# A COMPARATIVE STUDY ON WATER QUALITY AND MICROBIAL CONDITIONS OF OPEN WELL AND BORE WELL WATER FROM A SELECTED AREA OF KALABURAGI CITY, KARNATAKA, INDIA

**Sneha Sarikar[*], Sachin Wankhede[**], Shwetha Sarikar[***]**

[*] Sharnbasva University, Department of Post Graduate Studies and Research in Zoology, Kalaburagi, India
[**] Morarji Desai Residential P.U Science College, Devadurga, Raichur, India
[***] Akka Mahadevi Mahila Maha Vidyalaya Women's Degree College, Bidar, India

corresponding author: Shwetha Sarikar, e-mail: shwethasarikar@gmail.com



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## ABSTRACT

In order to assess the suitability of water sources for human consumption, six water samples were taken from open wells and drinking bore wells in several selected regions in the Kalaburagi district of Karnataka state, India, from December 2020 to January 2022. The analysis found that the local water sources are contaminated. Total dissolved solids, total alkalinity, chloride, calcium, and magnesium levels in the water exceeded the permissible limits. The samples analysed for the presence of microbial contamination indicate a worrying scenario from the point of view of public health. As a result, such studies must be expanded to include open wells and bore wells in individual homes, as well as detailed investigations of the physicochemical and microbiological quality of drinking water sources in Kalaburagi district.

***Keywords***: *groundwater, microbial contamination, physicochemical, Kalaburagi*

## INTRODUCTION

Water pollution is a global problem because it affects water quality and limits the use of water for various reasons [1]. Water located under the earth's surface in soil pores and rock cracks is called groundwater. Natural freshwater bodies, such as rivers, lakes, and wetlands, are the main sources of water supply for humans, agriculture, and industry [2]. Natural discharge often occurs in springs and seeps. Groundwater provides about 20 % of the world's freshwater and accounts for approximately 0.61 % of the world's water, including oceans [3]. Groundwater is the long-term reserve of the natural water cycle. However, high water consumption generates significant difficulties for both people and the ecosystem [4]. The most obvious issue is that the water is being reduced to quantities that exceed the capacity of the current wells.

India is the world's largest user of groundwater. In the 1960s, there had been less than a million groundwater wells, but by 2006, the number rose to almost 12 million [5]. Groundwater depletion and seawater intrusion are two potential consequences of a lower water table. In India, a potential solution to groundwater exploitation, known as "groundwater recharge", is emerging. It is the capture of rainwater and its use to restore aquifers. Groundwater contamination can occur as a consequence of toxins deposited in the soil. However, it faces serious water contamination issues as a result of increasing population growth and economic development [6]. Calcium and magnesium ions, as well as iron and manganese, are constantly present in groundwaters [7]. Their sensitive ecosystem must strike a balance between environmental stability and their surroundings, particularly in the face of human expansion and pollution [8].

In a densely populated country like India, biological or chemical pollution of drinking water sources is a fairly common occurrence. A multitude of factors, including agricultural runoff, sanitation concerns, and mineral storage, can contaminate groundwater and surface water [9]. Groundwater contamination can be caused by leaking sewage pipeline or improper waste disposal. Consumers may develop gastroenteritis as a result of intestinal infections such as E. coli, Salmonella, Shigella, and Vibrio. Their sensitive ecosystem must strike a balance between environmental stability and their surroundings, particularly in the face of human growth and pollution [10].

Water is tested for various factors to assess if it is appropriate for drinking and domestic use [11]. It can contain pathogenic bacteria, viruses, and parasites. The presence of faecal coliforms (such as E. coli) indicates sewage pollution. Protozoan oocysts such as Cryptosporidium, Giardia, Lamblia, Legionella, and viruses (intestinal) are also pollutants. pH, total dissolved solids, carbon dioxide, dissolved oxygen, and other physical and chemical parameters are included. Physical characteristics affect the aesthetics and taste of drinking water and can hinder microbiological pathogen eradication. Chemical factors are more likely to cause long-term health problems [12].

Coliforms serve as the basis for microbiological testing of water. The coliforms are members of the Enterobacteriaceae family. In standard methods for the examination of water and wastewater [13], the members of coliform group are described as: a) all aerobic and facultative anaerobic, Gram-negative, non-spore-forming rod-shaped bacteria that ferment lactose with gas and acid formation within 48 h at 35 °C (Multiple Tube Fermentation Technique) or b) all aerobic and numerous facultative anaerobic Gram-negative, rod-shaped bacteria, non-spore forming that grow as crimson colony with a metallic sheen in 24 h at 35 °C on a lactose-containing endo-type medium.

Coliforms are indicator organisms that serve as basic monitoring instruments for measuring changes in water quality and detecting diseases. Under identical physical, chemical, and nutritional circumstances, indicator organisms offer proof of the presence or absence of a surviving pathogenic organism. Indicator organisms are less hazardous than diseases and can be identified more easily [14]. Bacteria were chosen as markers because they are prevalent in the intestines of warm-blooded animals and indicate the presence of potentially hazardous diseases and illnesses. The presence of coliform bacteria, such as E. coli, in surface water indicates faecal contamination [15].

This study focused on various sources of drinking water in the Kalaburagi region, such as bore wells and open wells. Water consumption is increasing as the world's population grows. Rapid industrialization, rapid urbanization, agricultural runoff, human activities, inadequate drainage systems, and damaged pipelines are the primary causes of water pollution in Kalaburagi. Drinking waters in the study have become extremely contaminated as a result of numerous human activities, resulting in life-threatening illnesses in humans. Improper management of the water system can lead to major water quality issues. The current study will therefore examine the physicochemical properties and the existence of microbial communities in water samples from bore wells and open wells.

## MATERIALS AND METHODS

### Study area

Kalaburagi is a city in the Indian state of Karnataka. It is the administrative centre for the Kalaburagi district. It was previously part of Nizam's state of Hyderabad. Kalaburagi is located 200 km north of Hyderabad and 623 km north of Bangalore. Kalaburagi district is located in northern Karnataka between 16° 11' and 17° 19' N latitude and 76° 54' E longitude, with a total area of 16,244 km$^2$ [16]. The study area includes three sampling sites (Figure 1).

### Collection of water samples for examination of physicochemical parameters

Six water samples were collected from bore wells and open wells in the period from December 2020 to January 2022. Nine physicochemical parameters were determined in this examination: water temperature, pH, total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), chloride ($Cl^-$), calcium (Ca), magnesium (Mg) and sulphate ($SO_4^{2-}$). The samples were collected at the sampling locations during the morning hours (10:00 AM - 12:00 AM) in sterilized containers. Temperature and pH were assessed at the collection sites, and water samples were safely transported to the laboratory for analysis of various parameters [13].

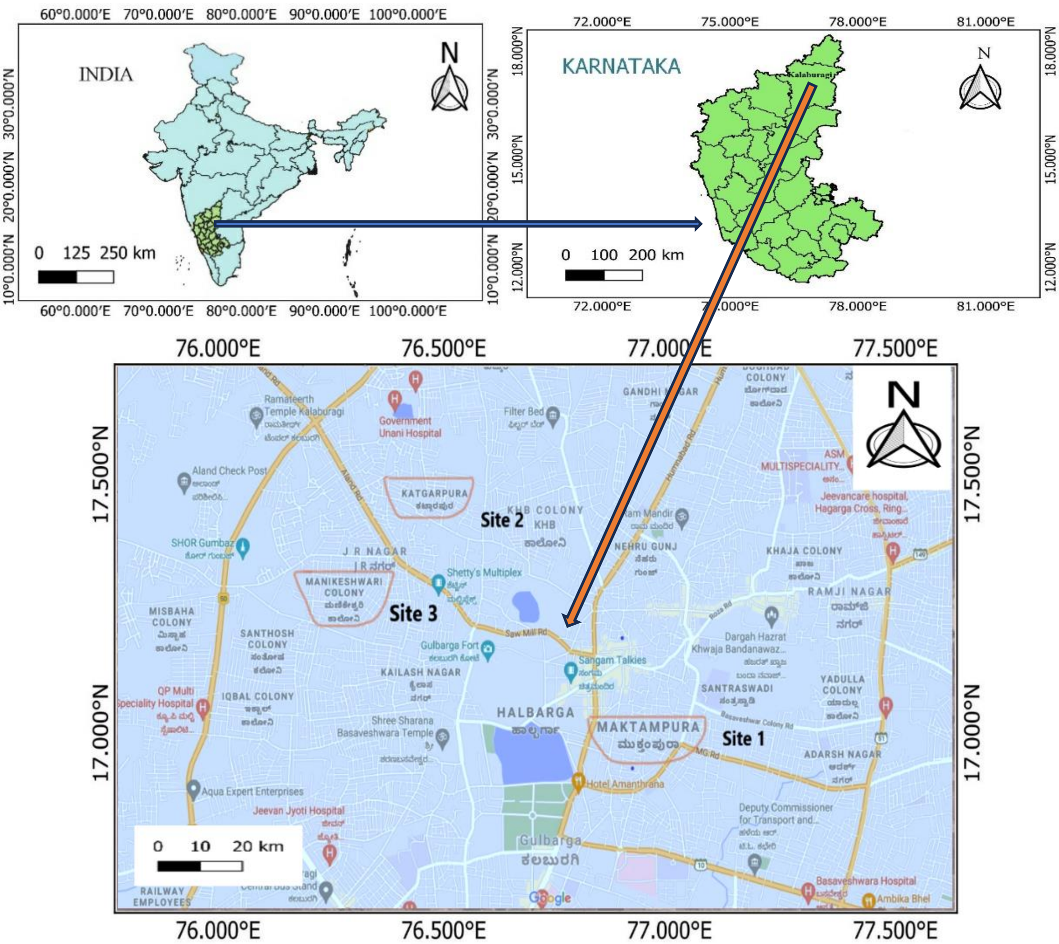


Figure.1 Satellite map showing three sampling sites (Source: QGIS 3.16)

**Microbiological methodology**

Sterile plastic vials were used for sample collection. The sampling bottle was kept unopened until it was time to fill. During sampling, the cork and neck of the bottle were protected from contamination.

**Standard plate count for enumeration of aerobic microbes**

The sample container was shaken vigorously 25 times. 0.1 ml or 1 ml of sample was transferred to each Petri dish and autoclave for 15 min at 15 lbs pressure before adding media to each dish at 43 °C to 45 °C. The agar and sample were mixed well before being allowed to solidify by tilting and rotating the plate. After solidification, the plates were inverted and kept at 37 °C for 24 h. Only plates with 30 to 300 colonies were used. For 24 h, counts were labelled as "Standard plate count at 37 °C" or "Standard plate count at 22 °C" for 72 h [13].

**Presumptive test for E. coli**

Six test tubes were used, and 10 ml of MacConkey soup was placed in an inverted Durham tube. After autoclaving the test tubes, 1 ml of water was added to each test tube and incubated at 37 °C for 24 h, and the presence or absence of gas formation was noted.

**Confirmation test for E. coli**

For the confirmation of E. coli, MacConkey broth (17 g bacto peptone, 3 g protease peptone, 10 g lactose, 15 g agar, 0.001 g crystal violet, 0.03 g neutral red, 1.0 l distilled water, pH = 7.1) was used. 250 ml of water was filtered through a 0.2 membrane filter before being placed in MacConkey broth and sterilized under 15 lbs pressure for 15 minutes, and subsequently incubated at 37 °C for 24 h. It was noted whether gas formation occurred or not. The tube with positive growth from MacConkey was then placed in brilliant green bile broth and cultured for 48 h at 37 °C. Positive tubes of brilliant green bile broth were streaked on MacConkey or Eosin-methylene blue (EMB) agar plates and the presence or absence of gas formation was noted, followed by E. coli strains growing with metallic sheen on EMB agar. It was determined whether E. coli colonies were present or absent.

**Test for yeast mould**

Yeast mould was confirmed using Potato Dextrose Agar media (PDA). 250 ml of water was filtered through a 0.2 membrane filter and added to the PDA medium, which was sterilized under 15 lbs pressure for 15 min and incubated at 25 °C for 5 days. It was determined whether Yeast mould colonies were present or not.

**RESULTS AND DISCUSSION**

The temperature of the water in this investigation ranged from 22.3 °C to 24 °C (Table 1). The highest temperature was recorded in the bore well in Manikeshwari colony (site 3), and the lowest in the open well in Maktampura colony (site 1). The pH of water measures the concentration of hydrogen ions in water and indicates whether the water is acidic or alkaline [17]. The pH of most natural fluids is determined by the balance of carbon dioxide, carbonate, and bicarbonate. Water samples from deep aquifers and hot springs may experience significant pH variations during transport from the collection site to the laboratory. The pH values in this study varied from 7.21 to 7.37 (Table 1). The pH was the highest in the bore well in Manikeshwari colony, and the lowest in the open well in Maktampura colony. All pH values were within acceptable limits. The amount of material dissolved in the water was also calculated. The effect of water as a solvent on solids, liquids, and gases results in dissolved materials. Dissolved chemicals can be organic or inorganic. Total dissolved solids (TDS) in the current study varied from 468.3 mg/L to 870 mg/L (Table 1). It was the highest in the bore well in Manikeshwari colony, and the lowest in the open well in Shaikroza colony (site 2).

Total alkalinity of water is its ability to neutralize a strong acid, which is often attributed to the presence of carbonate, bicarbonate, and hydroxyl ions. A high level of alkalinity gives an unpleasant taste and is detrimental to agriculture as it damages the soil and reduces crop production [18]. Total alkalinity in this study varied from 198.1 mg/L to 375.8 mg/L (Table 1). It was the highest in bore well in Manikeshwari colony, and the lowest in open well in Shaikroza colony. The total alkalinity of all tested water samples exceeded BIS recommendations [19]. The geological nature of the mineral levels in natural water determines the natural hardness of the water. The total hardness varied between 169 mg/L and 510.8 mg/L (Table 1). It was the highest in bore well in Shaikroza colony, and the lowest in open well in Manikeshwari colony. The highest value of hardness was recorded in the wet season and the lowest in the dry season. Total hardness of almost all tested water samples was higher than BIS recommendations [19].

Chlorides can be found in different amounts in natural water. As the mineral concentration increases, so does the chloride content. The chloride content in this study varied from 286.5 mg/L to 366.5 mg/L. It was the highest in the bore well in Manikeshwari colony, and the lowest in the open well in Shaikroza colony. The chloride content at the studied locations exceeds the permissible limits according to BIS [19]. The families of silicate mineral plagioclase, pyroxene, and amphibole in igneous and metamorphic rocks, and limestone, dolomite, and gypsum in sedimentary rocks, are the primary sources of calcium and magnesium in groundwater [20].

Calcium concentrations in this study varied from 155.9 mg/L to 351.8 mg/L (Table 1). It was the highest in the bore well in Shaikroza colony, and the lowest in the open well in Manikeshwari colony. Calcium levels in all tested water samples were higher than the BIS recommendations [19]. Magnesium concentrations in this study varied from 19.8 mg/L to 114.1 mg/L (Table 1). It was the highest in the bore well in Maktampura colony, and the lowest in the open well in Manikeshwari colony. The magnesium levels in almost all tested water samples were higher than the BIS recommendations [19]. Sulphate occurs naturally in water as a result of the leaching of gypsum and other common minerals. Sulphate concentrations in this study varied from 15.4 mg/L to 31.9 mg/L (Table 1). It was the highest in the bore well in Manikeshwari colony, and the lowest in the open well in Maktampura colony. Sulphate values for all tested water samples were within the permissible limits prescribed by BIS [19]. Parameters such as total dissolved solids, total alkalinity, chloride, calcium and magnesium were above the permissible limits prescribed by BIS [19] in almost all samples (Table 1).

It is generally accepted that water intended for human consumption must not contain chemical compounds and bacteria in proportions that would pose a health risk. Drinking water is water that is free of disease-causing microorganisms and chemical contaminants that are hazardous to health. Drinking water must not contain harmful microbes or bacteria that indicate faecal contamination. The detection of faecal indicator bacteria in drinking water provides a sensitive technique of quality evaluation, since it is not practical to test water for every possible pathogen that might be present [21]. Research in this study was conducted from December 2020 to January 2022. Bacteriological testing was performed on six water samples collected from different water sources in the Kalaburagi area. Water samples were obtained from three bore wells and three open wells. The primary goal is to evaluate different microbial populations in different water sources, such as bore wells and open wells. Coliform and E. coli were studied for 24 and 72 h, respectively. The results are presented in Table 2 and Figures 2 and 3.

Table 1. A comparative study of the average physicochemical parameters of water samples from open wells and bore wells in the selected area of Kalaburagi city

| | Parameters | BIS standard value [19] | Maktampura colony (Site 1) | | Shaikroza colony (Site 2) | | Manikeshwari colony (Site 3) | |
|---|---|---|---|---|---|---|---|---|
| | | | Open well | Bore well | Open well | Bore well | Open well | Bore well |
| 1 | Water temperature (°C) | - | 22.3 | 22.5 | 22.4 | 22.5 | 23.8 | 24 |
| 2 | pH | 8.5 | 7.21 | 7.27 | 7.3 | 7.28 | 7.33 | 7.37 |
| 3 | TDS (mg/L) | 500 | 678 | 670.8 | 468.3 | 745.5 | 510.3 | 870 |
| 4 | Total alkalinity (mg/L) | 200 | 275.2 | 322.4 | 198.1 | 308 | 240 | 375.8 |
| 5 | Total hardness (mg/L) | 300 | 489.5 | 424.5 | 397.5 | 510.8 | 169 | 298 |
| 6 | Chloride (mg/L) | 250 | 311.5 | 350.3 | 286.5 | 363.5 | 304 | 366.5 |
| 7 | Calcium (mg/L) | 75 | 292.3 | 335.9 | 312.8 | 351.8 | 155.9 | 254.9 |
| 8 | Magnesium (mg/L) | 30 | 53.5 | 114.1 | 52.5 | 101.9 | 19.8 | 85.8 |
| 9 | Sulphate (mg/L) | 150 | 15.4 | 22.2 | 16 | 27.2 | 16.4 | 31.9 |

Table 2. Results of determination of E. coli, coliforms and yeast mould in water samples from open wells and bore wells in the selected area of Kalaburagi city

| Sample | Sites | Aerobic microbial count | | E. coli and coliforms | Yeast mould |
|---|---|---|---|---|---|
| | | 37 °C | 22°C | | |
| 1 | Makhtampur (Bore well) | < 20 | < 100 | Present | Present |
| 2 | Makhtampur (Open well) | > 20 | > 100 | Present | Present |
| 3 | Shaikroza (Bore well) | > 20 | > 100 | Present | Present |
| 4 | Shaikroza (Open well) | > 20 | < 100 | Present | Present |
| 5 | Manikeshwari colony (Bore well) | < 20 | > 100 | Present | Present |
| 6 | Manikeshwari colony (Open well) | < 20 | > 100 | Present | Present |

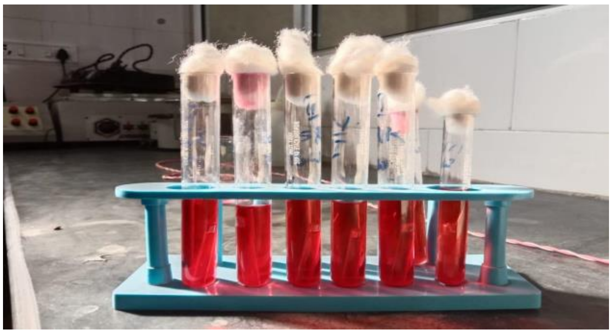

Figure. 2 Test for Escherichia coli

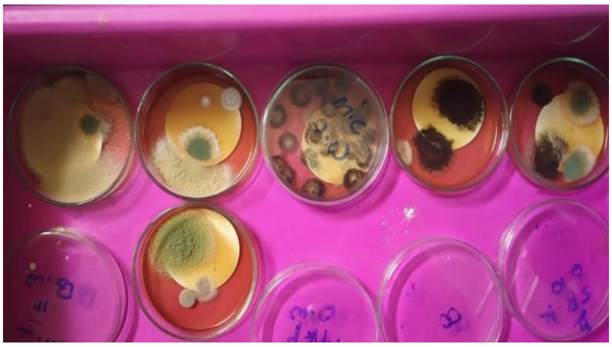

Figure. 3 Colonies of bacteria in water samples from open wells and bore wells in the selected area of Kalaburagi city

## CONCLUSION

In this study, an attempt was made to detect the route and contamination of major ions and nutrients in the groundwater of some of the selected locations in Kalaburagi district. The main sources of pollutants responsible for pollution in the study region are related to human activity and natural factors, and overexploitation of groundwater to fulfil the demand for freshwater is one of the main reasons for decrease in groundwater quality.

As a result, recommendations must be made to prevent further degradation of groundwater quality in the study area, since most of the water samples are polluted. In the study area, boiling and filtering water in households is likely to prevent waterborne diseases. Initiatives involving active community engagement, such as a mass cleanliness campaign, and awareness and health education campaigns, can be carried out since maintaining a suitable sanitary well is the most cost-effective preventative strategy against waterborne diseases. As a result, such studies must be expanded to include open wells and bore wells in individual homes, as well as detailed investigations of the physicochemical and microbiological quality of drinking water sources in Kalaburagi district. Based on this research, local authorities can be given recommendations for appropriate management measures for drinking water sources.

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