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Research Article

# Assessment of Seasonal Change in Ground Water Quality Index and Physio-Chemical Parameters for Babhulgaon Village Taluka-Yeola District-Nashik (Maharashtra) India

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## ABSTRACT

**Background:** The most basic human requirement is water. Both surface water and ground water are quickly being used as the world's population grows. Because groundwater and surface water are both utilized for drinking and other objectives, it is also vital to assess the quality of groundwater. Groundwater quality is significantly impacted by climate change, although seasonal variations also have an impact. Seasonal analysis of groundwater quality might also reveal discernible fluctuations. **Materials and Methods:** The primary objective of this investigation is to examine how the physio-chemical properties of groundwater and relative soil changes with the seasons. It also focuses on the drinking water quality index of Babhulgaon hamlet in the Nashik region. In the wet, winter, and summer seasons, soil and groundwater samples were gathered. Four samples of soil and water from bore wells in the Babhulgaon cultivation region were examined for general and physio-chemical characteristics. **Results:** Each season's four samples' groundwater was examined. The study area's Water Quality Index classified the water as "good water" during the winter and rainy seasons, but the summer sample had a higher WQI and was classified as "poor water." **Conclusion:** Analysis of soil samples from various seasons reveals variations in soil characteristics that affect soil quality. The winter soil sample's phosphorus content is higher than the ideal threshold.

**Keywords:** Babhulgaon Village, Groundwater, Physical-Chemical Parameters, Seasonal Impacts Soil Quality, Water Quality Index.

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## INTRODUCTION

All living things on Earth depend on water for growth and reproduction. Little 3% of Earth's water is fresh, and little over two-thirds of it is frozen in glaciers and polar ice caps. The majority of the fresh water that hasn't frozen comes from groundwater. One of the planet's most precious natural resources, groundwater is necessary for industrialization, agriculture, and drinking. Only after evaluating the amount and quality of groundwater can the resource be used and maintained as efficiently as possible. Approximately 80% of all human diseases are attributed to water, according to WHO organization.[1] Both surface and groundwater have been used for drinking, industry, and agriculture in recent years, it has been noted that the water is contaminated and has an impact on the environment, animals, crop yield, soil nutrients, human health, and biomass. The two main elements influencing groundwater quality are anthropogenic activity and climate change. Excessive fertilizer use has either directly or indirectly impacted the purity of groundwater in agricultural regions.[2] The basis of both rural and urban India's agriculture and drinking water security is groundwater. The key objective of the present investigation is to examine how the physio-chemical properties of groundwater and relative soil vary with the seasons. Water resource quality is determined by physio-chemical factors. The little village of Babhulgaon is in the Nashik area of Yeola Taluka-423401. According to the 2002 census, there were 7804 people living in Babhulgaon village. Since farming is the population's primary source of income, evaluations of the soil and water quality are crucial. The management tactics for profitable farming are heavily influenced by the quality of the irrigation water. Soil deterioration and nutrient depletion have steadily increased and are now major challenges to India's agricultural output. The issue of declining soil fertility may limit the potential for productivity increase. A significant amount of minerals and micronutrients are lost from soil each year, depending on the cropping plan, leaching, erosion, fertilizer applied, etc. Most agricultural development operations offer hazards to people,

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particularly when it comes to excessive pesticide use. The quality of the water that penetrates through affects the quality of the soil. The existing resources are under more stress because of the unplanned and nonscientific expansion of ground water resources, which is primarily the result of individual initiatives.[3] In basic terms, one of the best instruments for informing the public about water quality is the Water Quality Index (WQI). Organizations in charge of water supply and pollution control possess fervently supported the creation and application of indices. Anthropogenic activities and climate change are the two main elements influencing groundwater quality.[4] TSS varied seasonally, with highest concentrations in rainy season and absent in summer. Chloride and sulfate concentrations were well within permissible limits.[5] The WQI Model of Babhulgaon village's ground water is highlighted in this study. The WQI model, which is tailored to each individual, aids in determining seasonal variations in water quality. Furthermore, local residents, environmental agencies, public health agencies, etc., will find value in the data gathered from the study. The study's primary goals are to apply the Water Quality Index (WQI) model and analyze groundwater samples physically and chemically. The Water Quality Index (WQI) is one of the most effective tools for public awareness and regulatory monitoring of water quality.[6-9] The WQI model adopted for this study is tailored to understand seasonal variation in Babhulgaon's groundwater and provide actionable data for stakeholders. The purpose of the Water Quality Index (WQI) is to provide the Physio-Chemical Characteristics of Babhulgaon. Additionally, the soil samples were examined for the wet, winter, and summer seasons.

### Study Area

Babhulgaon (Taluka Yeola-423401 and district Nashik) is a study for seasonal effects on groundwater quality and associated soil. The village of Babhulgaon is in the Nashik District of Maharashtra State, India's Shahada Taluka. It is a part of Northern Maharashtra. Babhulgaon is located at latitude 20.0657 and longitude 74.4602 Papaya, mango, banana, and other horticultural crops are the primary crops grown in the area. The district's principal crops include rice, jowar, cotton, and pulses. The southwest portion of the district receives between 25% and 50% of the district's total rainfall, according to historical rainfall statistics. The rainfall issue in the research region Babhulgaon has an impact on crop productivity.

## MATERIALS AND METHODS

### Sample Collection and Analysis

In the wet, winter, and summer seasons, soil and groundwater samples were gathered. Four samples of soil and water from bore wells in the Babhulgaon cultivation region were examined for general and physio-chemical characteristics. The representative water sample should be the one that accurately represents the water sample's composition for analysis. Samples of soil and groundwater are gathered from the chosen area of Babhulgaon for the assessment because of the variable time that may pass between sample collection and analysis. Storage conditions must be such to prevent unwanted losses and contamination. A clean, one-liter plastic container was used to collect each water sample. Before the water that was gathered collected the sample, the container was rinsed two or three times. At each site, soil samples were taken from a depth of 0 to 15 cm, and they were prepared for analysis in accordance with established protocol. At least 500 grams of dry, sieved soil should be produced from the entire quantity of mineral or organic soils that are gathered. Soil and groundwater samples were collected in rainy, winter, and summer seasons from four borewell locations.

### Experimental Work for Soil Testing

Four distinct areas of the hamlet were used to gather the soil samples. The samples gathered are taken to the lab for examination. The tests are conducted using the standard procedures outlined by APHA. PH, electrical conductivity, organic carbon, nitrogen, phosphorus, zinc, and copper were all measured in the soil samples.

### Water Quality Index

Using APHA-recommended standard protocols of analysis, the water samples were examined for the following parameters: pH, EC, TDS, TH, TSS, Cl, SO4, COD, BOD, F, Zinc, and Lead. Physio-chemical characteristics of the samples were analyzed using standard protocols from APHA (2005).[10] Groundwater parameters included pH, EC, TDS, TH, TSS, Cl, SO4, COD, BOD, F, Zinc, and Lead. These were compared against WHO,[11] and BIS (2012)[12] standards. The Water Quality Index (WQI) for Babhulgaon groundwater quality has an impact on the drinking water's quality as well as the surface water's ability to sustain ecosystems and species. The purpose of water quality indices was to assign a single value to a source's water quality. Based on each sample's index value, anyone can then compare various samples for quality. Three steps must be taken in order to calculate the water quality index. Each of the seven characteristics was given a weight (wi) in the first phase based on how important it is to the overall quality of the drinking water. The criteria of total dissolved solids and fluoride have been given a maximum weight of five because of their significant significance in evaluating the quality of water. The WQI was calculated using the weighted arithmetic index method.[13-15] The following formula is used to calculate relative weight (Wi)

Where "n" is the number of parameters, (Wi) is the relative weight, and (wi) is the weight of each parameter. According to the BIS recommendations, the third stage assigns a quality rating scale (Qi) for each parameter by dividing its concentration in each water sample by the corresponding standard. The result is then multiplied by 100.

$$Wi=wi / \sum_{i=1}^{n} wi \text{----------(1)}$$

$$Qi=(Ci /Si) *100\text{----------(2)}$$

$$SIi=Wi*Qi\text{----------(3)}$$

$$\sum WQI=\sum Si\text{----------(4)}$$

Where, in accordance with the BIS-10500-1991 recommendations, Qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/L (apart from pH), and Si is the BIS (Bureau of Indian Standards) water standard for each chemical parameter in mg/L. The Sub Index (SI) for each chemical parameter is first calculated in order to calculate the WQI. The WQI is then calculated using the following equation:

SIi is the sub index of I th parameter, Qi is the rating based on concentration of ith parameter and n is the number of parameter. The computed WQI values are classified into five types "excellent water", "good water", "poor water" "very poor water", "water unsuitable for drinking" as shown in Table 1.

## RESULTS

**Table 1: Water quality classification based on WQI value.[10]**

| WQI value | Water quality |
|---|---|
| <50 | Excellent |
| 50-100 | good water |
| 100-200 | poor water |
| 200-300 | very poor water |
| >300 | Water unsuitable for Drinking |

## DISCUSSION

The pH range of 6.5 to 7.5 is considered moderate for the soil. Sodic soil is defined as having a pH higher than 7.5.[16] In our study's seasonal samples are all sodic in character. The increased concentration of bi-carbonate and carbonates is the cause of the pH rise. Between 0.195 and 0.375 ms/cm is the range of electrical conductivity. Conductivity is just a measurement of the ionized substances' overall conductance. Ion mobility, valences, and real and relative concentrations all have an impact on conductivity. Concentration of physio-chemical parameters is shown in Table 2. Whereas Results of Normal series of water quality parameters of ground water of rainy season, Normal series of water quality parameters of ground water of winter season, Normal series of water quality parameters of ground water of summer season are shown in Tables 3-5 respectively.

The pH of hemic substances determines the range of organic carbon, which is between 0.72 and 1.10%. Only during the rainy and winter seasons does the amount of nitrogen vary, ranging from 155.45 kg/ha to 342.32 kg/ha. In every season but in the winter, the level of nitrogen is below the allowable limits. Phosphorus levels range from 30.95 kg/ha to 58.60 kg/ha. The winter season samples have the highest phosphorus concentration, which is marginally above the allowable limit. In every season sample, the concentration of metals such as copper and zinc is particularly high. In every season sample, the concentration of metals such as copper and zinc is particularly high. Seasonal variations in soil quality are evident in its physiochemical properties. Because too much copper inhibits plant growth, the soil in the study area must be kept free of copper and zinc contamination.

The samples pH levels ranged from 6.9 to 7.8 during the rainy season, 7.27 to 7.37 during the winter, and 7.72 to 7.86 during the summer. Samples from each season had pH levels that fell within the ranges established by the BIS and WHO. The samples' electrical conductivity ranges between 0.89 to 1.38 falling within the BIS range. 500 mg/L of total dissolved salts is the maximum amount that can be present in drinking water; if there is no source of potable water, the maximum amount that can be present is 2000 mg/L. The research reveals that every water sample from every season falls under the 2000 mg/L upper limit.[17,18] TDS levels in the study region range from 600 mg/L to 604.5 mg/L in samples taken during the rainy season, 565.05 mg/L to 572.0 mg/L during the winter, and 818 mg/L to 820 mg/L during the summer. The winter and summer seasons differ significantly. Upon comparing these findings, it was shown that temperature had an impact on groundwater quality. High TDS concentrations are linked to cardiovascular disease, coronary heart disease, and malignancy. People with heart and kidney conditions may be affected by these. Additionally, water with high solids content may have laxative or constipating effects. During the rainy season, the total hardness ranged from 235.60 mg/L to 238.96 mg/L; during the winter, it ranged from 198.00 mg/L to 199.92 mg/L; and during the summer, it ranged from 237.00 mg/L to 239.12 mg/L. In every season, the overall hardness is below the threshold. There is a significant variation in TSS concentration, ranging from 0 mg/lit to 309 mg/lit. TSS concentrations are zero in summertime samples and greatest during the wet season. The range of the chloride level was 100.05 mg/L to 230.08 mg/L. Samples taken during the rainy season have the lowest concentration, whereas samples taken during the summer are the highest. Here, the samples' chloride concentrations are substantially below the acceptable range of 250-100 mg/lit. From the rainy to the summer season, the sulfate level fluctuated between 36.00 mg/lit and 87.03 mg/lit. The levels of sulfate are substantially within the acceptable range. Given health issues with teeth and bones, the amount of fluoride in drinking water is crucial. While tooth decay is caused by low fluoride concentrations (<0.5 mgL-1), high fluoride concentrations are extremely toxic to humans and can cause dental and skeletal fluorosis. One milligram of fluoride per liter is the recommended ideal limit.[1] All samples from every season in the current research region have fluoride contents that are well

**Table 2:** Concentration of physio-chemical parameters.

| Sl. No. | Parameter | Rainy Season | Winter Season | Summer Season |
|---|---|---|---|---|
| 1 | pH | 8.28 | 8.43 | 8.01 |
| 2 | Elect. Conductivity (mS/cm) | 0.208 | 0.228 | 0.370 |
| 3 | Organic Carbon (%) | 1.10 | 0.74 | 0.88 |
| 4 | Available Nitrogen (kg/ha) | 160.87 | 342.32 | 190.67 |
| 5 | Available Phosphorus (kg/ha) | 31.94 | 57.80 | 44.91 |
| 6 | Available Zinc (ppm) | 3.96 | 1.14 | 4.22 |
| 7 | Available Copper (ppm) | 5.18 | 3.4 | 7.19 |

**Table 3:** Normal series of water quality parameters of ground water of rainy season.

| Sl. No. | Parameters | Minimum | Maximum | Mean | S.D | C.V |
|---|---|---|---|---|---|---|
| 1 | pH | 7.50 | 7.80 | 7.65 | 0.13 | 0.02 |
| 2 | EC | 0.890 | 0.930 | 0.912 | 0.017 | 0.0002 |
| 3 | TDS mg/lit | 600.00 | 604.5 | 601.637 | 2.139 | 4.575 |
| 4 | TH mg/lit | 235.60 | 238.96 | 237.702 | 1.487 | 2.213 |
| 5 | TSS mg/lit | 300.0 | 309.0 | 305.75 | 4.031 | 16.25 |
| 6 | Cl mg/lit | 100.05 | 102.96 | 101.252 | 1.289 | 1.663 |
| 7 | $SO_4$ mg/lit | 36.00 | 39.02 | 38.242 | 1.495 | 2.235 |
| 8 | F mg/lit | 0.52 | 0.57 | 0.55 | 0.0216 | 0.0004 |

**Table 4:** Normal series of water quality parameters of ground water of winter season.

| Sl. No. | Parameters | Minimum | Maximum | Mean | S.D | C.V |
|---|---|---|---|---|---|---|
| 1 | pH | 7.27 | 7.37 | 7.32 | 0.045 | 0.002 |
| 2 | EC | 0.890 | 0.985 | 0.951 | 0.043 | 0.001 |
| 3 | TDS mg/lit | 565.0 | 572.0 | 568.01 | 3.545 | 12.567 |
| 4 | TH mg/lit | 198.00 | 199.92 | 198.99 | 0.784 | 0.616 |
| 5 | TSS mg/lit | 35 | 40 | 37.5 | 2.886 | 8.333 |
| 6 | Cl mg/lit | 133.35 | 135.99 | 134.96 | 1.146 | 1.315 |
| 7 | $SO_4$ mg/lit | 81.80 | 83.37 | 82.792 | 0.689 | 0.474 |
| 8 | F mg/lit | 0.80 | 0.84 | 0.815 | 0.0191 | 0.0003 |

**Table 5:** Normal series of water quality parameters of ground water of summer season.

| Sl. No. | Parameters | Minimum | Maximum | Mean | S.D | C.V |
|---|---|---|---|---|---|---|
| 1 | pH | 7.72 | 7.86 | 7.78 | 0.061 | 0.003 |
| 2 | EC | 1.250 | 1.381 | 1.29 | 0.061 | 0.003 |
| 3 | TDS mg/lit | 810 | 820 | 816 | 4.320 | 18.66 |
| 4 | TH mg/lit | 235.15 | 239.12 | 237.56 | 1.88 | 3.54 |
| 5 | TSS mg/lit | 0 | 0 | 0 | 0 | 0 |
| 6 | Cl mg/lit | 225.80 | 230.08 | 228.50 | 2.013 | 4.052 |
| 7 | $SO_4$ mg/lit | 85.00 | 87.03 | 86.25 | 0.948 | 0.90 |
| 8 | F mg/lit | 0.75 | 0.78 | 0.765 | 0.012 | 0.0001 |

**Table 6:** Relative weight and W.Q.I of water quality parameters for rainy season.

| Sl. No. | Parameters | Indian Standard | Weightage (wi) | Relative Weight (Wi) | Quality rating (Qi) | Sub Index (Sli) |
|---|---|---|---|---|---|---|
| 1 | pH | 6.5-8.5 | 3 | 0.115 | 117.69 | 13.57 |
| 2 | EC | 0.7-3.0 | 3 | 0.115 | 130.28 | 15.03 |
| 3 | TDS mg/lit | 500-2000 | 5 | 0.192 | 120.32 | 23.13 |
| 4 | TH mg/lit | 300-600 | 3 | 0.115 | 79.23 | 9.14 |
| 5 | Cl mg/lit | 250-1000 | 3 | 0.115 | 40.50 | 4.67 |
| 6 | $SO_4$ mg/lit | 200-400 | 4 | 0.153 | 19.12 | 2.94 |
| 7 | F mg/lit | 1-1.5 | 5 | 0.1923 | 55 | 10.57 |
| | | | ∑ wi=26 | | WQI=∑ Sli=79.08 | |

**Table 7:** Relative weight and W.Q.I of water quality parameters for winter season.

| Sl. No. | Parameters | Indian Standard | Weightage (wi) | Relative Weight (Wi) | Quality rating (Qi) | Sub Index (Sli) |
|---|---|---|---|---|---|---|
| 1 | pH | 6.5-8.5 | 3 | 0.115 | 112.61 | 12.99 |
| 2 | EC | 0.7-3.0 | 3 | 0.115 | 135.85 | 15.67 |
| 3 | TDS mg/lit | 500-2000 | 5 | 0.192 | 113.60 | 21.84 |
| 4 | TH mg/lit | 300-600 | 3 | 0.115 | 66.33 | 7.653 |
| 5 | Cl mg/lit | 250-1000 | 3 | 0.115 | 53.98 | 6.22 |
| 6 | $SO_4$ mg/lit | 200-400 | 4 | 0.153 | 41.39 | 6.36 |
| 7 | F mg/lit | 1-1.5 | 5 | 0.1923 | 81.5 | 15.67 |
| | | | ∑ wi=26 | | WQI=∑ Sli=86.44 | |

**Table 8:** Relative weight and W.Q.I of water quality parameters for summer season.

| Sl. No. | Parameters | Indian Standard | Weightage (wi) | Relative Weight (Wi) | Quality rating (Qi) | Sub Index (Sli) |
|---|---|---|---|---|---|---|
| 1 | pH | 6.5-8.5 | 3 | 0.115 | 119.69 | 13.81 |
| 2 | EC | 0.7-3.0 | 3 | 0.115 | 184.28 | 21.26 |
| 3 | TDS mg/lit | 500-2000 | 5 | 0.192 | 163.2 | 31.38 |
| 4 | TH mg/lit | 300-600 | 3 | 0.115 | 79.18 | 9.14 |
| 5 | Cl mg/lit | 250-1000 | 3 | 0.115 | 91.4 | 10.55 |
| 6 | $SO_4$ mg/lit | 200-400 | 4 | 0.153 | 43.13 | 6.63 |
| 7 | F mg/lit | 1-1.5 | 5 | 0.1923 | 76.5 | 14.71 |
| | | | ∑ wi=26 | | WQI=∑ Sli =107.48 | |

within allowable limits. The amount of biodegradable organic matter in an aquatic environment that is exposed to aerobic degradation by bacteria is estimated by the Biological Oxygen Demand (BOD). As a result, it offers a precise assessment of the pollution level.[1] The samples collected from the research area do not contain BOD. Together with the metals lead and zinc, the samples also show zero levels of COD. Samples from each season were subjected to statistical analysis. For precise results, the statistical analysis yields a mean value. The WQI of every sample collected during each season was determined using the previously described methodology, and the results are shown in Tables 6-8. According to the study's findings, Babhulgaon groundwater's WQI is "good water" for the winter and rainy seasons. WQIs were calculated to be 79.08 and 86.44, respectively. According to Table 1, the summertime WQI is 107.48, or "poor water."

## CONCLUSION

The investigation of the variation in soil parameters showed that the soils in the research region are alkaline. The research area's copper and zinc concentrations should be decreased by implementing preventive measures. Following a thorough examination, interpretation, and discussion of the numerical data, it was discovered that all the samples from each season had soft water. The fluoride concentration is substantially within the

acceptable range. Every sample from every season had a total dissolved solids concentration that is well within the allowable range. For the rainy and winter seasons, the Water Quality Index (WQI) is in the Good range; for the summer season samples, it is in the Poor range. Every sample from every season had dissolved solids that are well within the allowable limit. For the rainy and winter seasons, the Water Quality Index (WQI) is in the Good range; for the summer season samples, it is in the Poor range. This study's usage of the Water Quality Index (WQI) has been beneficial in evaluating the overall water quality on a seasonal basis. This approach provides a comparative assessment of each sample's water quality and seems more methodical. All three samples have sulphate and chloride amounts that are well below allowable limits. According to the analysis, the groundwater in the study region has to be treated before being consumed.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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## ABBREVIATIONS

**WQI:** Water Quality Index; **WHO:** World Health Organization; **BIS:** Bureau of Indian Standards; **APHA:** American Public Health Association; **EC:** Electrical Conductivity; **TDS:** Total Dissolved Solids; **TH:** Total Hardness; **TSS:** Total Suspended Solids; **Cl:** Chloride; **$SO_4$:** Sulphate; **COD:** Chemical Oxygen Demand; **BOD:** Biological Oxygen Demand; **F:** Fluoride; **pH:** Potential of Hydrogen (acidity/alkalinity level); **OC:** Organic Carbon; **Zn**-Zinc; **Cu:** Copper; **SD:** Standard Deviation; **CV:** Coefficient of Variation; **Si:** Standard permissible limit (from BIS/WHO); **Ci:** Concentration of the i-th parameter; **Qi:** Quality Rating for the i-th parameter; **Wi:** Relative Weight of the i-th parameter; **SIi:** Sub-index for the i-th parameter.

## SUMMARY

The study evaluates the seasonal changes in Babhulgaon village, Yeola Taluka, Nashik district, Maharashtra, in terms of soil properties and groundwater quality. Soil and groundwater samples were examined during the rainy, winter, and summer seasons using physico-chemical parameters and the Water Quality Index (WQI). The findings show "poor" water quality in the summer because of increased TDS and conductivity, but "good" water quality during the rainy and winter seasons. Seasonal variations were found in the soil, with high amounts of heavy metals and phosphorus, particularly during the winter. The study emphasizes how anthropogenic and seasonal factors affect water-soil systems. In order to guarantee safe groundwater use, it promotes routine monitoring and water treatment, particularly during the summer.

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