REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
VOLUME - 14 | ISSUE - 3 | DECEMBER - 2024

SEASONAL VARIATIONS IN GROUNDWATER QUALITY: A CASE STUDY OF MUDARGI TALUKA, KARNATAKA

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ABSTRACT

This study examines the seasonal fluctuations in groundwater quality within Mudargi Taluka, Karnataka, through the analysis of 14 groundwater samples (seven pre-monsoon and seven post-monsoon) obtained from various villages. The samples were tested for pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), fluoride content, and chemical oxygen demand (COD) using standard laboratory techniques. The findings revealed notable seasonal disparities in the groundwater quality. In the pre-monsoon period, Attikotti exhibited the highest fluoride level (1.13), whereas several villages, including Badnal, Basapur, and Budihal, displayed lower concentrations (1.08). Conversely, during the post-monsoon phase, Dambal had the highest fluoride content (0.09). Correlation analysis indicated that the pre-monsoon pH exhibited moderate to strong correlations with most of the other pre-monsoon variables. In contrast, post-monsoon pH showed an inverse relationship with certain parameters. This study highlights the influence of seasonal rainfall on groundwater quality and emphasises the importance of ongoing monitoring to ensure potable water safety. These results offer crucial insights into local water resource management and public health-planning strategies.

KEYWORDS: *Groundwater quality, Mudargi Taluka, pH, TDS, Electrical Conductivity, Fluoride, COD, Correlation analysis.*

1. INTRODUCTION:

Groundwater water serves as a vital resource for potable use, farming, and industrial purposes (Abdalla & Scheytt, 2012), (Boualem & Egbueri, 2024), particularly in rural regions such as Mudargi Taluka, Karnataka. Nevertheless, its quality faces increasing threats from both natural and human-induced factors, including seasonal fluctuations, excessive extraction, and pollution (Quddoos et al., 2024), (Lasagna et al., 2020). Temporal variations, notably during pre- and post-monsoon periods, substantially affect groundwater quality due to changes in replenishment rates and pollutant dilution (Patel et al., 2019), (Batabyal & Chakraborty, 2015) . This research seeks to evaluate the seasonal influence on groundwater quality by examining crucial parameters like pH, TDS, EC, Fluoride, and COD. Understanding these fluctuations is crucial for sustainable water management and for ensuring safe drinking water for local populations. The study also emphasises the significance of complying with WHO standards for groundwater quality to reduce the health risks associated with contaminated water

2. SIGNIFICANCE OF THE STUDY:

This research offers valuable insights into how groundwater quality fluctuates across seasons, contributing to the formulation of efficient water management plans and access to potable water for rural populations.

3. OBJECTIVES:

The objectives are as follows:

1. To evaluate the seasonal fluctuations in groundwater quality indicators (pH, TDS, EC, Fluoride, and COD) within Mudargi Taluka.
2. To examine the groundwater quality in relation to WHO acceptable standards during both pre-monsoon and post-monsoon periods.
3. To utilise statistical methods to investigate the relationships between various water quality parameters.

4. MATERIALS AND METHODS

4.1 Study Area

Mundargi taluka, the focus area of this research, is located in the northern region of Karnataka State, India, and is administrative part of Gadag District (Gazetteer of India, 2011). Geographically, this taluka spans from 15°00' to 15°30' North latitude and 75°45' to 76°15' East longitude.

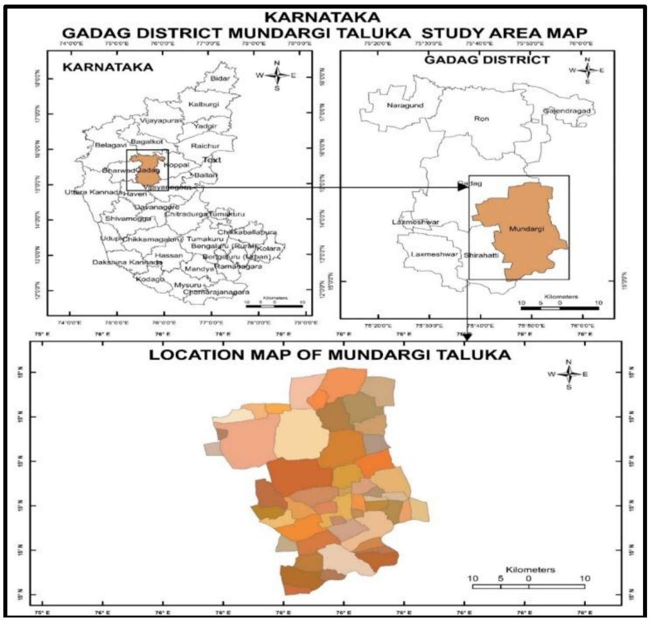

Fig 1

4.2 Sample details

Groundwater samples were obtained from various villages in Mudargi Taluka, comprising 7 pre-monsoon and 7 post-monsoon specimens, totalling 14. The samples were contained in 100 ml plastic bottles that were sealed, labelled, and their GPS coordinates recorded. Standard procedures were utilised to analyse pH, TDS, EC, Fluoride, and COD in a laboratory setting. To examine the data and identify parameter relationships, correlation heatmaps were employed. The findings were then evaluated against WHO guidelines to determine compliance.

Table 1 GPS locations of Samples collected (Mundargi taluka)

Sample no	Location name	latitude	longitude
S-1	Attikotti	15.272895	75.654448
S-2	Badnal	15.171786	75.849824
S-3	Basapur	15.212222	75.882261
S-4	Budihal	15.105624	75.788986
S-5	Dambal	15.242172	75.85813
S-6	Korlhalli	15.12531	75.89022
S-7	Shirol	15.205835	75.87367

Source; computed by author

Table No:2 Various methods or instruments used in the laboratory

Serial No	Parameters	Method or instrument
1	pH	Recorded by pH meter
2	Electrical Conductivity, EC	Measured by conductivity meter
3	Total Dissolved Solids, TDS	Evaporation method
4	Fluoride, F^-	Alizarin spectrophotometric method
5	Chemical Oxygen Demand, COD	Titrated with an excess of $K_2Cr_2O_7$

5. RESULTS AND DISCUSSION:

Table 3 displays the evaluation of groundwater quality indicators, including the concentrations of various parameters and their respective units of measurement.

Table 3 Pre- Monsoon Season and Post-monsoon seasons Groundwater Quality Parameters of Study Area

Village Name	No. of water samples	Pre- Monsoon					Post- Monsoon				
		pH	TDS (PPT)	Conductivity	Fluoride	COD	pH	TDS (PPT)	Conductivity	Fluoride	COD
Attikotti	S1	8.41	0.2	19.7	1.13	72	6.8	0.44	0.47	0.01	81
Badnal	S2	8.6	0.25	21.3	1.08	71	6.1	0.45	0.11	0.01	81
Basapur	S3	8.7	0.34	59.3	1.08	71	6.1	0.45	0.11	0.01	81
Budihal	S4	8.76	0.22	21.5	1.08	75	6.7	0.44	0.35	0.08	76
Dambal	S5	8.61	0.41	21.7	1.12	66	6.6	0.69	0.21	0.09	80
Korlhalli	S6	8.5	0.21	21.2	1.1	71	6.5	0.44	0.19	0.06	77
Shirol	S7	8.2	0.2	21.2	1.11	74	6.6	0.49	0.28	0.03	79

Source: Data computed by the author

Table 5. Drinking Water Standards

Parameter	ICMR	BIS (IS: 10500:2012)		WHO Permissible Limits
		Acceptable Limits	Permissible Limits	
PH	6.5-8.5	6.5-8.5	No relaxation	6.5 – 8.5
EC	300	----	---	30mS/m = 300 µS/cm
TDS	500-1500	500	2000	1500ppm =1.05 ppt
Fluoride	1.5	1.5	1.5	1.5 mg/l
COD	-	-	-	10 mg/l

Source: World health organisation Bureau of Indian Standards (BIS) ISSN: 2320-8163, Indian Counsel of Medical Research (ICMR) ISSN 2249-6866.

5.1. PH analysis:

Pre-monsoon Analysis:

The pre-monsoon pH values range from 8.41 (Attikotti) to 8.76 (Budihal). Budihal recorded the highest pH value at 8.76, indicating a more alkaline water environment during the pre-monsoon period. This could be due to lack of rainfall dilution and higher concentration of alkaline minerals. Conversely, Attikotti registered the lowest pH at 8.41, suggesting its water might be less influenced by alkaline geological formations or have a higher presence of buffering agents. The high and narrow range of pre-monsoon pH values across the villages points toward a consistent geochemical makeup across the region, with subtle variations in mineral content (Batabyal, 2018).

Post-monsoon Analysis:

During the post-monsoon season, pH values fall noticeably, ranging from 6.1 to 6.8. Badnal and Basapur reported the lowest pH at 6.1, suggesting these areas experience a more significant effect of rainwater dilution or higher influx of organic acids. Attikotti stands out with the highest pH at 6.8, which might indicate less dilution or local buffering effects. The overall lower pH in post-monsoon samples across villages confirms that rainfall and increased runoff play a major role in diluting mineral content and possibly introducing organic acids into the water supply (Duffy & Weber-Scan, 2007) .

5.2. TDS (Total Dissolved Solids):

Pre Monsoon:

The TDS values range from 0.2 to 0.41. The lowest TDS is observed at 0.2 (Attikotti and Shirol) and the highest at 0.41 (Dambal). A lower TDS typically indicates purer water with fewer dissolved solids, while higher TDS levels can indicate higher mineral content or contamination.

Post Monsoon:

The values range from 0.44 to 0.69, with the lowest recorded in Attikotti, Budihal, and Korlhalli, and the highest in Dambal. The increase in TDS post-monsoon generally reflects the runoff effects where minerals and impurities become more concentrated due to rain, or possibly dilution anomalies in some areas (Devesa & Dietrich, 2018) .

5.3. Conductivity:

Pre Monsoon:

The conductivity readings vary widely from 19.7 (Attikotti) to 59.3 (Basapur). Higher conductivity can be due to higher dissolved ion concentrations (minerals or pollutants), so Basapur stands out with significantly higher levels, while Attikotti, with the lowest value, suggests less ionic content in its water.

Post Monsoon:

The values are notably lower, ranging from 0.11 (Badnal and Basapur) to 0.47 (Attikotti). The reduction in conductivity post-monsoon indicates a dilution of ion-rich water after rainfall. Attikotti's higher post-monsoon conductivity might be due to localized factors, such as less effective dilution or specific contamination sources (Ramzi et al., 2018) .

5.4. Fluoride:

Pre Monsoon:

Fluoride levels range from 1.08 to 1.13. Attikotti registers the highest fluoride (1.13), while several villages like Badnal, Basapur, and Budihal show lower levels (1.08). The concentration of fluoride can be influenced by the underlying geology where naturally occurring fluoride dissolves into the water (Abiye et al., 2017).

Post Monsoon:

These values are significantly lower, from 0.01 to 0.09. Dambal shows the highest post-monsoon fluoride (0.09), while Attikotti, Badnal, and Basapur have the lowest (0.01). The major decrease in fluoride post-monsoon might be due to a heavy dilution effect from rainwater, which reduces the relative concentration of fluoride in the samples (Farooq et al., 2018).

5.5. COD (Chemical Oxygen Demand):

Pre Monsoon: COD values range from 66 to 75. Budihal exhibits the highest COD (75), which could suggest more organic or inorganic pollutants demanding oxygen for breakdown, whereas Dambal records the lowest (66).

Post Monsoon: The COD is generally higher during this period, ranging from 76 to 81. Attikotti, Badnal, and Basapur show the maximum levels (81), and Budihal has the lowest (76). Increased COD indicates more organic load, often linked to runoff containing organic matter during the post-monsoon period; however, the dynamics might be influenced by local anthropogenic activities and landscape features (Yufen et al., 2008) . Seasonal differences suggest the pre-monsoon period concentrates certain ions and dissolved solids due to evaporation and less dilution, while the post-monsoon period exhibits dilution effects and influences from runoff. Each village displays unique characteristics likely determined by local geological, hydrological, and anthropogenic factors.

5.6. Correlation Analysis:

The correlation analysis was conducted among the water quality variables across the pre and post-monsoon seasons (Patel et al., 2023). Notably, the pre-monsoon pH shows moderate to high correlations with most other pre-monsoon variables (Fig 2). In contrast, the post-monsoon pH is inversely related to certain parameters, indicating that seasonal dilution effects can alter the interplay between variables. Strong correlations among TDS, conductivity, and COD in the pre-monsoon season suggest that higher mineral content is often accompanied by increased ionic strength and organic loading. Conversely, post-monsoon values demonstrate distinct patterns, with some variables becoming less strongly correlated, potentially due to the heavy influence of rainfall diluting the water chemistry. These insights help in understanding the seasonal dynamics and the underlying geochemical processes affecting water quality in the region.

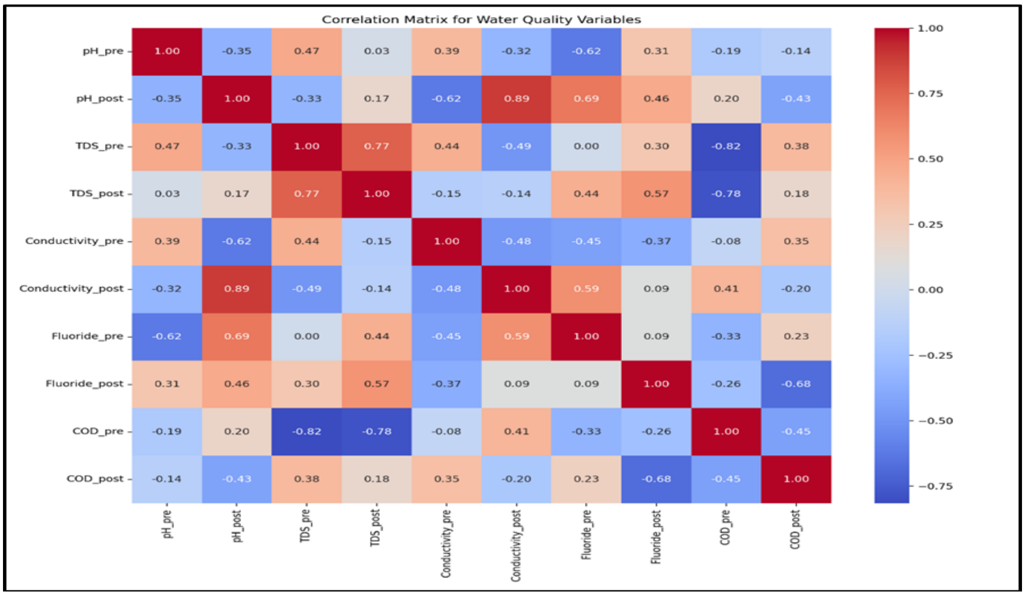

Fig-2

CONCLUSION:

Overall, the analysis reveals that the water quality in these villages is distinctly influenced by seasonal variations. In the pre-monsoon period, higher pH values alongside strong correlations among TDS, conductivity, and COD indicate a concentrated solution of minerals and potential pollutants, likely stemming from minimal dilution and evaporative effects. In contrast, the post-monsoon season exhibits lower pH values and altered correlation patterns, highlighting the pronounced dilution effect of rainwater and the accompanying shift in ion composition and organic content. These findings emphasize the importance of seasonal monitoring to understand the geochemical dynamics at play, aiding local stakeholders in making informed decisions regarding water resource management and treatment strategies.

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