IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, July 2024

Comparative Physiochemical Appraisal of Groundwater and Drinking Water Quality Assessment in Hisar District

Surender Singh Malik[1] and Dr. Vishnu Dev Gupta[2]
Research Scholar[1]
Research Guide[2]
Shri J.J.T University, Jhunjhunu, Rajasthan, India
ssmalikhry@gmail.com

Abstract: *Having access to clean drinking water is crucial, especially in rural areas where groundwater is the main water supply. This study has assessed the physicochemical quality of the groundwater in hisar District, Haryana, India. The following physiochemical parameters were determined on 30 samples samples that were gathered from thirty different locations: pH, total dissolved solids, total hardness, alkalinity, electrical conductivity, calcium, magnesium, sodium, potassium, nitrate, fluoride, and sulfate. These findings were compared to the standards set by the Indian Council of Medical Research, the Bureau of Indian Standards, the World Health Organization, and other regulatory authorities. The majority of the required parameters were found to be within allowable bounds; but, total hardness, calcium, and magnesium were shown to be higher than advised in several locations. According to the Water Quality Index, groundwater in certain regions is becoming unsafe for human consumption due to its diminishing quality. This study emphasizes the need of routine monitoring in addition to providing vital information to support mitigation efforts and guarantee the supply of sustainable and clean water resources for the residents of the hisar district in the state of Haryana.*

Keywords: Physiochemical, ground water, water quality, hisar, water quality index

I. INTRODUCTION

For all living things on Earth's surface, water is necessary. Water is necessary for home, industrial, and agricultural purposes and is vital to human existence. Overuse of groundwater resources has led to deteriorating water levels and quality in many regions, making sustainable water management difficult. To overcome these challenges, strategies for sustainable water management are needed. These include pushing for water conservation in commercial and residential contexts, enforcing laws governing groundwater extraction, and efficiently managing water in agriculture by using innovative techniques like drip irrigation. Furthermore, enhancing water infrastructure—constructing reservoirs and strengthening water distribution networks, for instance—may make it easier to manage the water supplies that are now available. Water usage efficiency and conservation must be given top priority in the state of Haryana and many other areas throughout the world. This means that in addition to managing the current water resources, it is also necessary to replenish and safeguard them for future generations. Integrated water resource management techniques that include surface and groundwater sources must be put into practice in order to guarantee both environmental sustainability and water security. Educating the people on the need of sustainable practices and water conservation is also crucial. Education and community engagement are necessary to create a culture that prioritizes ethical resource use and conservation of water. In conclusion, water is an invaluable natural resource and a national asset, but sustainable management is even more critical in light of growing demand and environmental concerns. Through coordinated conservation, regulatory, and public engagement efforts, we can guarantee that water resources continue to be abundant and conveniently accessible to everyone. The sustainable development and management of groundwater resources consequently need exact assessment based on recognized and valid scientific criteria, because groundwater is essential to the state's economy and so requires scientific monitoring in terms of both quality and quantity.

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Geographical Description of Area of Study

Hisar, one of Haryana's biggest cities, is located at 29° 09" North and 75° 42" East. Hisar is located 164 kilometers east of Delhi on National Highway 10. The elevation above mean sea level is 215 meters. There are 301,249 people living in Hisar City, with an 844 sex ratio and an 81.04% literacy rate. The hisaral Steel Industry, the Rajiv Gandhi Thermal Power Plant, as well as other cotton and pharmaceutical businesses, are the main causes of pollution in Hisar. Hisar is quite hot, with an average summer temperature of 32.5 0C. Hisar's average winter temperature is 17.50°C. There is 490.5 mm of precipitation in Hisar City per year. The groundwater in Hisar City is too saline to be used as a freshwater source. The city gets its water from the Balsamand branch, Hisar main, and Rana distributaries. The water works that provide treated water include PTU Water Works, Kaimri Road Water Works Number 2, and Mahavir Colony Water Works. Apart from HUDA, Guru Jumbheshwar University and Haryana Agriculture University have two other canal-based water works. The provision of potable water in the cantonment areas of Hisar is distinct.

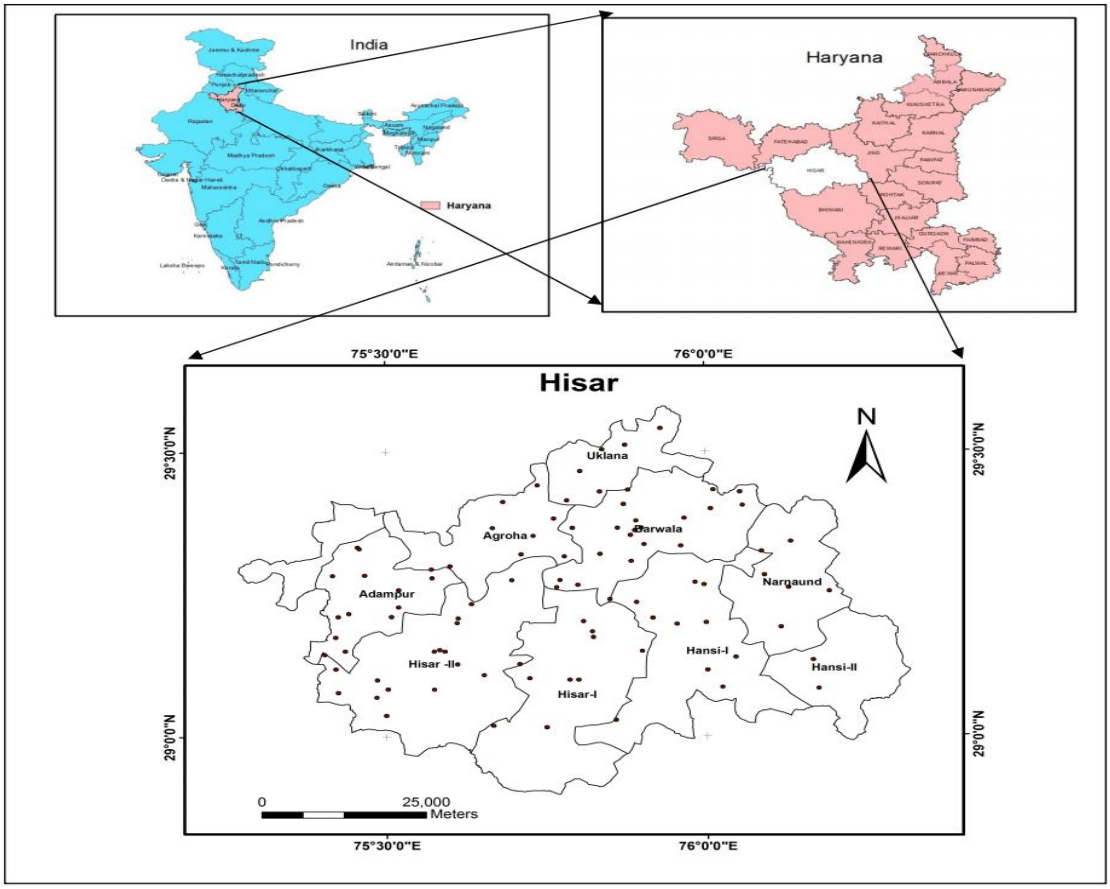

Fig 1: geographcal map of hisar district

Collection of Samples

The samples were collected over the course of five months, from January 2024 to May 2024, from a variety of locations in the region, including both urban and rural communities. The stations (A1-A30) are the locations where the water samples were taken. Every 1.5-liter plastic bottle that had been previously cleaned and tagged was used to collect the water samples. Before being used, the bottles were washed with 2% nitric acid and three times with distilled water. By taking this precaution, you may be confident that the containers are free of contaminants and clean, which might affect the water samples. Following collection, the water samples were quickly preserved using the industry-standard methods outlined in the 2005 APHA (American Public Health Association) guidelines to guarantee sample integrity throughout storage and transportation.The APHA standards' stated methods were followed in order to examine the water samples.

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These techniques are reliable and consistent for monitoring a wide range of parameters, including as pH, turbidity, dissolved oxygen, nutrients, and possible contaminants. To collect trustworthy data on the characteristics and quality of the water from these many sources, a methodical approach is essential.

Specifications of drinking water

The World Health Organization estimates that in 1975, 1, 230 million people lacked access to potable water. In response to these terrible facts, the United Nations declared 1981 to be the International Year of Drinking Water Supply and Sanitation. The Fifth Five Year Plan of India gave careful thought to ensuring that the general populace had access to safe drinking water. Consequently, the standard was developed with the goal of assessing the quality of water resources and confirming the effectiveness of water treatment and delivery by the appropriate authorities. Comparative chemometric analyses of the drinking subsurface water quality indicators in rural and urban locations were used to achieve this. The eleventh five-year plan document for India (2007–12) states that in order to provide a safety margin to protect public health, various regulatory bodies, including the Bureau of Indian Standards (BIS), Indian Council of Medical Research (ICMR), and World Health Organization (WHO), have established permissible ranges of quality parameters of safe drinking water. Table 2 lists the safe range of different physiochemical parameters established by different regulating organizations.

Table 1. Analytic methods, BIS, ICMR & WHO parameters for the drinking water

Parameter	BIS standard	ICMR standard	WHO standard
pH	6.5 – 8.5	7.0 – 8.5	6.5 – 8.5
TDS (mg/L)	500 - 2000	500-3000	1000
TH (mg/L)	300-600	300-600	500
Ca2+ (mg/L)	75-200	75-200	200
Mg2+ (mg/L)	30-100	50	50
Cl– (mg/L)	250-1000	200-1000	200
Turbidity(NTU)	1	1-5	5
SO_4^{2-}(mg/L)	200-400	200-400	400
NO_3^- (mg/L)	45-100	20-100	10
PO_4^{3-} (mg/L)	-	-	-
Na^+ (mg/L)	-	-	200/15
K^+(mg/L)			
Fe^{3+} (mg/L)	0.3-1.0	0.1	1.0
F^- (mg/L)	1.0	1-1.5	1.5

II. RESULTS AND DISCUSSION

Thirty samples were taken from hand pumps, tube wells from villages, temples, bus station, and several diverse sites. These samples were evaluated for different physicochemical characteristics . The approach used for the analysis was from standard method (APHA). All the results are compared with the allowable limit established by the Bureau of Indian Standards (BIS),Indian Council of Medical Research (ICMR) and World Health Organization (WHO). Characterizations of the physio-chemical parameters of different locations in District hisar, Haryana, India are reported in Tables 3

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block	Site code	ph	TDS	EC	TH	TA	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	F^{-}	SO_4^{2-}	PO_4^{3-}	NO_3^{-}
Adampur	Ad1	8.12	589	0.910	250	308	51	26	120	91	103	2.8	50	1.2	8
	Ad2	7.82	857	1.325	410	315	83	49	198	35	271	0.6	104	2.2	5
	Ad3	7.44	599	0.930	244	280	43	36	163	16	163	2.8	67	1.5	8
	Ad4	7.65	1147	1.943	530	475	146	64	124	13	319	1.1	114	1.2	6
	Ad5	8.76	540	0.850	286	225	58	38	44	5	104	2.0	69	1.0	8
Hansi	Ha1	7.89	1011	1.632	521	345	101	63	219	65	280	1.0	142	1.0	21
	Ha2	8.16	696	1.088	390	280	78	47	227	5	241	2.0	79	0.3	9
	Ha3	7.80	781	1.218	511	230	103	62	177	7	190	1.5	66	0.3	13
	Ha4	8.44	904	1.428	505	290	95	54	111	13	161	6.3	148	1.1	4
	Ha5	8.36	241	0.238	99	145	21	11	63	5	83	0.0	27	0.8	4
Barwala	Ba1	7.61	801	1.250	316	291	60	38	90	6	119	0.7	165	0.6	5
	Ba2	7.64	388	0.593	230	123	49	26	33	21	50	1.1	65	0.5	6
	Ba3	7.32	787	1.230	428	291	90	44	110	22	310	0.7	178	0.8	8
	Ba4	8.66	438	0.635	190	155	40	22	55	3	65	0.6	56	0.1	17
	Ba5	8.43	335	0.461	165	136	30	21	50	4.1	70	0.5	109	1.1	6
Uklana	Uk1	7.41	1260	2.018	798	441	170	56	217	43	319	1.2	130	1.3	26
	Uk2	8.41	449	0.669	215	210	43	31	108	6	135	3.0	90	1.9	11
	Uk3	7.72	720	1.141	300	272	60	38	150	3	189	3.1	169	1.5	28
	Uk4	8.12	360	0.529	173	133	35	25	62	6	91	0.4	130	2.7	22
	Uk5	8.03	900	1.436	465	333	90	55	200	19	259	1.1	204	1.6	36
Narnaund	Na1	7.61	1242	2.009	550	381	113	68	210	31	363	1.7	83	0.3	18
	Na2	7.95	896	1.351	445	345	88	56	278	6	309	1.4	121	0.9	39
	Na3	7.72	481	0.693	215	212	41	27	90	2	170	2.2	34	0.5	11
	Na4	7.36	1491	2.435	750	563	149	85	320	12	419	3.3	145	0.6	36
	Na5	7.93	679	1.036	340	303	71	37	155	13	165	3.5	22	0.6	30
Agroha	Ag1	8.71	376	0.558	98	210	18	17	175	21	191	2.5	26	0.4	26
	Ag2	7.92	618	0.958	300	305	64	31	242	31	290	0.0	128	2.1	42
	Ag3	8.02	860	1.364	391	330	88	46	155	8	181	1.5	165	1.0	3
	Ag4	7.79	500	0.782	260	230	48	27	180	8	215	0.5	140	0.4	30
	Ag5	7.93	431	0.625	219	180	48	25	165	6	181	0.6	56	1.1	4

All parameters have been expressed as mg/L except pH and EC. The unit of EC is mS

Table 2. Chemical characteristics of ground water of different places of Hisar City

DOI: 10.48175/IJARSCT-19270

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Adampur block

pH ranges from 7.44 to 8.76 with a mean value of 7.95. TDS range was from 540 to 1147 with a mean value of 746.4 mg/l. electrical conductivity range was 0.85 to 1.94 mS with a mean value of 1.19 mS. Range of total hardness was from 250 to 530 mg/l and mean value was 344 mg/l. Ca^{2+} ion concentration Was between 51 to 146 mg/l and mean value was76.2 mg/l. magnesium ranges from 26 to 64 and mean value was 42.6 mg/l. sodium ion concentration of the block was between 44 to 198 mg/l and mean value was129 mg/l. K^{+} was in the range of 5 to 91 mg/l and mean value was 32 mg/l. fluoride ion range was 0.6 to 2.8 mg/l with a mean value of 1.86 mg/l. sulphate ion concentration was between 50 to 114 mg/l and mean concentration was 80.8 mg/l. phosphate ion concentration Was in a range of 1.0 to 2.2 mg/l and mean value was 1.42 mg/l. nitrate ion concentration was between 5 to 8 mg/l and mean concentration Was 7 mg/l in the sample.

Hansi block

pH ranges from 7.89 to 8.44 with a mean value of 8.13. TDS range was from 241 to 1011 with a mean value of 726.6 mg/l. electrical conductivity range was 0.23 to 1.63 mS with a mean value of 1.12 mS. Range of total hardness was from 99 to 521 mg/l and mean value was 405 mg/l. Ca^{2+} ion concentration Was between 21 to 103 mg/l and mean value was 79.6 mg/l. magnesium ranges from 11 to 64 and mean value was 47.4 mg/l. sodium ion concentration of the block was between 63 to 227 mg/l and mean value was159 mg/l. K^{+} was in the range of 5 to 65 mg/l and mean value was 19 mg/l. fluoride ion range was 0 to 6.3 mg/l with a mean value of 2.16 mg/l. sulphate ion concentration was between 27 to 148 mg/l and mean concentration was 92.4 mg/l. phosphate ion concentration was in a range of 0.3 to 1.1 mg/l and mean value was 0.7 mg/l. nitrate ion concentration was between 4 to 21 mg/l and mean concentration was 10.2 mg/l in the sample.

Barwala block

pH ranges from 7.32 to 8.66 with a mean value of 7.93. TDS range was from 335 to 801 with a mean value of 549.8 mg/l. electrical conductivity range was 0.46 to 1.25 mS with a mean value of 0.833 mS. Range of total hardness was from 165 to 428 mg/l and mean value was 265 mg/l. Ca^{2+} ion concentration Was between 30 to 90 mg/l and mean value was 53.8 mg/l. magnesium ranges from 21 to 44 and mean value was 30.2 mg/l. sodium ion concentration of the block was between 33 to 110 mg/l and mean value was 67.6 mg/l. K^{+} was in the range of 3 to 22 mg/l and mean value was 11.22 mg/l. fluoride ion range was 0.5 to 1.1 mg/l with a mean value of 0.72 mg/l. sulphate ion concentration was between 56 to 178 mg/l and mean concentration was 114.6 mg/l. phosphate ion concentration was in a range of 0.1 to 1.1 mg/l and mean value was 0.62 mg/l. nitrate ion concentration was between 6 to 17 mg/l and mean concentration Was 8.4 mg/l in the sample.

Uklana block

pH ranges from 7.41 to 8.41 with a mean value of 7.93. TDS range was from 360 to 1260 with a mean value of 737.8 mg/l. electrical conductivity range was 0.52 to 2.01 mS with a mean value of 1.15 mS. Range of total hardness was from 173 to 798 mg/l and mean value was 390 mg/l. Ca^{2+} ion concentration Was between 35 to 170 mg/l and mean value was 79.6 mg/l. magnesium ranges from 25 to 56 and mean value was 41 mg/l. Sodium ion concentration of the block was between 62 to 200 mg/l and mean value was 147.4 mg/l. K^{+} was in the range of 3 to 43 mg/l and mean value was 15.44 mg/l. fluoride ion range was 0.4 to 3.1 mg/l with a mean value of 1.76 mg/l. Sulphate ion concentration was between 90 to 204 mg/l and mean concentration was 114.6 mg/l. phosphate ion concentration Was in a range of 1.3 to 2.7 mg/l and mean value was 1.8 mg/l. Nitrate ion concentration was between 11 to 36 mg/l and mean concentration Was 24.6 mg/l in the sample.

Narnaund block

pH ranges from 7.36 to 7.95 with a mean value of 7.71. TDS range was from 481 to 1491 with a mean value of 957.8 mg/l. electrical conductivity range was 1.03 to 2.43 mS with a mean value of 1.5 mS. Range of total hardness was from 215 to 750 mg/l and mean value was 460 mg/l. Ca^{2+} ion concentration Was between 41 to 149 mg/l and mean value was 92.4 mg/l. magnesium ranges from 27 to 85 and mean value was 54.6 mg/l. Sodium ion concentration of the

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block was between 90 to 320 mg/l and mean value was 210 mg/l. K^+ was in the range of 2 to 31 mg/l and mean value was 12.8 mg/l. fluoride ion range was 1.4 to 3.5 mg/l with a mean value of 2.42 mg/l. Sulphate ion concentration was between 22 to 145 mg/l and mean concentration was 81 mg/l. phosphate ion concentration Was in a range of 0.3 to 0.9 mg/l and mean value was 0.58 mg/l. nitrate ion concentration was between 11 to 39 mg/l and mean concentration Was 26.8 mg/l in the sample. All the tests were carried out in a well equiped laboratory and were conducted uuunder proper guidelines of concerned regulatory authority

Agroha block

pH ranges from 7.79 to 8.71 with a mean value of 8.07 which indicates the slightly basic nature of tap water. TDS range was from 376 to 860 with a mean value of 557 mg/l. electrical conductivity range was 0.55 to 1.36 mS with a mean value of 0.85 mS. Range of total hardness was from 98 to 391 mg/l and mean value was 253 mg/l. Ca^{2+} ion concentration Was between 18 to 88 mg/l and mean value was 53.2 mg/l. magnesium ranges from 17 to 46 and mean value was 29.2 mg/l. sodium ion concentration of the block was between 155 to 242 mg/l and mean value was 183.4 mg/l. K^+ was in the range of 6 to 31 mg/l and mean value was 14.8 mg/l. fluoride ion range was 0 to 25 mg/l with a mean value of 1.02 mg/l. sulphate ion concentration was between 56 to 140 mg/l and mean concentration was 103 mg/l. phosphate ion concentration Was in a range of 0.4 to 2.1 mg/l and mean value was 1.0 mg/l. nitrate ion concentration was between 3 to 30 mg/l and mean concentration Was 21 mg/l in the sample. All the tests were carried out in a well equiped laboratory and were conducted uuunder proper guidelines of concerned regulatory authority

III. CONCLUSION

The quality of drinking water is affected by the physio-chemical characteristics of the groundwater samples that were taken from seven blocks in District Hisar, Haryana, India. The pH of water samples collected nearby indicates a slightly alkaline inclination; this tendency is often within acceptable levels for drinking water quality. Alkalinity and TDS readings at several sites were within allowable bounds, indicating that the surrounding conditions were fit for household and drinking usage.Numerous groundwater tests revealed fluoride levels above WHO standards, raising the possibility of health concerns. This suggests that in order to lessen fluoride pollution in the impacted regions, treatment techniques would be required. Taking everything into account, groundwater in Hisar Block is judged safe for drinking and residential usage. Areas with high concentrations of fluoride, chloride, and hardness may need treatment in order to avoid pollution and guarantee the safety of drinking water. There were no indications of pesticide, fertilizer, animal dung, or sediment pollution in the results of the groundwater testing. To preserve the water's cleanliness, it is imperative that human and animal waste not be disposed of near water sources. To minimize groundwater contamination, cut down on the quantity of fertilizers and pesticides used in agriculture and adhere to standard-quality goods. Every person may help to preserve and conserve water resources by adopting moral actions and lowering their exposure to pollution. In summary, while the district's groundwater generally meets drinking water requirements, some locations need extra care due to high concentrations of certain pollutants, such fluoride. Prolonged preservation of water quality will need adequate mitigation measures and continuous monitoring for the benefit of the local people.

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