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Assessment of Physico-Chemical Quality of Groundwater in Pre and Post Monsoon Season by

Analysis of some Populated Villages nearby Shujalpur Tehsil , MP, India

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ABSTRACT

Water quality is a critical environmental issue, especially in developing nations where access to clean drinking water remains a challenge. This study assesses the seasonal variations in groundwater water quality in Shujalpur tehsil, Shajapur district, Madhya Pradesh, by analyzing pre-monsoon (April 2024) and post-monsoon (November 2024) water samples from 12 different locations. Key physical and chemical parameters such as pH, turbidity, phosphate, fluoride, nitrate, iron, total dissolved solids (TDS), total alkalinity, chloride, sulfate, hardness, DO, BOD, COD were observed . Results indicate significant seasonal variations in water quality, with notable improvements post-monsoon due to natural dilution effects. However, certain parameters, including nitrate remained above permissible limits in some samples, posing potential health risks. This study highlights the urgent need for improved water management practices and pollution control measures to ensure sustainable and safe drinking water sources in the region.

KEYWORDS: Water quality, groundwater, seasonal variation, water pollution, BOD, Physicochemical etc.

INTRODUCTION

In recent decades, water has become one of the most pressing environmental concerns of the twenty-first century. Following global warming, many regions—particularly arid and semi-arid areas—are experiencing severe water shortages, while others are struggling with significant water pollution **(Mansour et al., 2024).** Globally, approximately 1.5 billion people lack access to safe drinking water, and around 5 million people die each year due to water-related issues. In developing nations, 75% of the population does not have access to clean drinking water **(Khatri et al., 2016),** while 80% of industrial waste is directly discharged into water bodies, leading to widespread contamination **(Du Plessis, 2022).** The demand for water continues to rise due to factors such as improved living standards, population growth, industrial expansion, development, ineffective water policies, and other external influences **(Abbaspour et al., 2015).** Groundwater serves as the primary sources of fresh water, supporting more than half of the world's population. However, the availability of clean water remains a critical issue, as water quality is directly linked to public health. Numerous waterborne diseases, including cholera, typhoid, and viral hepatitis, contribute significantly to global mortality rates **(Shaibur et al., 2019).**

Our study focuses on Shujalpur, one of the nine tehsils in the Shajapur district. It is the largest tehsil in the district by area, while Shujalpur holds the highest population. This research aims to assess seasonal variations, both pre-monsoon and post-monsoon, in the quality of groundwater in Shujalpur tehsil, located in Shajapur district, Madhya Pradesh.

MATERIALS AND METHODS

Study area

The water quality analysis conducted in April 2024 (Pre-Monsoon) and November 2024 (Post-Monsoon) in Shujalpur tehsil, located in Shajapur district, Madhya Pradesh.

Sample collection

The water samples were collected from 12 sampling sites of ground water sources. The study covers various water sources across different locations in Shujalpur tehsil. Bore well (BW) water is sourced from Amlai Patthar, while hand pump (HP) water is collected from Chintoni Gaon, Kisoni Gaon, and Chakrod. Tube well (TW) water is sampled from Bheelkhedi, Meharkhedi, Shujalpur Mandi, Awantipur Badodiya, Kamliya, and Undai. Well water is obtained from Bheempura Gaon and Jhirniya Gaon.

Parameter for analysis

Physical Parameters

Temperature was recorded using a digital laboratory thermometer (-10°C to 110°C) by immersing it in the water sample for one minute. Odor was assessed through the threshold odor test, wherein samples were presented in increasing concentrations to determine detect ability. The pH of water samples was measured using a calibrated EI auto digital pH meter. Turbidity was determined through turbidity meter **(Spellman, 2008; Adams, 2017).**

Chemical Parameters

Total alkalinity was determined via acidimetric titration using phenolphthalein and methyl orange indicators with 0.02N H_2SO_4. Total hardness was measured by complexometric titration using Eriochrome Black-T as an indicator and EDTA as the titrant. Calcium hardness was analyzed by titration in an alkaline medium using EDTA and a murexide indicator. Magnesium hardness was calculated as the difference between total hardness and calcium hardness. Sulfate concentration was determined using a colorimetric method with barium chloride precipitation. Chloride levels were assessed via Mohr's titration using silver nitrate and potassium chromate. Nitrate was measured spectrophotometrically at 220 nm and corrected at 275 nm to account for dissolved organic matter interference. Fluoride concentration was analyzed using an ion-selective electrode **(Rahman et al., 2024; Spellman, 2008; Adams, 2017)**.

Data analysis

Table 1 Water analysis data (May-2024) – Pre-monsoon

S. no.	Water sample Name	Source	pH	Turbidity (NTU)	Phosphate	Fluoride	Nitrate(mg/L)	Iron (mg/L)	Total dissolved solids (mg/L)	Total Alkalinity	Chloride (mg/L)	Sulphate (mg/L)	Calcium Hardness	Magnesium (mg/L)	Total Hardness (mg/L)	Coli form	Temperature	Conductivity at 25°C	Dissolved oxygen (mg/L)	Biochemical	Chemical oxygen
1	**Amlai Patthar**	BW	6.8	0.7	0.3	0.4	2.5	0.13	421	375	87	21	103.41	32.84	402	Nil	31.5	623	5.3	3.7	284
2	**Bheelkhedi**	TW	7.9	1.4	0.4	0.3	8	0.04	678	189	78	34	92	42	542	Nil	31	765	6.1	7.6	675
3	**Bheempura**	Well	6.4	1.8	0.7	0.6	5.9	0.27	825	524	139	67	102	37.4	456	Nil	30.74	1028	5.2	5.04	1645
4	**Chintoni**	HP	6.3	2.5	0.5	0.4	2.3	0.13	392	357	149	29	136.24	31.28	451	Nil	31.8	824	5.1	4.2	294
5	**Jhirniya**	well	6.2	1.2	1.0	0.5	4.9	0.`8	721	408	189	72	206	59.1	651	Nil	30.5	1002	6.4	10.21	521
6	**Kisoni**	HP	6.9	3.9	0.6	0.6	3.1	0.14	603	527	149	37	75.5	34.51	286	Nil	32.4	850	4.3	0.14	421
7	**Meharkhedi**	TW	7.6	2.4	0.6	0.1	8	0.02	784	168	70	28	103	52	488	Nil	31	876	5.7	9.8	689
8	**Shujalpur Mandi**	TW	6.4	1.4	0.4	0.9	2.1	0.13	342	247	132	31	154	31.64	423	Nil	34.05	602	4.8	8.5	321
9	**Awantipur badodiya**	TW	6.9	1.9	0.5	0.2	13	0.07	890	167	70	32	109	34	566	Nil	34	984	3.5	7.1	768
1	**Chakrod**	HP	7.8	2.4	0.7	0.1	9	0.03	987	210	89	22	132	43	654	Nil	32	865	3.4	8.4	567
1	**Kamliya**	TW	7.5	2.1	0.8	0.3	12	0.04	870	188	76	32	117	58	540	Nil	31	786	7.8	11.9	743
1	**Undai**	TW	7.3	1.6	0.6	0.3	10	0.01	734	168	78	32	103	38	424	Nil	32	1300	3.4	6.5	378

Table 2 Water analysis data (Nov-2024) – post-monsoon

S. no.	Water sample Name	Source	pH	Turbidity (NTU)	Phosphate	Fluoride	Nitrate(mg/L)	Iron (mg/L)	Total dissolved solids (mg/L)	Total Alkalinity (mg/L)	Chloride (mg/L)	Sulphate (mg/L)	Calcium Hardness	Magnesium (mg/L)	Total Hardness (mg/L)	Coli form	Temperature (^0C)	Conductivity at 25°C	Dissolved oxygen (mg/L)	Biochemical oxygen Demand	Chemical
1.	**Amlai Patthar**	BW	7.4	0.1	0.5	0.9	1.0	0.09	395	292	45	37	96	28.8	360	Nil	26.5	563	5.9	1.4	228
2.	**Bheelkhedi**	TW	7.62	1.2	0.5	0.1	2.1	0.11	832	240	110	38	90	43	412	Nil	26	678	6.8	3.0	256
3.	**Bheempura Gaon**	well	8.12	0.1	0.3	0.7	4.5	0.14	706	490	104	98	88	29.76	344	Nil	25.9	1002	7.0	6.0	1500
4.	**Chintoni Gaon**	HP	7.69	1.6	0.5	0.4	1.5	0.08	348	308	97	48	102.4	26.88	368	Nil	26.6	720	6.2	2.9	348
5.	**Jhirniya Gaon**	Well	7.56	0.7	0.5	0.3	3.5	0.12	649	340	168	89	152	43.2	560	Nil	26.1	924	7.0	9.5	482
6.	**Kisoni Gaon**	HP	7.67	2.8	0.2	0.4	2.0	0.10	549	464	98	52	67.2	23.04	264	Nil	26	782	5.2	0.8	352
7.	**Meharkhedi**	HP	8.1	2.3	0.2	0.2	11	0.15	890	187	78	32	123	45	456	Nil	26	789	7.8	4.5	533
8.	**Shujalpur Mandi**	TW	7.83	0.8	0.3	0.4	1.3	0.09	264	220	78	38	103.2	24.48	360	Nil	26.1	565	5.0	7.2	264
9.	**Kamliya**	HP	8.5	3.2	0.4	0.1	16	0.10	904	242	122	30	101	50	470	Nil	26	658	7.6	1.8	345
10.	**Awantipur Badodiya**	TW	8.4	3.8	0.3	0.1	14	0.08	694	188	98	34	72	38	338	Nil	26	456	6.8	2.9	345
11.	**Chakrod**	TW	8.2	2.8	0.3	0.3	08	0.08	712	218	98	28	72	38	338	Nil	26.9	896	5.6	2.8	345
12.	**Undai**	HP	8.3	4.2	0.4	0.3	10	0.12	823	278	104	24	87	52	523	Nil	26	234	6.3	3.9	234

HP is Hand pump water, BW is bore well, TW is tube well, well etc.

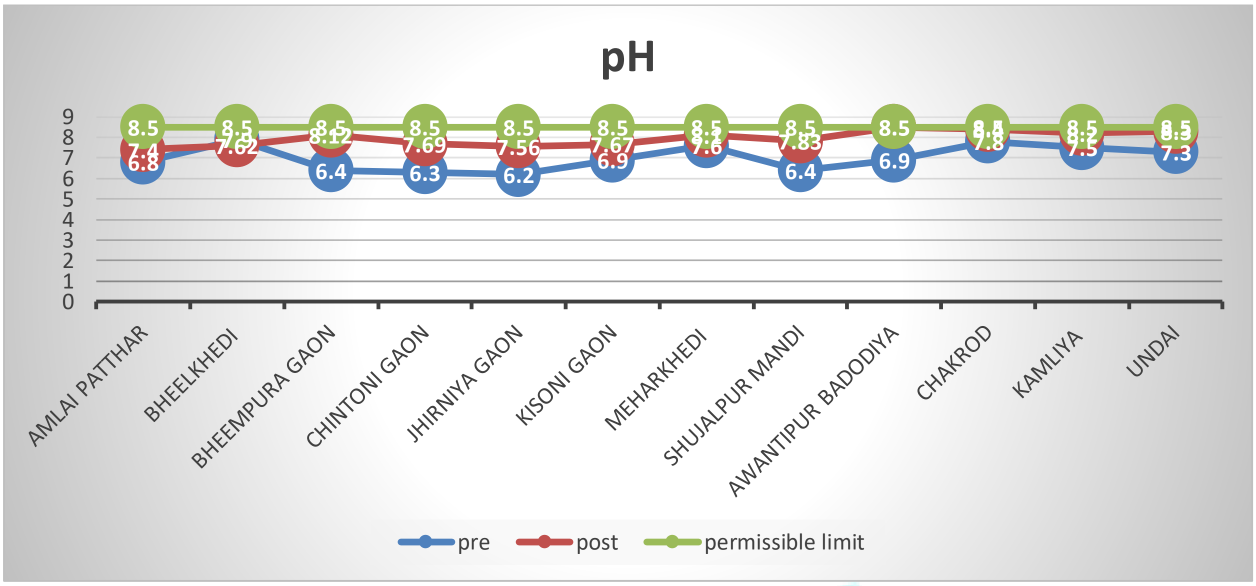
Table 3 Permissible limits of water parameters

Parameter	Permissible limit WHO
Temperature	20^0C
pH	8.5
Conductivity	1000
Turbidity	5 (NTU)
Phosphate	1 (Mg/L)
Fluoride	1.5
Nitrate	45 (Mg/L)
Iron	1 (Mg/L)
Total Dissolved solids	2000 (Mg/L)
Sulphate	400 (Mg/L)
Calcium hardness	200 (Mg/L)
Magnesium	100 (Mg/L)
Total Hardness	600 (Mg/L)
D O	6 (Mg/L)
BOD	3 (Mg/L)
COD	No specific limit

Result and discussions

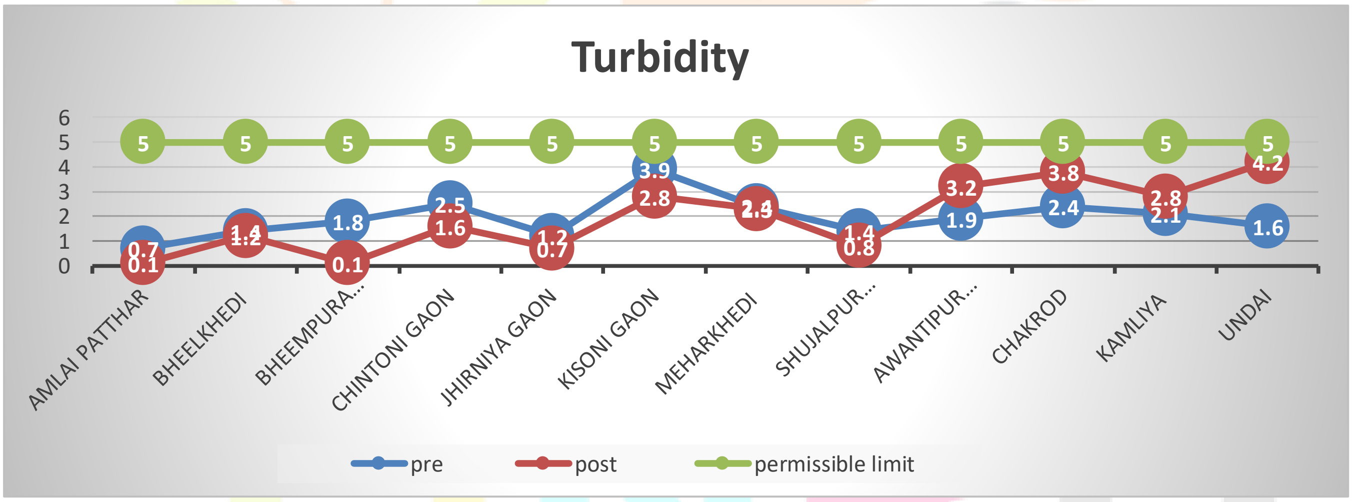
The water quality analysis conducted in April 2024 (Pre-Monsoon) and November 2024 (Post-Monsoon) highlights significant variations in different water parameters across multiple sources, including borewells (BW), tube wells (TW), wells, and hand pumps (HP). The analysis compared these parameters with the permissible limits to assess water safety and quality.

1. pH: The permissible pH limit for drinking water is 8.5. Most of the pre-monsoon samples had pH values between 6.2 and 7.9, with some samples slightly acidic. In the post-monsoon analysis, pH values generally increased, with several samples approaching the upper permissible limit. The increased pH post-monsoon could be attributed to reduced contamination and dilution effects from rainfall.



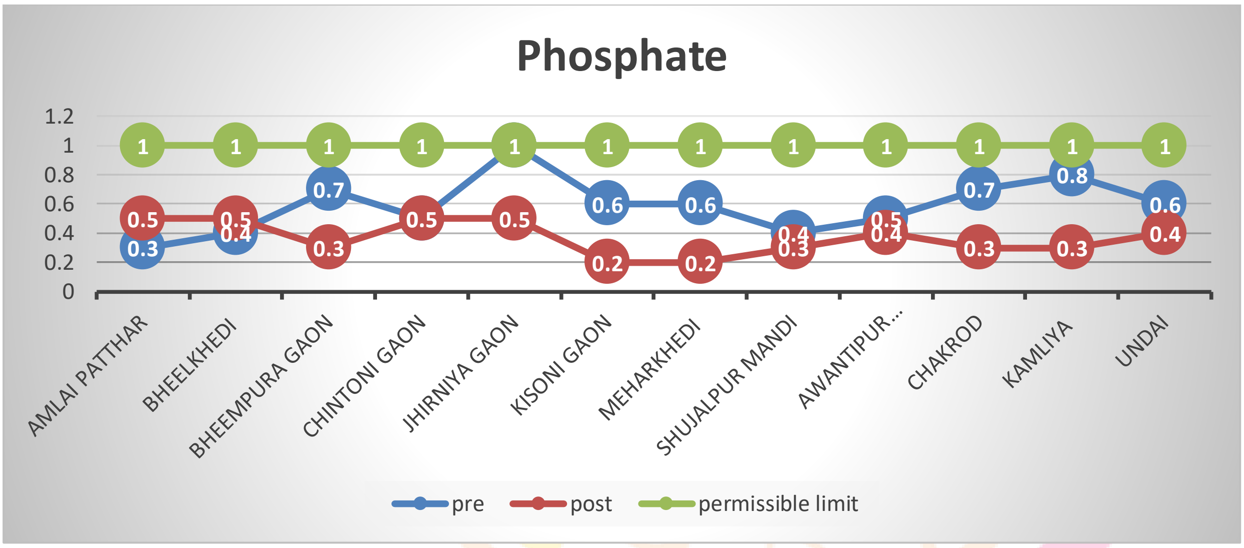
Graph 1 pH comparison in pre and post monsoon

2. Turbidity (NTU) : The permissible turbidity limit is 5 NTU. Post-monsoon turbidity levels significantly decreased, with most samples falling below the permissible limit, likely due to sedimentation and dilution by rainwater.



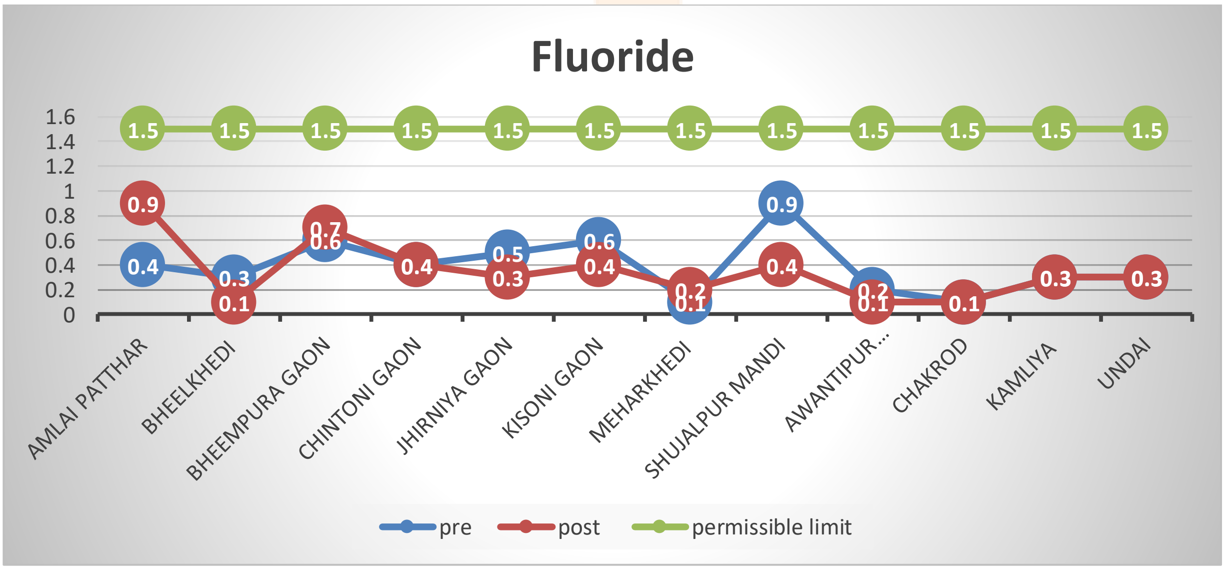
Graph 2 Turbidity comparison in pre and post monsoon

3. Phosphate (Mg/L): The permissible fluoride limit is 1 mg/L. Both pre-monsoon and post-monsoon samples were well within this limit, with values ranging from 0.2 to 0.8 mg/L. This indicates the water sources are not at risk for Phosphate-related health issues



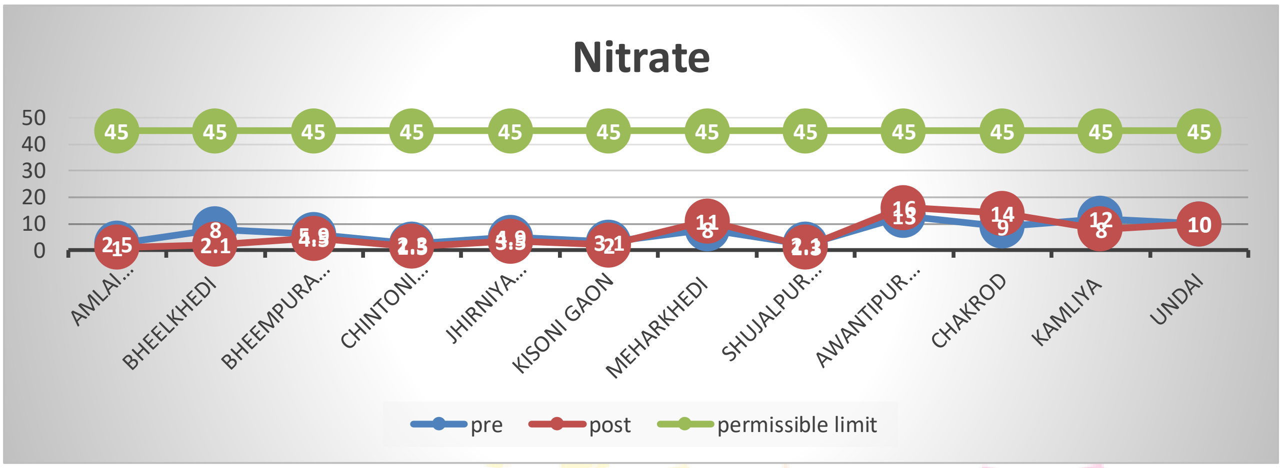
Graph 3 Phosphate comparison in pre and post monsoon

4. Fluoride (mg/L): The permissible fluoride limit is 1.5 mg/L. Both pre-monsoon and post-monsoon samples were well within this limit, with values ranging from 0.1 to 0.9 mg/L. This indicates the water sources are not at risk for fluoride-related health issues such as fluorosis.



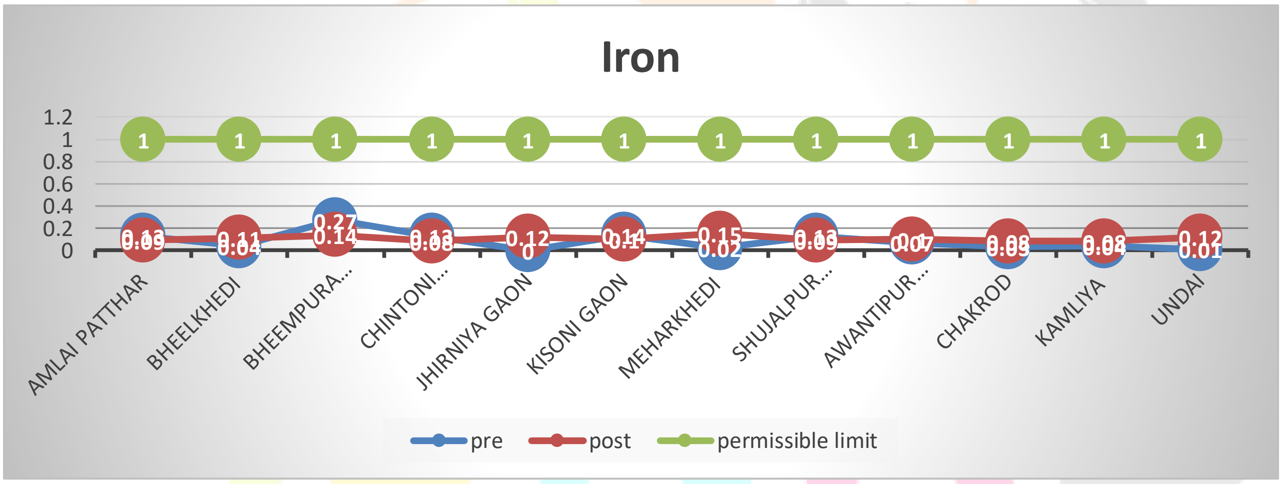
Graph 4 Fluoride comparison in pre and post monsoon

5. Nitrate (mg/L): The permissible nitrate limit is 45 mg/L. Pre-monsoon nitrate levels were significantly lower, mostly below 16 mg/L, but in Awantipur Badodiya (13 mg/L) However, post-monsoon nitrate levels were elevated in some areas, indicating potential contamination from agricultural runoff.



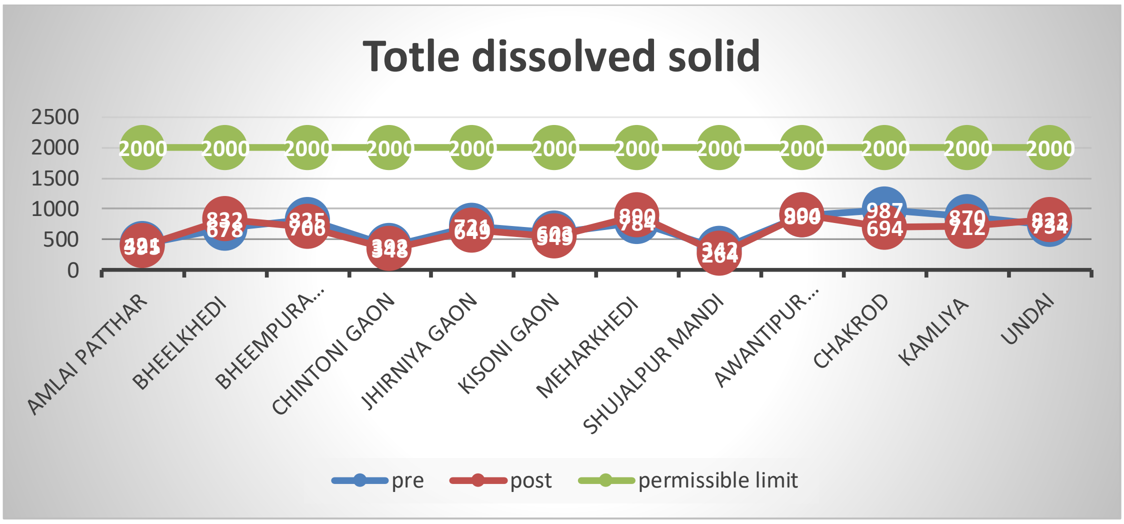
Graph 5 Nitrate comparison in pre and post monsoon

6. Iron (mg/L): The permissible iron limit is 1 mg/L. Most samples had iron concentrations well below the limit, with pre-monsoon values peaking at 0.27 mg/L in Bheempura Gaon. Post-monsoon, iron levels remained within safe limits, with minor variations due to leaching from soil and sediment.



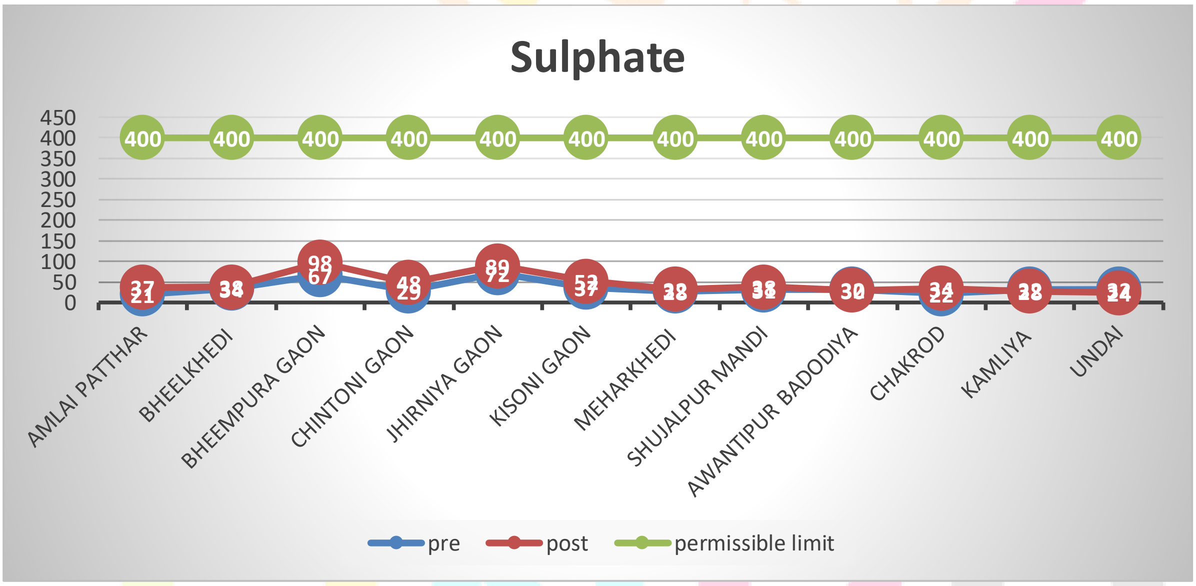
Graph 6 Iron comparison in pre and post monsoon

7. Total Dissolved Solids (TDS) (mg/L): The permissible TDS limit is 2000 mg/L. All water samples, both pre-monsoon and post-monsoon, had TDS values well below this limit, indicating acceptable salinity and mineral content.



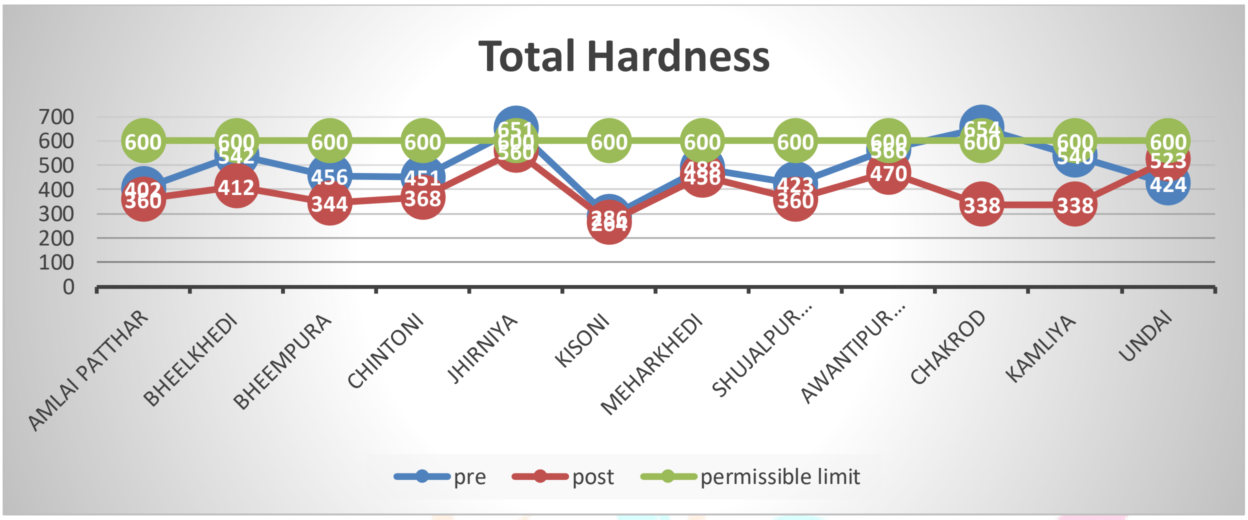
Graph 7 Total dissolved solid comparison in pre and post monsoon

8. Sulphate (mg/L): The permissible sulphate limit is 400 mg/L. All samples were well within the limit, with pre-monsoon values ranging from 21 to 72 mg/L and post-monsoon levels showing a similar trend.



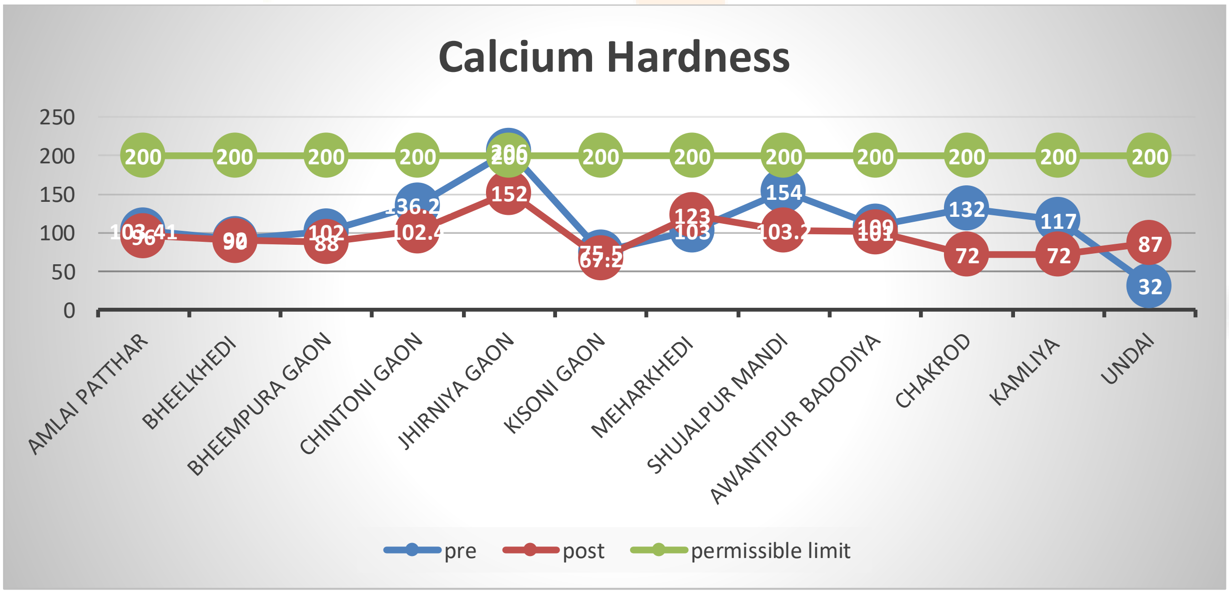
Graph 8 Sulphate comparison in pre and post monsoon

9. Total Hardness (mg/L): Total hardness (sum of calcium and magnesium hardness) has a permissible limit of 600 mg/L. While most samples remained within safe limits, certain pre-monsoon samples such as Jhirniya Gaon (651 mg/L). Increased hardness levels post-monsoon indicates potential mineral leaching from geological formations.



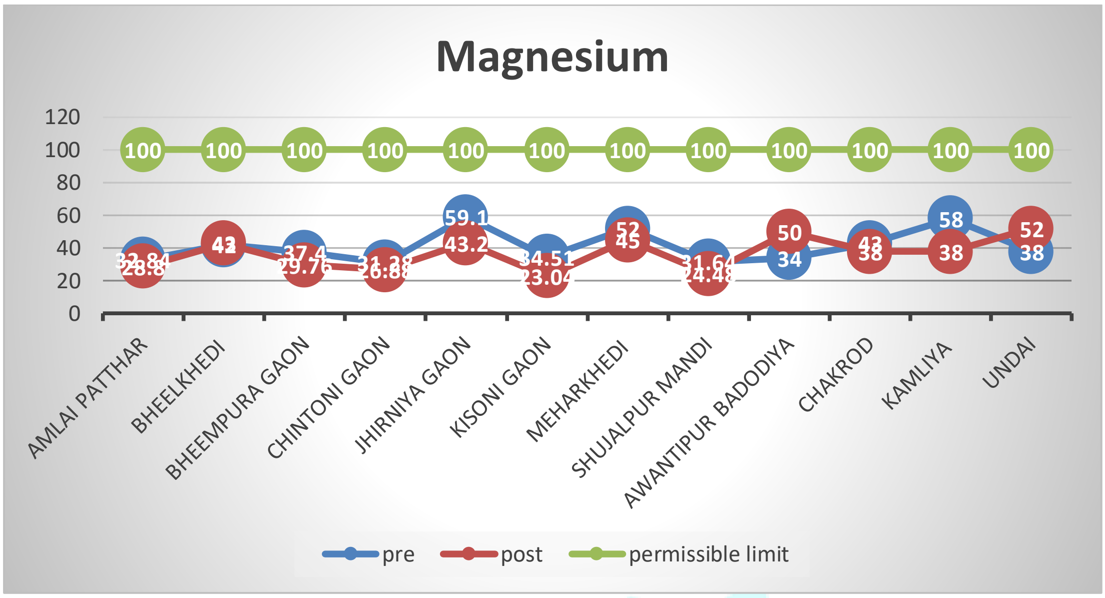
Graph 9 Total Hardness comparison in pre and post monsoon

10. Calcium Hardness (mg/L): Calcium hardness has a permissible limit of 200 mg/L. While most samples remained within safe limits, certain pre-monsoon samples such as Jhirniya Gaon (206 mg/L). Increased calcium hardness levels post-monsoon indicates potential mineral leaching from geological formations



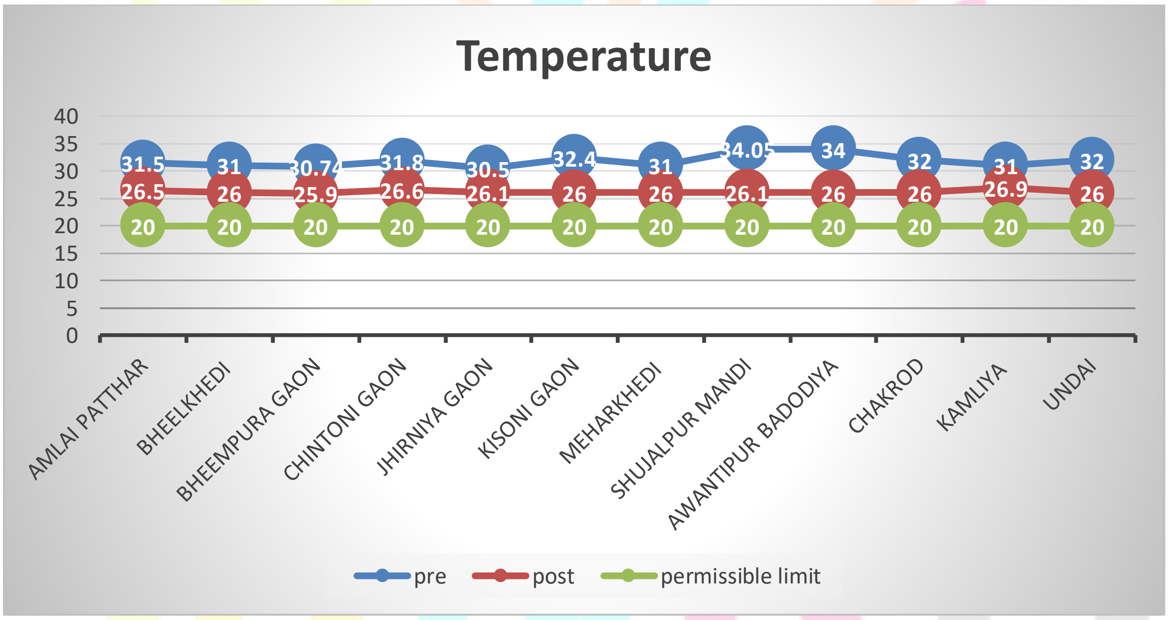
Graph 10 Calcium Hardness comparison in pre and post monsoon

11. Magnesium : The permissible turbidity limit is 100 (Mg/L). Post-monsoon turbidity levels significantly decreased, with most samples falling below the permissible limit, likely due to sedimentation and dilution by rainwater.



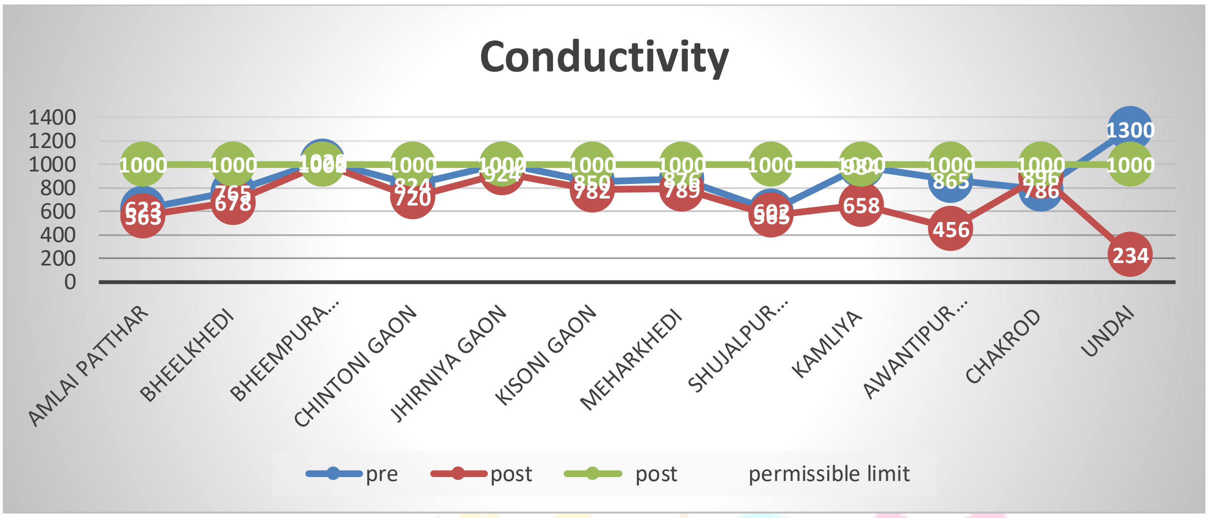
Graph 11 Magnesium comparison in pre and post monsoon

12. Temprature : The permissible Temperature limit 20^{0}C . Post-monsoon Temperature less then significantly decreased, with most samples falling below the permissible limit, likely due to sedimentation and dilution by rainwater.



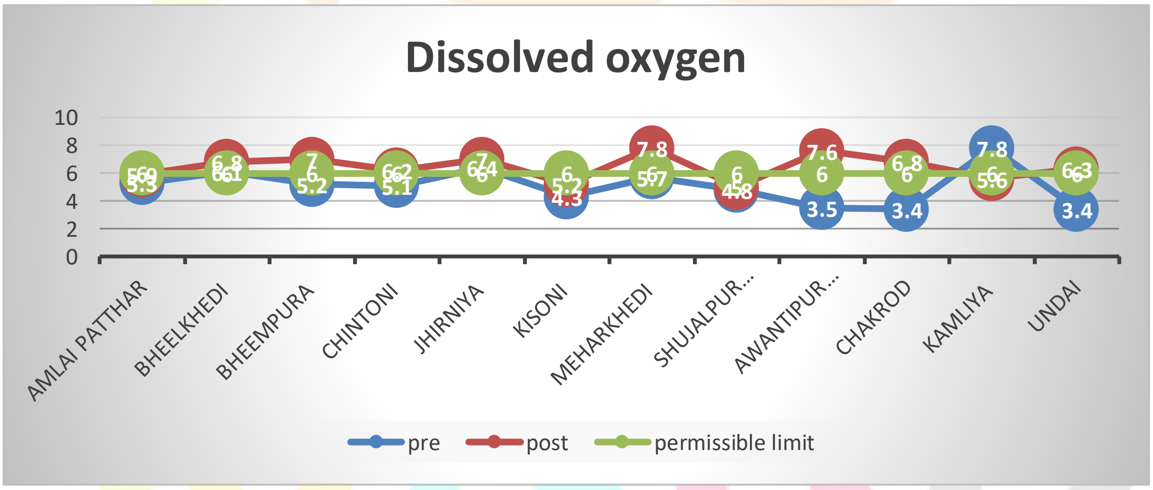
Graph 12 Temperature comparison in pre and post monsoon

13. Conductivity (Mg/L) : The permissible turbidity limit is 1000 (Mg/L). Post-monsoon turbidity levels significantly decreased, with most samples falling below the permissible limit, likely due to sedimentation and dilution by rainwater.



Graph 13 Conductivity comparison in pre and post monsoon

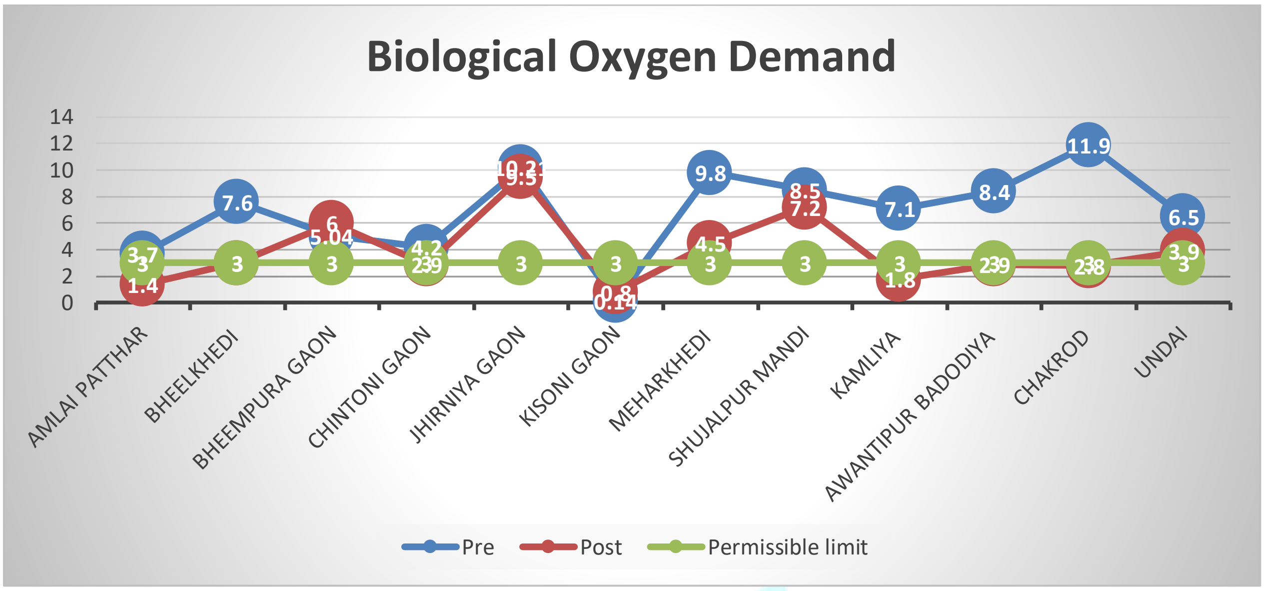
14. Dissolved Oxygen (DO): Dissolved oxygen levels were generally stable in ground water, with values ranging from 3.4 to 7.8 mg/L. Post-monsoon, DO levels improved in some samples, indicating enhanced oxygenation due to water movement COD levels, which indicate organic pollution, were elevated in some pre-monsoon samples but reduced post-monsoon



Graph 14 Dissolved oxygen comparison in pre and post monsoon

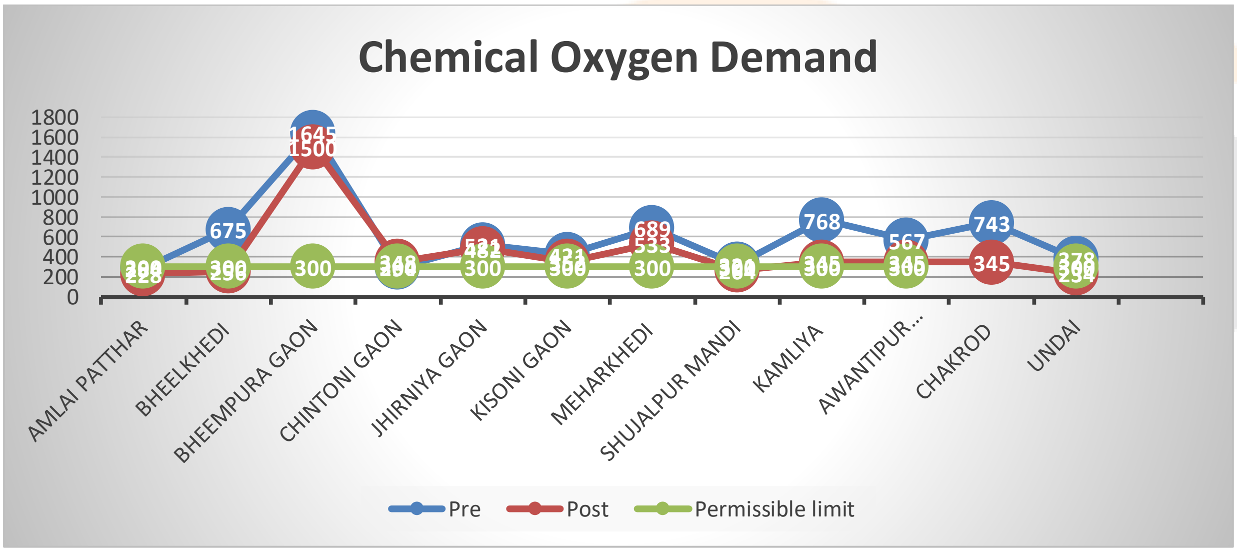
15. Biological Oxygen Demand (BOD): BOD is a measure of organic material contamination in water, specified in mg/L. BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites). Typically, the test for BOD is conducted over a five-day period.

BOD levels were generally stable in ground water, with values ranging from 0.14 to 11.9 mg/L. BOD levels improved in some samples, indicating enhanced oxygenation due to water movement which indicate organic pollution, were elevated in some pre-monsoon samples but reduced post-monsoon.



Graph 15 Biological oxygen Demand comparison in pre and post monsoon

16. Chemical Oxygen Demand (COD): COD is another measure of organic material contamination in water specified in mg/L. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. The result of a chemical oxygen demand test indicates the amount of water-dissolved oxygen (expressed as parts per million or milligrams per liter of water) consumed by the contaminants. The higher the chemical oxygen demand, the higher the amount of pollution in the test sample. Chemical oxygen demand levels were generally stable in ground water certain pre-monsoon samples such as bheempura Gaon 1645 (Mg/L) and 1500 Mg/L in Post-monsoon, COD indicating enhanced oxygenation due to water movement COD levels, which indicate organic pollution, were elevated in some pre-monsoon samples but reduced post-monsoon



CONCLUSION

The findings of this study underscore the critical importance of monitoring seasonal variations in water quality to safeguard public health. The post-monsoon season exhibited improved water quality due to dilution, yet several contaminants remained at concerning levels, necessitating intervention. High nitrate levels and microbial contamination in some samples indicate anthropogenic influences such as agricultural runoff and inadequate sanitation. The study emphasizes the need for stricter water quality regulations, routine monitoring, and the implementation of effective water purification and management strategies to ensure safe drinking water for the local population. Further research incorporating microbial assessments and heavy metal analysis is recommended for a more comprehensive understanding of regional water quality dynamics.

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