



Original Article

Assessment of Ground Water Quality from Rural Areas of Chandrapur District, Maharashtra, India

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Abstract:

Groundwater serves as a vital resource for drinking and household needs across rural communities in Maharashtra's Chandrapur District. This research was conducted to examine the physicochemical properties of local groundwater and determine its viability for human consumption and daily use. Water samples gathered from various rural sites in the district underwent laboratory testing for key parameters using standard analytical methods, encompassing color, calcium, chloride, electrical conductivity, fluoride, magnesium, nitrate, pH, total dissolved solids, total alkalinity, total hardness, turbidity, iron, and sulfate, with results benchmarked against established drinking-water standards. Furthermore, the study highlights geographic variations in water quality driven by regional geology and human factors such as farming practices, domestic wastewater, and improper waste disposal. This evaluation pinpoints specific water parameters and locations requiring focused public water management, ultimately emphasizing the necessity of consistent monitoring, proper treatment, source safeguarding, and contamination control to preserve safe and sustainable groundwater supplies in rural Chandrapur.

Keywords: Groundwater Quality, Physicochemical Parameters, Rural Areas, Chandrapur District, Water Quality Assessment, Drinking Water.

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Introduction:

Water is an essential natural resource required for the survival of human beings and for agricultural, domestic and industrial

activities. Although water covers a major portion of the Earth's surface, only a relatively small proportion is readily available as freshwater for human use. Groundwater



therefore represents an important and comparatively reliable source of freshwater, particularly in rural regions[1, 2].

Groundwater is extensively used for drinking, cooking, washing, livestock and irrigation. Its quality is consequently as important as its quantity. The chemical composition of groundwater is controlled by several natural processes, including the mineralogical composition of the aquifer, dissolution and weathering of rocks, ion exchange, recharge conditions and residence time[3, 4]. Groundwater quality can also be affected by human activities, including agricultural fertilizer and pesticide application, sewage disposal, septic systems, industrial activities and improper disposal of solid wastes. The Central Ground Water Board (CGWB) recognizes that groundwater quality is controlled by physical, chemical and bacteriological factors[5]. In phreatic aquifers, water chemistry is influenced by the nature of rocks and minerals and can additionally be affected by domestic, agricultural and industrial contamination. Chandrapur District is located in the eastern part of Maharashtra in the Vidarbha region. The district covers approximately 11,443 km² and consists of 15 administrative blocks[6]. Groundwater represents an important resource for many rural communities within the district. Groundwater-quality assessment is particularly relevant in Chandrapur because regional monitoring has identified groundwater-quality concerns in parts of Maharashtra, including elevated nitrate and fluoride. Therefore, the present investigation focuses on the assessment of groundwater quality in selected rural areas of Chandrapur District by analyzing major physicochemical parameters

and comparing the results with established drinking-water standards[7].

Materials and Method:

1. Study Area:

Chandrapur District is situated in the eastern part of Maharashtra State and forms part of the Vidarbha region. It has a geographical area of approximately 11,443 km². The rural population depends on groundwater obtained from dug wells, bore wells, tube wells and hand pumps for drinking and other household purposes. Agricultural activities and settlements around groundwater sources may also influence shallow groundwater quality. Because geological conditions, land use, agricultural practices, sanitation and groundwater abstraction differ from village to village, the chemical composition of groundwater may exhibit considerable spatial variation. Hence ground water samples collected through handpump from different villages including Deulwada, Ghot Nimbala, Kesurli, Durgapur and Chincholi.

2. Sample Collection:

Samples were gathered in clean plastic bottles. Prior to collection, bottles were washed out with sample water. The specimens were safeguarded and transferred to the lab for examination.

3. Analytical Methods:

The physicochemical parameters were analyzed using standard procedures. The following parameters were studied:

- Colour
- Calcium
- Chloride
- Electrical Conductivity (EC meter)
- Fluoride



- Magnesium
- Nitrate
- pH (using pH meter)
- Total Dissolved Solids (TDS meter)
- Total Alkalinity (acid titration method)
- Total Hardness (EDTA titration method)

- Turbidity
- Iron
- Sulphate

Table 1 shows the methods[8–11] that were used in the analysis of above parameters.

Table 1. Analytical Methods

Parameter	Analytical Method
Colour	APLHA 23 RD EDN, METHOD 2120C
Calcium	APLHA 23 RD EDN, METHOD 3500 Ca-B
Chloride	APLHA 23 RD EDN, METHOD 4500 Cl-B
Electrical Conductivity	APLHA 23 RD EDN, METHOD 2510B
Fluoride	APLHA 23 RD EDN, METHOD 4500 Ac-B
Magnesium	APLHA 23 RD EDN, METHOD 4500
Nitrate	APLHA 23 RD EDN, METHOD 4500 NO ₃ -B
pH (using pH meter)	APLHA 23 RD EDN, METHOD 4500
Total Dissolved Solids (TDS meter)	APLHA 23 RD EDN, METHOD 2540C
Total Alkalinity (acid titration method)	APLHA 23 RD EDN, METHOD 2320B
Total Hardness (EDTA titration method)	APLHA 23 RD EDN, METHOD 2340C
Turbidity	APLHA 23 RD EDN, METHOD 2130B
Iron	APLHA 23 RD EDN, METHOD 3500 Fe-B
Sulphate	APLHA 23 RD EDN, METHOD 4500 SO ₄ -B

Standard analytical procedures were followed throughout the investigation. Instruments were calibrated before measurements and suitable blanks and standards were used for quality assurance.

Results and Discussion:

The quality of water is defined by different physical and chemical analyses. Different observations gathered throughout the experimental work are organized in table 2.

Table 2: Physico-chemical Parameters of Water Samples

SN	Parameter	Villages				
		Deulwada	Ghot Nimbala	Kesurli	Durgapur	Chincholi
1	Colour	Clear	Clear	Clear	Clear	Clear
2	Calcium (mg/L)	84.8	99.2	65.6	72	97.6
3	Chloride (mg/L)	128	148	100	108	148
4	Electrical Conductivity	1654	1910	1286	1408	1906
5	Fluoride (mg/L)	0.57	0.37	0.80	0.84	0.32
6	Magnesium (mg/L)	57.15	66.29	44.32	48.6	65.71
7	Nitrate (mg/L)	29.1	30	17	10	29



SN	Parameter	Villages				
		Deulwada	Ghot Nimbala	Kesurli	Durgapur	Chincholi
8	pH (using pH meter)	7.4	7.6	7.6	7.8	7.8
9	Total Dissolved Solids (TDS meter) (mg/L)	1075	1241	835	915	1238
10	Total Alkalinity (acid titration method) (mg/L)	236	272	180	200	272
11	Total Hardness (EDTA titration method) (mg/L)	320	372	248	272	368
12	Turbidity (NTU)	1.13	0.97	0.97	1.05	0.92
13	Iron (mg/L)	0.01	0.01	0.01	0.01	0.08
14	Sulphate (mg/L)	52	40	42	56	38

The groundwater samples collected from Deulwada, Ghot Nimbala, Kesurli, Durgapur, and Chincholi show noticeable variation in their physicochemical characteristics. The results can be interpreted as follows: All five groundwater samples were clear, indicating the absence of visible suspended matter, coloration, or obvious physical contamination.

Calcium: Calcium concentrations ranged from 65.6 to 99.2 mg/L. The lowest concentration was observed at Kesurli (65.6 mg/L), while the highest was at Ghot Nimbala (99.2 mg/L). Calcium is an important contributor to water hardness, and these values indicate appreciable calcium mineralization in the groundwater.

Chloride: Chloride concentrations ranged from 100 to 148 mg/L. Kesurli showed the lowest concentration (100 mg/L), whereas Ghot Nimbala and Chincholi showed the highest value (148 mg/L). These concentrations are below the commonly used BIS acceptable limit of 250 mg/L for drinking water.

Electrical Conductivity (EC): EC varied considerably, from 1286 to 1910 $\mu\text{S/cm}$. Kesurli recorded the lowest EC (1286 $\mu\text{S/cm}$), while Ghot Nimbala recorded the highest (1910

$\mu\text{S/cm}$), closely followed by Chincholi (1906 $\mu\text{S/cm}$). The relatively high EC values indicate substantial concentrations of dissolved ionic salts, particularly at Ghot Nimbala and Chincholi.

Fluoride: Fluoride concentrations ranged from 0.32 to 0.84 mg/L. Chincholi had the lowest fluoride level (0.32 mg/L), while Durgapur had the highest (0.84 mg/L). All samples were below the BIS maximum permissible limit of 1.5 mg/L. However, several samples are also below the commonly cited desirable level of about 1.0 mg/L.

Magnesium: Magnesium concentrations ranged from 44.32 to 66.29 mg/L. Kesurli recorded the lowest value (44.32 mg/L), while Ghot Nimbala recorded the highest (66.29 mg/L). All values exceed the BIS acceptable limit of 30 mg/L, although they remain below the permissible limit of 100 mg/L in the absence of an alternate source. The elevated magnesium levels contribute significantly to groundwater hardness.

Nitrate: Nitrate concentrations ranged from 10 to 30 mg/L. Durgapur recorded the lowest concentration (10 mg/L), while Ghot Nimbala showed the highest (30 mg/L). All samples are



below the BIS drinking-water limit of 45 mg/L, suggesting that nitrate contamination is not excessive in the studied samples.

pH: The pH values ranged from 7.4 to 7.8, showing that the groundwater is neutral to mildly alkaline. Deulwada had the lowest pH (7.4), whereas Durgapur and Chincholi had the highest (7.8). All samples fall within the generally acceptable drinking-water pH range of 6.5–8.5.

Total Dissolved Solids (TDS): TDS ranged from 835 to 1241 mg/L. Kesurli showed the lowest TDS (835 mg/L), while Ghot Nimbala showed the highest (1241 mg/L), closely followed by Chincholi (1238 mg/L). All samples exceed the BIS acceptable value of 500 mg/L, indicating considerable dissolved mineral content. However, they remain below the permissible limit of 2000 mg/L applicable in the absence of an alternate source.

Alkalinity: Total alkalinity ranged from 180 to 272 mg/L. Kesurli recorded the lowest value (180 mg/L), whereas Ghot Nimbala and Chincholi recorded the highest value (272 mg/L). Four of the five samples exceed the BIS acceptable value of 200 mg/L, but all are well below the permissible value of 600 mg/L. The alkalinity indicates the acid-neutralizing capacity of the groundwater, mainly due to bicarbonate and carbonate ions.

Total Hardness: Total hardness varied from 248 to 372 mg/L. Kesurli had the lowest hardness (248 mg/L), while Ghot Nimbala had the highest (372 mg/L). All samples exceed the BIS acceptable value of 200 mg/L, although they remain below the permissible limit of 600 mg/L. Based on commonly used hardness classifications, these waters can generally be considered hard to very hard, mainly because of their calcium and magnesium content.

Turbidity: Turbidity ranged from 0.92 to 1.13 NTU. Chincholi showed the lowest turbidity (0.92 NTU), while Deulwada showed the highest (1.13 NTU). Most samples are around the BIS acceptable value of 1 NTU; Deulwada (1.13) and Durgapur (1.05) slightly exceed it but remain well below the permissible limit of 5 NTU.

Iron: Iron concentrations ranged from 0.01 to 0.08 mg/L. The first four locations contained only 0.01 mg/L, while Chincholi recorded 0.08 mg/L. These concentrations are low and below the BIS acceptable limit of 0.3 mg/L, indicating no significant iron contamination.

Sulphate: Sulphate concentrations ranged from 38 to 56 mg/L. Chincholi showed the lowest concentration (38 mg/L), whereas Durgapur showed the highest (56 mg/L). All samples are substantially below the BIS acceptable limit of 200 mg/L.

The groundwater from the five villages is clear and mildly alkaline, with acceptable levels of chloride, nitrate, fluoride, iron, and sulphate. The major water-quality concerns are the relatively high TDS, total hardness, magnesium, electrical conductivity, and, in some samples, alkalinity. Ghot Nimbala and Chincholi generally show the greatest degree of mineralization, whereas Kesurli has comparatively lower EC, TDS, alkalinity, and hardness.

Conclusion:

The present study assessed the physicochemical quality of groundwater collected from Deulwada, Ghot Nimbala, Kesurli, Durgapur, and Chincholi. The results revealed noticeable spatial variations in groundwater quality among the selected villages. All samples were clear and mildly



alkaline, with pH values ranging from 7.4 to 7.8. The concentrations of chloride, nitrate, fluoride, iron, and sulphate were within the prescribed drinking-water limits. However, relatively high values of electrical conductivity, total dissolved solids (TDS), magnesium, total hardness, and alkalinity indicated considerable mineralization of the groundwater. TDS ranged from 835 to 1241 mg/L, while total hardness varied from 248 to 372 mg/L, exceeding their respective BIS acceptable limits in all samples. Among the studied locations, Ghot Nimbala and Chincholi showed comparatively higher mineralization, whereas Kesurli exhibited relatively better physicochemical characteristics. Overall, the groundwater quality is mainly affected by elevated dissolved mineral content and hardness. Appropriate treatment for the reduction of hardness and dissolved solids, along with regular groundwater-quality monitoring, is therefore recommended. Further studies incorporating microbiological parameters and potentially toxic metals are necessary for a comprehensive assessment of the suitability of groundwater for drinking purposes.

Recommendations:

1. **Regular monitoring and treatment:** Groundwater quality should be monitored periodically, and water with high TDS, hardness, or turbidity should be appropriately treated before drinking.
2. **Pollution prevention:** Proper waste disposal, sanitation, and protection of groundwater sources from domestic, agricultural, and industrial contamination should be ensured.
3. **Sustainable groundwater management:** Rainwater harvesting, groundwater

recharge, and public awareness regarding safe water use should be promoted to maintain groundwater quality in the long term.

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