60	2.12	0.0
S4	4.40	0.430	4.802	0.40	1.41	0.5
S5	0.00	3.530	4.800	0.30	1.06	0.0
S6	2.80	1.600	2.040	0.45	1.56	0.0
S7	0.72	2.400	0.722	0.50	1.77	0.0

Table-5. Descriptive Statistics for Physicochemical Parameters of Water Samples Collected from Seven Distinct Sites within Koppal City.

Sample	pH	Conductivity (µS/cm)	TS (mg/l)	TDS (g/l)	Acidity (mg/l as CaCO3)	Chloride (mg/l)	Total Hardness (mg/l)	Ca Hardness (mg/l)	Mg Hardness (mg/l)	DO (mg/l)	BOD (mg/l)	Residual Chlorine (mg/l)	Chlorine Demand
S1	8.0	726.30	800	0.4	54.00	127.46	200.00	90.00	110.00	0.00	02.88	03.90	0.00
S2	7.0	508.60	600	0.2	42.00	30.99	120.00	76.00	44.00	2.40	04.69	01.77	0.00
S3	6.0	533.30	1000	0.4	44.00	37.48	148.00	80.00	68.00	0.00	03.60	02.12	0.00

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S4	8.0	385.50	1000	0.6	56.00	17.49	112.00	58.00	54.00	4.40	04.80	01.41	0.50
S5	8.0	707.50	1000	0.8	120.00	12.49	342.00	240.00	102.00	0.00	04.80	01.06	0.00
S6	8.0	757.10	1400	1.0	96.00	37.48	128.00	56.00	72.00	2.80	02.04	01.56	0.00
S7	7.0	545.50	1400	1.0	46.00	29.99	142.00	90.00	52.00	0.72	00.72	01.77	0.00
Mean	7.43	594.83	1028.57	0.63	65.43	41.91	170.29	98.57	71.71	1.47	03.36	01.94	0.07
SD	0.79	137.71	292.77	0.31	30.33	38.90	81.01	63.85	25.39	1.74	01.58	00.92	0.19
Min	6.0	385.50	600	0.2	42.00	12.49	112.00	56.00	44.00	0.00	00.72	01.06	0.00
Max	8.0	757.10	1400	1.0	120.00	127.46	342.00	240.00	110.00	4.40	04.80	03.90	0.50
CV (%)	10.59	23.15	28.46	50.07	46.35	92.82	47.58	64.78	35.40	118.34	46.90	47.63	264.58

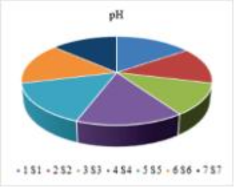

Figure-02: Comparative chart for pH measurement

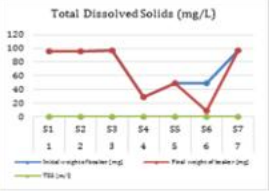

Figure-03: Comparative chart for TDS measurement

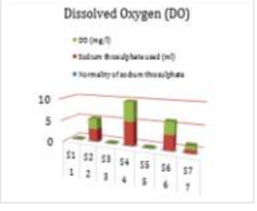

Figure-04: Comparative chart for DO measurement

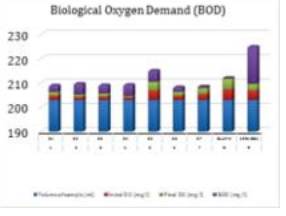

Figure-05: Comparative chart for BOD measurement

4.4 Residual Chlorine and Water Disinfection
Residual chlorine levels in drinking water were found to be excessive at some sites, highlighting the need for optimized chlorination practices to balance microbiological protection with water quality concerns. While residual chlorine is crucial for preventing microbial regrowth and maintaining public health, high levels can also have undesirable effects on the taste and odor of the water. Therefore, it is essential to strike a balance between maintaining adequate protection against microbiological threats and minimizing potential negative impacts on water quality.

4.5 Compliance with Drinking Water Standards
Most measured parameters complied with BIS and WHO drinking water standards, indicating effective management of the municipal water supply. This suggests that existing treatment practices are generally effective in controlling major contaminants. However, localized variations in water quality suggest that decentralized monitoring programs are necessary to ensure uniform water quality throughout the distribution network. Regular maintenance of storage facilities and infrastructure is also crucial to prevent localized microbial activity.

4.6 Environmental, Public Health Implications and Study Limitations
The analysis suggests that while there are no widespread chemical contamination issues, routine surveillance is necessary due to potential impacts of urban expansion on water quality. Continuous monitoring will enable early detection of emerging contaminants and inform evidence-based decision-making by municipal authorities. From a public health perspective, the study highlights the need for ongoing surveillance to detect emerging issues before they become major problems.

The study was limited by seasonal sampling and conventional parameters, neglecting critical variables like heavy metals, pathogens, and nutrients. Future research must incorporate seasonal variability, microbiological assessments, and advanced hydrogeochemical modeling for a complete understanding. Crucially, the findings emphasize that continuous monitoring and proactive maintenance of storage facilities are essential to prevent stagnation and ensure the safe, reliable supply of drinking water in Koppal City.

5. CONCLUSION
In conclusion, Koppal City's water quality largely complies with WHO and BIS standards, making most sources chemically suitable for domestic consumption. However, localized issues arise from natural interactions between the granitic terrain and water bodies, contributing to elevated hardness and total dissolved solids. Our investigation also revealed oxygen depletion and biochemical oxygen demand in some areas, indicating potential organic pollution. To ensure sustainable water management practices, continued monitoring is crucial. Future efforts should prioritize seasonal monitoring, microbiological assessments, and trace metal analysis to provide a comprehensive understanding of the region's water quality and inform evidence-based decision-making.

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REFERENCES
[1] UNESCO, *United Nations World Water Development Report*. Paris: UNESCO, 2024.
[2] W. H. Organization, *Guidelines for Drinking-water Quality*, 4th ed., i. Geneva: WHO, 2022.
[3] P. Li, R. Tian, C. Xue, and J. Wu, "Progress in groundwater quality assessment: A review," *Environ. Rev.*, 2021.
[4] N. Adimalla and H. Qian, "Groundwater quality evaluation using water quality index (WQI) for drinking purposes and human health risk assessment in an agricultural region of South India," *Ecotoxicol. Environ. Saf.*, vol. 176, pp. 153–161, 2019.
[5] APHA, AWWA, and WEF, *Standard Methods for the Examination of Water and Wastewater*, 24th ed. Washington, DC: American Public Health Association, 2023.
[6] W. H. Organization, *World Health Forum Bulletin: The Ten Biggest Killers in the World*. Geneva: WHO, 2007.
[7] M. Varol and A. Davraz, "Assessment of groundwater quality using physicochemical parameters and multivariate statistical techniques," *Environ. Monit. Assess.*, 2022.
[8] L. K. Mogane, T. Masebe, T. A. M. Msagati, and E. Ncube, "A comprehensive review of water quality indices for lotic and lentic ecosystems," *Environ. Monit. Assess.*, vol. 195, p. 926, 2023.
[9] A. Tiwari, M. Kumar, and S. Thakur, "Groundwater quality assessment for drinking purpose using traditional and fuzzy-GIS-based water quality index in Gurugram District of Haryana, India," *Environ. Geochem. Health*, vol. 46, p. 52, 2024.
[10] Y. Yan, Y. Zhang, R. Yao, and others, "Groundwater suitability assessment for irrigation and drinking purposes by integrating spatial analysis, machine learning, water quality index, and health risk model," *Environ. Sci. Pollut. Res.*, vol. 31, pp. 39155–39176, 2024.
[11] B. of Indian Standards, *IS 10500:2012 Drinking Water—Specification*. New Delhi, India, 2012.
[12] I. M. Department, *Climatological Tables of Observatories in India*. Pune, India: IMD, 2024.
[13] K. S. N. D. M. Centre, *Annual Rainfall Report*. Bengaluru: KSNDMC, 2025.
[14] G. S. of India, *District Resource Map: Koppal District, Karnataka*. Bengaluru: GSI, 2011.
[15] C. G. W. Board, *Ground Water Year Book – Karnataka State*. New Delhi: Ministry of Jal Shakti, 2023.
[16] O. of the Registrar General and C. Commissioner, *District Census Handbook: Koppal District*. New Delhi: Government of India, 2011.
[17] C. G. W. Board, *Aquifer Mapping and Management Plan: Koppal District*. New Delhi: Ministry of Jal Shakti, 2023.
[18] S. Suryakant S., "Synthesis and characterization of Schiff base metal complexes derived from Napthofuran-2-Carbohydrazide and 4-(methylthio)benzaldehyde," *Int. J. Sci. Res. Arch.*, vol. 7, no. 2, pp. 466–473, 2022.
[19] Sadu Suryakant S., "Synthesis, Characterization And Biological Studies of Metal Complexes With 3-Amino-5-Bromobenzofuran-2-Carboxamide Schiff Base," *J. Appl. Chem.*, vol. 3, no. 4, pp. 1543–1551, 2014.
[20] A. I. Vogel, "A text book of quantitative Inorganic analysis. By A. I. Vogel," *J. Soc. Chem. Ind.*, vol. 59, no. 9, pp. 153–153, Mar. 1940.
[21] L. W. Winkler, "Die Bestimmung des im Wasser gelösten Sauerstoffes," *Berichte der Dtsch. Chem. Gesellschaft*, vol. 21, pp. 2843–2855, 1888.
[22] S. Suryakant, "Synthesis, Characterization and Biological Activities of Heterocyclic Schiff Base and Its Metal Complexes," 2018.
[23] X. jun Cui, X. zhou Lin, C. hai Liu, R. song Yang, X. wen Zheng, and M. Gong, "Fabrication and corrosion resistance of a hydrophobic micro-arc oxidation coating on AZ31 Mg alloy," *Corros. Sci.*, vol. 90, pp. 402–412, 2015.
[24] Y. Wen, G. Schoups, and N. van de Giesen, "Organic pollution of rivers: Combined threats of urbanization, livestock farming and global climate change," *Sci. Rep.*, vol. 7, p. 43289, 2017.
[25] I. Helm, L. Jalukse, and I. Leito, "A highly accurate method for determination of dissolved oxygen: Gravimetric Winkler method," *Anal. Chim. Acta*, vol. 741, pp. 21–31, 2012.