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# RESEARCH ARTICLE

# COMPARATIVE STUDY OF PHYSICOCHEMICAL CHARACTERISTICS OF GROUND WATER AND SURFACE WATER IN BHOPAL CITY, INDIA

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## ABSTRACT

The comparative study of physicochemical characteristics of ground water and surface water type sources of water was conducted during the present work. The methodology for physicochemical analysis of water samples was followed from scientific manuals (Adoni *et al.,* 1985; APHA, 2005). The studied results reveal that both the water types are moderately hard in nature and suitable for various purposes.

***Key words:*** Water quality, Piper diagram, physicochemical, runoff.



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## INTRODUCTION

Water is vital for the existence of all life forms and is essential for all activities of human beings (Harinath, 2009). Surface water and ground water is the most important source of water supply for drinking, cooking, bathing, irrigation and industrial purpose. The surface water is highly vulnerable to pollution due to absorption and transportation of domestic, industrial and agricultural waste water (Simeonov *et al.,* 2003). Hence, it is imperative to identify the sources of water pollution to have control over the pollutants (Khound *et al.,* 2012). The quality of ground water is the resultant of all the processes and reactions that act on the water from the movement it condensed in the atmosphere to the time it is discharged by well. Therefore, determination of ground water quality is also important to observe its suitability for particular use (Kalakar *et al.,* 2016). The importance of water quality in human health has also recently attracted a great deal of interest. The importance of the groundwater for drinking and agricultural purposes in the area cannot be ignored as it serves not only the population living nearby but also those who live in the surrounding areas (Narsimha *et al.,* 2013). The quality of water gets deteriorated or polluted due to contamination of chemicals as well as fertilizers which come from industries and agricultural areas as well as from domestic effluents and leachates of dumping site (Pathare, 2008). The present investigation has been undertaken to assess the impact of such activities on water quality of surface water and ground water sources.

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## MATERIALS AND METHODS

### *Study area*

The present study was conducted on two different types of water resources *viz.,* surface water and ground water. Upper Lake (Station 1) served as source of surface water and Sanjay Gandhi New Hostel (Station 2), Barkatullah University form ground water source of water. Upper Lake is major source of drinking water for the population of Bhopal city on the other hand, the other source is serving students for fulfilling their water requirements. The present study aims to identify the variation in water quality from different sources of water.

### *Methodology*

During the present investigation, water samples were collected in two different seasons (monsoon and winter) from Station-1 (Surface water) and Station-2 (Ground water) in 1 liter sterile polyethylene bottles. The standard methods were followed for collection, storage and laboratory analysis of the water samples (Adoni *et al.,* 1985; APHA, 2005). Temperature was measured by using thermometer while pH and TDS, turbidity were measured by portable meters.

## RESULTS AND DISCUSSION

The physicochemical characteristics of ground water and surface water type sources of water were assessed during the present study. During the present study the value of pH ranged from 6.65 to 7.78 shows that quality of water samples was slightly alkaline.


**Fig. 1. Study area**

pH is the indicator of acidity and alkalinity of water and measures the concentration of hydrogen ions. Even though pH has no direct effect on human health, its higher range accelerates the scale formations in water heating apparatus. In water the total dissolved solid are composed mainly of carbonates, phosphates, hardness of calcium and magnesium, organic matter and other particles. During the present study, the maximum value of TDS was recorded 270 ppm at ground water in monsoon and the minimum value of TDS was recorded 105 ppm at surface water in winter. The higher values during monsoon was due to the increased volume of runoff enter the sources contributing to increased value of TDS while lower values in winter due to reduction of water volume. Turbidity in water arises due to the presence of very finely divided solids. The existence of turbidity in water will affect its acceptability for drinking purpose (EPA, 2001). During the present study, the minimum value of turbidity was recorded 0.8 NTUs at ground water in winter and maximum value was recorded 5.9 NTUs in monsoon at surface water.

Chloride exists in all natural water, and is one of the important indicators of pollution. In the present study, the minimum value was recorded 14 $mgl^{-1}$ in winter at ground water and maximum value of chloride was recorded 24 $mgl^{-1}$ in the winter at surface water. During the present study, The lower value at ground water attributed to low contributions from the geological formations of the area (Mariappan *et al.,* 2000; Khound *et al.,* 2012) and also value of chloride were not recorded very high at surface water due to the low rate of percolation of agricultural and domestic wastes (Khound *et al.,* 2012).

**BDL-Below detection limit**

The alkalinity of water gives an idea about the presence of natural salts. It is primarily caused by the carbonates and bicarbonate ions. During the present study, the maximum value of alkalinity was recorded 336 $mgl^{-1}$ at ground water in monsoon and minimum value was recorded 100 $mgl^{-1}$ at the surface water in winter.

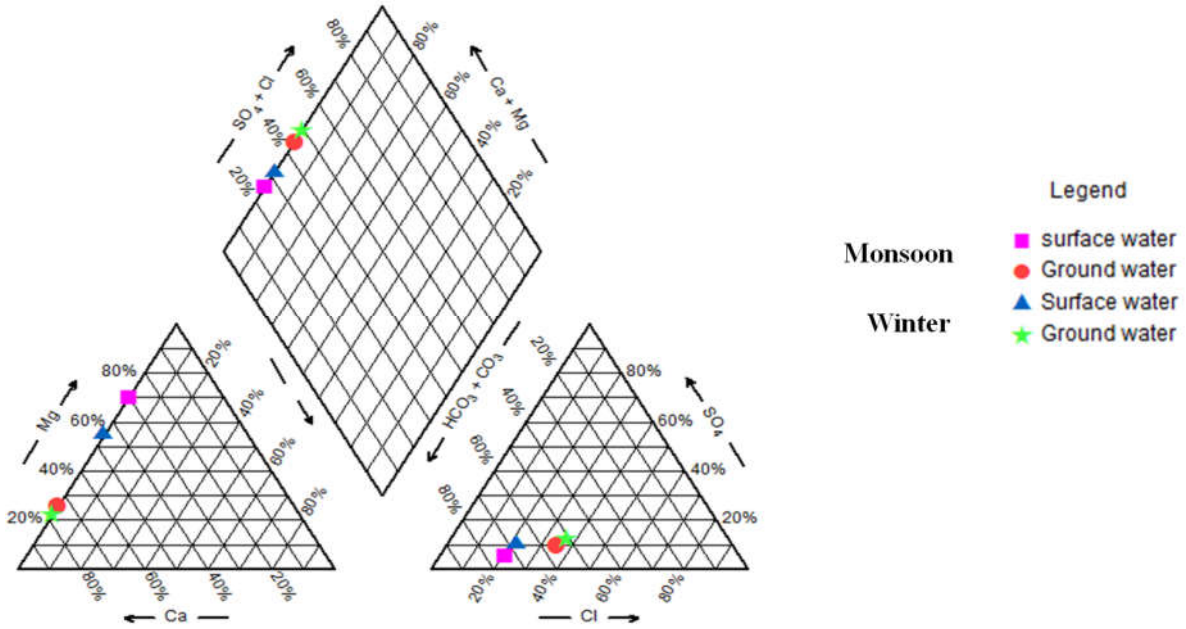


**Fig. 2. Piper diagram of the surface water and ground water**

The alkalinity values were found increasing in monsoon due to the movement of pollutants into the ground water with precipitation (Khwaja and Aggarwal, 2014). Total hardness in water is the sum of the concentrations of alkaline earth metal cations. During the present survey, the maximum value of total hardness was recorded 280 $mgl^{-1}$ in the monsoon at ground water sample and minimum value was recorded 96 $mgl^{-1}$ in winter at the surface water. The increased value of hardness was due to the entry of untreated or partial treated sewage, detergents and other domestic wastes (Kalakar *et al.,* 2016).

**Table.1 Physicochemical properties of surface water**

| S. No. | Parameters | Monsoon | Winter |
|---|---|---|---|
| 1 | Temperature (°C) | 27.1 | 25.8 |
| 2 | pH | 7.78 | 7.3 |
| 3 | Turbidity (NTU) | 5.9 | 5.5 |
| 4 | TDS (PPM) | 250 | 105 |
| 5 | Total Alkalinity ($mgl^{-1}$) | 120 | 100 |
| 6 | Chloride ($mgl^{-1}$) | 20 | 24 |
| 7 | Total Hardness ($mgl^{-1}$) | 96 | 100 |
| 8 | Calcium Hardness ($mgl^{-1}$) | 40 | 58 |
| 9 | Magnesium Hardness ($mgl^{-1}$) | 56 | 42 |
| 10 | Sulphate ($mgl^{-1}$) | 6.97 | 14 |
| 11 | Nitrate ($mgl^{-1}$) | 0.5 | 0.3 |

Calcium is essential for all organisms, being an important cell wall constituent, and regulates various physiological functions in animal and an adequate intake is essential for normal growth and health. It has a direct effect on pH and carbonates system. During the present study, the minimum value was recorded 40 $mgl^{-1}$ in monsoon at surface water and the maximum value of calcium hardness was recorded 95 $mgl^{-1}$ in the monsoon at ground water. The higher concentration of calcium in groundwater is more often which can come from rocks such as limestone, from dolomite and calcite leachates in the soil and also due to its higher solubility (Khwaja and Aggarwal, 2014). Like calcium, magnesium is abundant and a major dietary requirement for humans. During the present study, the minimum value was recorded 42 $mgl^{-1}$ in winter at surface water and maximum value of magnesium hardness was recorded 63 $mgl^{-1}$ in monsoon at ground water.

The source of magnesium in ground water was geological source and it also ends up from application of fertilizers and from cattle feed (Saana *et al.,* 2016). Sulphates are generally present in appreciable concentration and impart hardness to the water. During the present study, the minimum value was recorded 6.97 $mgl^{-1}$ during monsoon at the surface water and maximum value of sulphate was recorded 76 $mgl^{-1}$ in winter at ground water. The higher values of sulphates in ground water mostly appear from domestic wastes and from sulphate fertilizers in the catchment area and due to the leaching action

**Table. 2 Showing physicochemical properties of ground water**

| S. No. | Parameters | Monsoon | Winter |
|---|---|---|---|
| 1 | Temperature (°C) | 26.8 | 24.3 |
| 2 | pH | 6.65 | 7.26 |
| 3 | Turbidity(NTU) | 1.2 | 0.8 |
| 4 | TDS(ppm) | 270 | 205 |
| 5 | Total Alkalinity ($mgl^{-1}$) | 336 | 316 |
| 6 | Chloride ($mgl^{-1}$) | 17 | 14 |
| 7 | Total Hardness ($mgl^{-1}$) | 280 | 240 |
| 8 | Calcium Hardness ($mgl^{-1}$) | 95 | 85 |
| 9 | Magnesium Hardness ($mgl^{-1}$) | 60 | 63 |
| 10 | Sulphate ($mgl^{-1}$) | 50 | 76.99 |
| 11 | Nitrate ($mgl^{-1}$) | BDL | BDL |

in monsoon (Khwaja and Aggarwal, 2014). During the present study, the minimum value of Nitrate was recorded 0.3 $mgl^{-1}$ at surface water in winter and maximum value of nitrate 0.5 $mgl^{-1}$ also at surface water in monsoon. Nitrate was beyond detection limit in ground water in the both seasons. The higher value of nitrate in surface water was due to excessive use of agriculture fertilizers, decayed vegetable water, domestic effluent, sewage disposal, industrial discharges, leachable from refuse dumps (Makhijani and Manoharan, 1999; Singh *et al.,* 2016).

## Piper diagram

A piper diagram is a diagrammatical representation of hydrogeochemistry of water samples. It consists of two triangles, cations expressed as percentage of total cations in $meql^{-1}$ as a single point on the left triangle while anions plot in

the right triangle and diamond shape in the piper diagram signifies both, cations and anions field (Piper, 1944). The point where the extension intersects indicates the character of the water as represented by the relationship among $Na^+ + K^+$, $Ca^{2+} + Mg^{2+}$, $CO3^- + HCO3^-$ and $Cl^-$, $SO4^{2-}$ ions. Aquachem 4.0 scientific software was used for the plotting of piper diagram. It clearly explains the variations or domination of concentration of cations and anions. The similarities and disparities among water samples can be revealed as water of similar qualities will tend to plot together as groups. In the present survey, the anion found is of $HCO_3^-$-$SO_4^{2-}$-$Cl^-$ type showed in right triangle of the piper diagram. The higher value of alkalinity at ground water was due to its dissolution by the rainwater recharge of the ground water storage. Bicarbonates was found slightly higher levels at ground water during monsoon indicating contribution from weathering process due to heavy runoff in the catchment. The increased hardness was due to sewage influents, detergents and other domestic and industrial wastes at both the water sources. This also shows that ground water source of the area is not protected properly. The water plotted near the left corner showed water sample rich in $HCO_3^-$ and is reflecting temporary hardness of water. The present study showed that both the surface and ground water in post monsoon and winter season were $Ca^{++}$ $Mg^{++}$ $HCO3^-$ type. The major cations, $Ca^{++}$, $Mg^{++}$ show almost similar trend in both seasons. The study of physicochemical characteristics of surface water and ground water source shows that both the water types are moderately hard in nature but suitable for drinking, domestic and irrigation purposes.

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