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"Analyzing Drinking Water Parameters in Villages of Ratia Block, Fatehabad District, Haryana"

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Abstract -

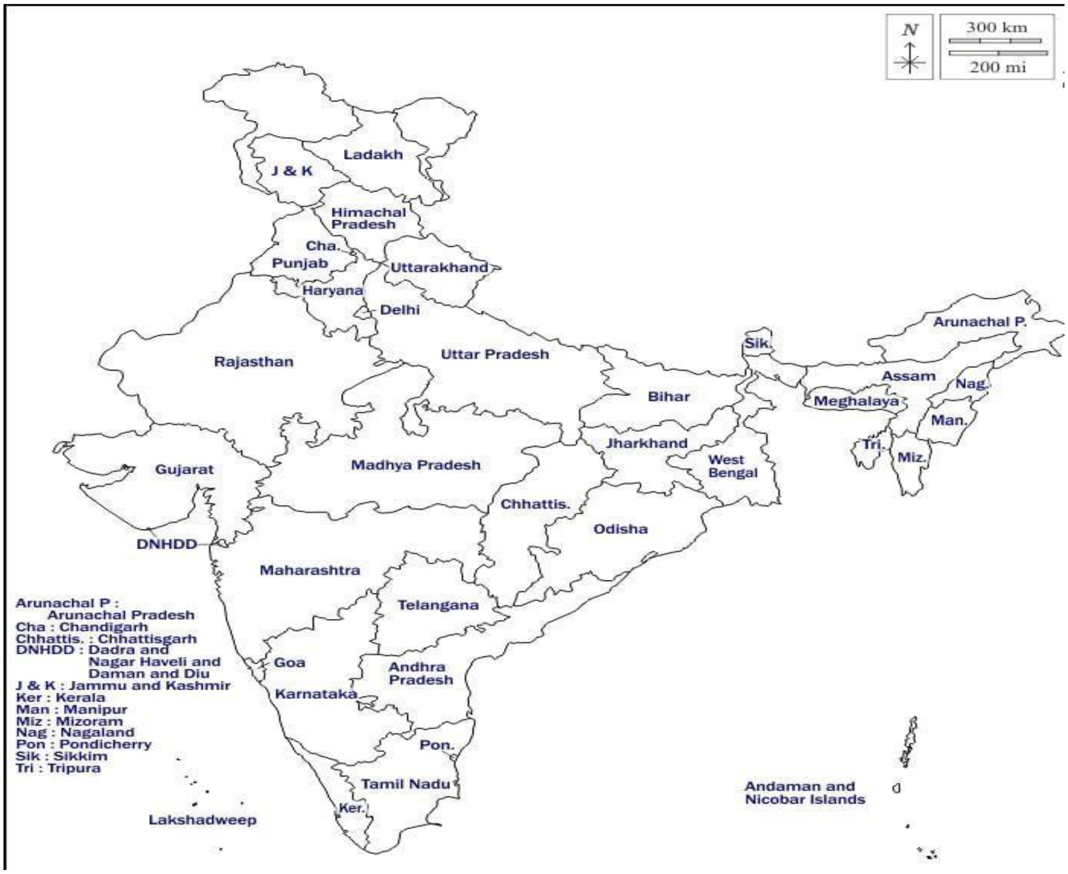
In this study, an effort has been made to evaluate the drinking water quality in both urban and rural areas of Ratia Block, located in Fatehabad District, Haryana. A total of 32 water samples were collected from various villages within the block and analyzed for their physico-chemical properties. These results were compared with the standards set by WHO, ICMR, and BIS for drinking water quality. The parameters tested included pH, total dissolved solids, alkalinity, hardness, chloride, fluoride, calcium, magnesium, among others. The findings indicated that certain parameters such as fluoride, total dissolved solids, hardness, and magnesium exceeded the recommended and permissible limits for safe drinking water. The data suggests significant variation in water quality across different villages in Ratia Block. To ensure safe drinking water for all residents, it is crucial to implement targeted water management and treatment interventions based on these findings.

Introduction

Water is essential for human life, yet a significant portion of the population lacks access to safe drinking water. According to a World Health Organization report, about 37% of urban residents and 64% of rural individuals in India face this issue Freshwater is crucial not just for survival but also for industrial use, food production, waste management, and cultural practices .Groundwater, a vital source of freshwater, has been increasingly contaminated due to human activities, leading to a rise in waterborne diseases. This highlights the importance of understanding water chemistry, which encompasses the composition, sources, and interactions within aquatic environments. Water quality is directly linked to human well-being.India is among the most populous nations, with a population of approximately 1.27 billion as of January 28, 2017. About 31% of this population resides in urban areas. According to the 2011 Census, Haryana, located in northern India, has a population of around 3.09 crore, making it the 18th most populated state or union territory in the country. Established on November 1, 1966, after the linguistic reorganization of Punjab, Haryana is one of India's wealthiest states and ranks 21st in land area.In Haryana, the Fatehabad district contains the Ratia block, where we will analyze the drinking water quality in villages. Ratia, a municipal committee city in Fatehabad district, has a population of 37,152 and is divided into 17 wards.The states of Punjab and Haryana, located in the north-western region of India, are known for their agricultural advancements but are currently facing severe groundwater depletion. Historically connected, Punjab and Haryana share a complex past. In 1858, following the First War of Indian Independence, the British merged Haryana with the Punjab province as a form of political retribution.[1]For the following century, Haryana remained politically marginalized. In 1966, the Indian Parliament passed the Punjab Reorganization Act, dividing Punjab into two states: Punjab and Haryana. Certain territories that had previously been part of Punjab were incorporated into the newly formed state of Haryana.[2]This study analyzed groundwater from 25 tube wells in Ambala Cantonment, comparing its physicochemical parameters with WHO and BIS standards. The water is generally safe for drinking, though moderately hard, and further research is recommended to explore sources of contamination and improve water quality.[3]The pond water's low dissolved oxygen (DO) level, likely due to algae and temperature variations, is affecting aquatic life. Solutions include artificial aeration, redirecting rainwater, groundwater recharge, controlling untreated waste discharge, and installing low-cost treatment systems for water purification.[4]In 2011, tap water emerged as the dominant drinking water source for rural households in Haryana, primarily due to the Indira Gandhi Drinking Water Scheme, while the use of handpumps and wells declined, particularly in districts like Mewat, Jind, and Bhiwani.[5]Tap water samples from Gurgaon met BIS/WHO chemical standards, but 30.7% were unsafe for drinking due to coliform contamination.[6]A survey of groundwater samples from two blocks in Jind district, Haryana, found that 93% of the water was too hard for drinking and required treatment.[7]The groundwater in the study area was found to be mostly alkaline, with varying levels of salinity, hardness, and fluoride content, exceeding permissible limits in many locations.[8]The uranium concentration in drinking water samples from Sonipat and Panipat districts exceeded permissible limits in several areas, with higher levels observed in samples with elevated TDS, necessitating treatment to mitigate health risks.[9]The study found that 30.9% of groundwater samples exceeded WHO limits, with high TDS increasing uranium solubility, posing chemical toxicity risks in 23.5% of samples, and while cancer risks remained within safe limits, remediation is needed for sites with elevated uranium levels.[10]Pesticide residues were found in groundwater and surface water samples, with contamination levels varying across districts and exceeding safety limits in a significant number of cases.[11]Haryana faces significant challenges in water supply due to declining levels and contamination, particularly in rural areas, necessitating strategic planning to address disparities and ensure safe drinking water.[12]The study highlights severe water quality and scarcity issues in Jhajjar district, where reliance on contaminated groundwater for domestic and irrigation use poses significant health risks, necessitating remedial measures such as water treatment, dilution, and conservation training.[13]The study indicates that fluoride pollution in Siwani block's groundwater has reached critical levels due to various geological and anthropogenic factors, rendering it unsuitable for irrigation in many areas.[14]Groundwater in Ambala, Haryana, exhibits high alkalinity and fluoride levels due to poor drainage and agricultural activities, raising concerns for health and water quality despite being a primary drinking source.[15]The study reveals that central Haryana faces high fluoride levels in underground water, affected by depth, location, and seasonal changes, necessitating sustainable defluoridation methods and improved dietary habits to protect vulnerable populations from fluorosis.[16]The analysis of underground water samples in Ambala District, Haryana, reveals concerning fluoride concentrations exceeding permissible limits, necessitating chemical treatment before the water can be deemed safe for drinking.[17]The study concludes that drinking water from various sources falls within an acceptable category, with certainty levels between 44% and 100%, indicating it can be safely used for consumption if no alternative sources are available.[18]The study reveals that while certain water samples from Assam exhibit high levels of Total Dissolved Solids (TDS) and Dissolved Oxygen (DO), indicating possible bacterial contamination, there is no significant uniformity in water quality parameters to suggest hospitals influence the surrounding drinking water quality.[19]The study reveals that while certain water samples from Assam exhibit high levels of Total Dissolved Solids (TDS) and Dissolved Oxygen (DO), indicating possible bacterial contamination, there is no significant uniformity in water quality parameters to suggest hospitals influence the surrounding drinking water quality.[20]The study found that the pH of industrial effluents consistently remained high across all seasons, exceeding the desirable limits for drinking water.[21]Mahendergarh district in Haryana faces high fluoride levels in underground water, especially in the Narnaul block, while agriculture forms the core of its economy in this semiarid, industrial-free zone. This study emphasizes the need for government and NGO initiatives to address fluoride contamination in drinking water.[22] Access to safe drinking water in rural India is severely hampered by declining water sources and pollution, leading to health issues, as highlighted by disparities in tap water availability across villages in Haryana.[23] An analysis of 54 water samples from Chandigarh and its surrounding areas revealed negligible levels of pesticides, highlighting the effectiveness of Integrated Pest Management and government initiatives promoting bio-pesticides, while recommending further preventive measures for water quality improvement, including sewage treatment and strict regulation of industrial effluents.[24] This study develops traditional and fuzzy GIS-based Water Quality Indices to evaluate groundwater quality in Gurugram, revealing that while central groundwater is mostly suitable for drinking, areas in the northeast, southwest, and west are not, and it highlights contamination sources and suggests further research using machine learning for future assessments.[25] Water is crucial for human survival, yet many people in India lack access to safe drinking water, with the World Health Organization noting that 37% of urban residents and 64% of rural individuals are affected. Groundwater, a vital freshwater source, is increasingly contaminated, resulting in waterborne diseases and emphasizing the need for understanding water chemistry. Haryana, a populous and wealthy state, faces significant challenges related to groundwater quality, particularly in the Ratia block, where water from tube wells is generally safe but moderately hard. Various studies indicate issues like high levels of total dissolved solids (TDS), coliform contamination, and excessive fluoride and uranium concentrations in drinking water. These challenges are compounded by agricultural practices, leading to severe contamination. Solutions include improving water treatment methods, enhancing rainwater management, and conducting awareness programs. The overall findings highlight the urgent need for remedial measures and sustainable practices to ensure safe drinking water for Haryana's population, especially in rural areas, where reliance on contaminated sources poses health risks.

Study Area –

In April 2023, a total of 32 water samples were collected. These samples were carefully gathered using pre-treated, labeled 1.5-liter plastic bottles. The bottles were immediately preserved and analyzed according to the standard protocols outlined by the American Public Health Association (APHA, 2005). Before collection, each bottle was thoroughly cleaned by washing with a 2% nitric acid solution, followed by three rinses with distilled water to ensure proper sterilization. The sampling locations, referred to as stations, were labeled from R1 to R32.Ratia Block is located in Fatehabad District, Haryana, primarily in rural areas. Agriculture is the main occupation of the residents, with major crops including wheat, rice, and mustard. Situated on the banks of the Ghaggar River, about 23 km north of Fatehabad city, Ratia lies at a latitude of approximately 29.68° N and a longitude of 75.57° E. According to the 2011 Census, the population of Ratia is 37,852, with around 58% living in rural areas. The block has a semi-arid climate with hot summers and cool winters, and the local economy relies on both agriculture and small-scale industries.Due to its location, Ratia faces challenges in water quality, making studies on water safety and management essential for sustainable resource use.The water samples were stored in polypropylene containers, thoroughly cleaned with a 2% nitric acid solution and rinsed with double-distilled water. Reagent-grade Qualigens Excela R acids and high-purity indicators were used in the chemical analysis. Heavy metal concentrations were measured using an Atomic Absorption Spectrophotometer (PerkinElmer USA, model 3100). pH, total dissolved solids (TDS), and conductivity were measured with dedicated meters. Total alkalinity (TA) was determined by titration using hydrochloric acid, while total hardness (TH) and calcium (Ca^{2+}) content were measured through titration with disodium ethylenediaminetetraacetate (Na_2EDTA). Magnesium (Mg^{2+}) content was derived by subtracting the calcium value from total hardness. Chloride (Cl^-) concentration was determined using silver nitrate ($AgNO_3$), and sulphate (SO_4^{2-}) levels were analyzed spectrophotometrically. Dissolved oxygen (DO) and biological oxygen demand (BOD) were evaluated through titration methods.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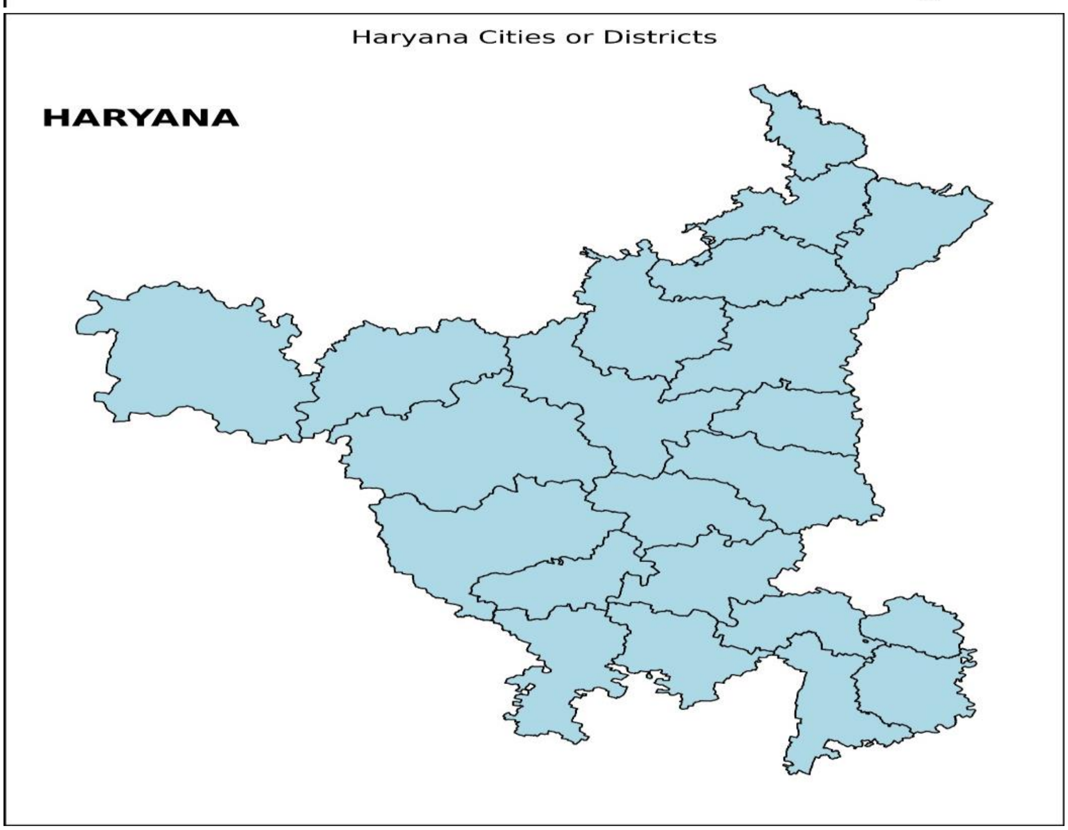
Haryana Cities or Districts
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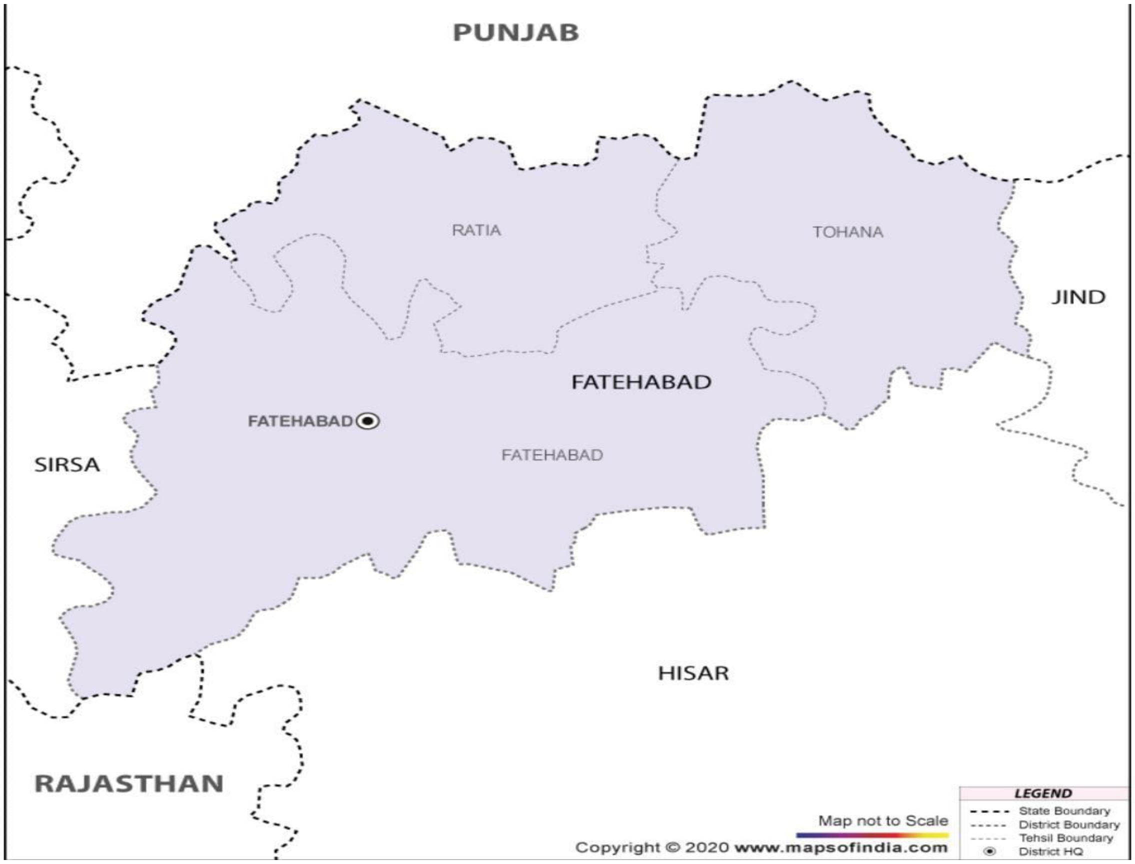
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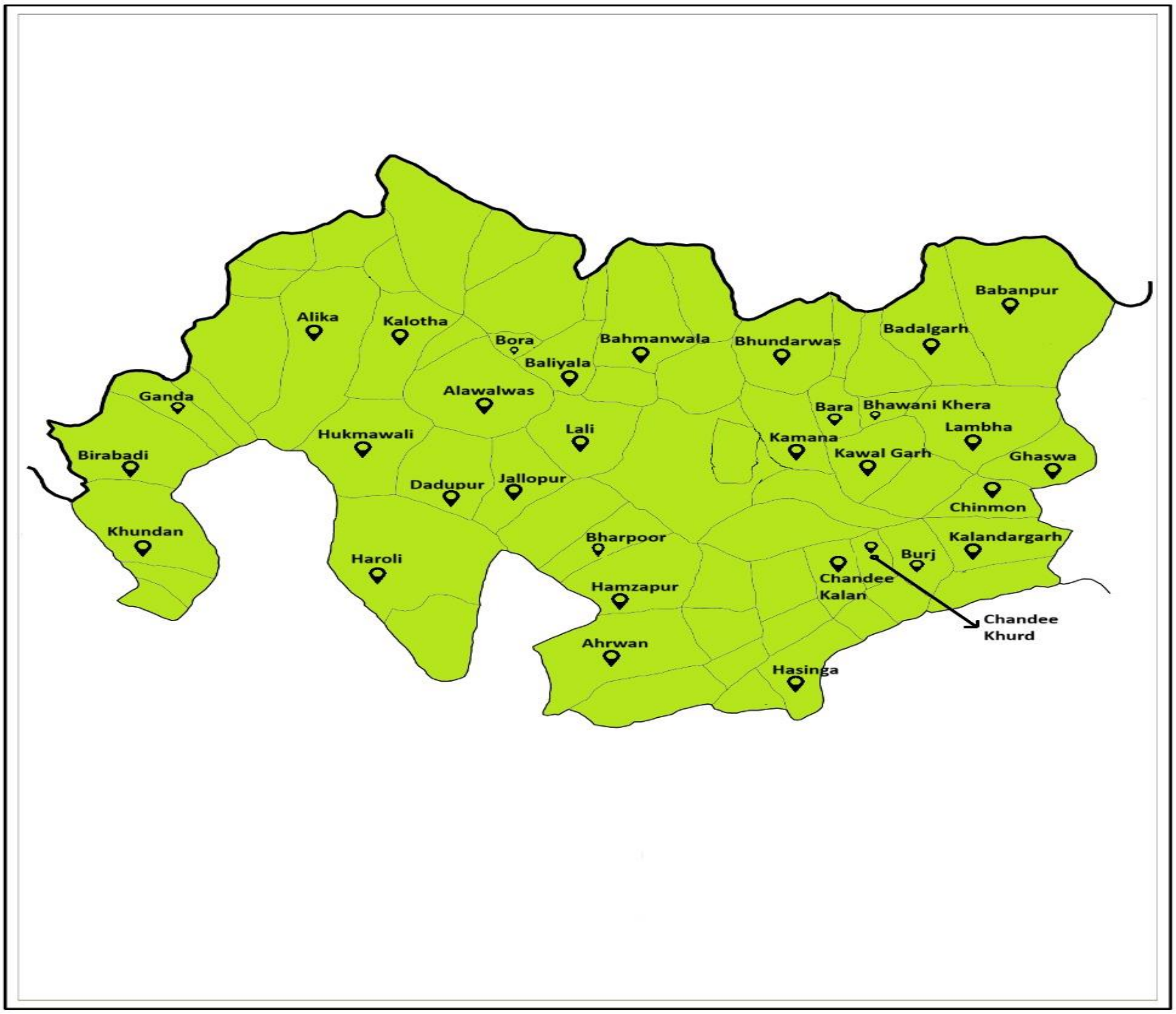


Map of villages of Ratia block

Analysis of water of Ratia block -

S. No.	Sampeling Site	Sources	Code
1	Ahrwan	Handpump	R_1
2	Alawalwas	Supply	R_2
3	Alika	Handpump	R_3
4	Babanpur	Handpump	R_4

5	Badalgarh	Supply	R_5
6	Bahmanwala	Supply	R_6
7	Baliyala	Handpump	R_7
8	Bara	Supply	R_8
9	Bharpoor	Supply	R_9
10	Bhawanikhera	Handpump	R_{10}
11	Bundarwas	Supply	R_{11}
12	birabadi	Handpump	R_{12}
13	Bora	Supply	R_{13}
14	Burj	Supply	R_{14}
15	Chandekalan	Handpump	R_{15}
16	Chandekhurd	Supply	R16
17	Chinmon	Supply	R17
18	Dadupur	Handpump	R18
19	Ganda	Supply	R19
20	Ghaswa	Supply	R20
21	Hamzapur	Handpump	R21
22	Haroli	Supply	R22
23	Hasinga	Handpump	R23
24	Hukmawali	Handpump	R24
25	Jallopur	Supply	R25
26	kalandargarh	Supply	R26
27	kalotha	Supply	R27
28	kamana	Handpump	R28

29	Kawal Garh	Supply	R29
30	Khundan	Supply	R30
31	Lali	Supply	R31
32	Lambha	Handpump	R32

Analytic methods, BIS, ICMR, & WHO parameters for drinking water

			Prescribed by				
			BIS(IS 10500-91)		**ICMR**		**WHO**
S. No.	**Parameter**	**Method employed**	**Desirable limit**	**Max. permissible limit**	**Desirable limit**	**Max. permissible limits**	**WHO**
1	Ph	Digital pH meter	6.5-8.5	No relaxation	7.0-8.5	6.5-9.2	6.5-8.5
2	TDS(mg/L)	Digital TDS Meter	500	2000	500	1500-3000	1000
3	TH(mg/L)	Titrimetric (EDTA)	300	600	300	600	500
4	Ca^{+2}(mg/L)	Titrimetric (EDTA)	75	200	75	200	200
5	Mg^{+2}(mg/L)	Titrimetric (EDTA)	30	100	50	-	50
6	Cl^{-}(mg/L)	Titrimetric ($AgNO_3$)	250	1000	200	1000	200
7	Turbidity(mg/L)	Nephelometry	1	5	1	5	5
8	So_4^{-2}(mg/L)	Spectrometric Method	200	400	200	400	400
9	No^{3-}(mg/L)	Spectrometric Method	45	100	20	100	10
10	Po_4^{-3}(mg/L)	Spectrometric Method	-	-	-	-	-
11	Na/K(mg/L)	Flame photometer	-	-	-	-	-
12	Fe^{+3}(mg/L)	Spectrometric Method	0.3	1.0	0.1	1.0	1.0
13	F^{-}(mg/L)	APHA-Method	1.0	1.5	1	1.5	1.5

Code	Longitude lattitude	Temp. ‘c	pH	EC ds	TDS mg/L	TH mg/L	Ca^{+} mg/L	Mg^{2+} mg/L	TA mg/L	Cl- mg/L	F- mg/L	Na+ mg/L	K^{+} mg/L	So_4^{2-} mg/L	Po_4 mg
R-1	29.6821° N, 75.5919° E	31.1	7.61	0.602	655	412	95	45	298	123	2.9	198	8	37	4
R-2	29.6210° N, 75.4844° E	30.2	7.20	0.601	853	560	52	62	167	143	2.5	220	4	97	5
R-3	29.6858° N, 75.6636° E	29.9	7.40	1.306	1707	660	93	78	267	156	2.5	260	21	84	8
R-4	29.7012° N, 75.5338° E	27.8	7.60	1.650	676	310	78	86	245	267	2.0	301	3	69	3
R-5	29.6982° N, 75.6243° E	28.5	7.53	1.924	893	465	85	93	235	178	1.8	212	7	83	1
R-6	29.6935° N, 75.5501° E	29.7	7.65	1.762	1402	595	138	37	345	121	2.8	376	72	93	1

R-7	29.6343° N, 75.4607° E	27.3	8.72	2.353	1228	938	127	86	480	478	2.8	456	30	76	0
R-8	29.6786° N, 75.5132° E	28.7	8.61	1.895	1452	565	125	40	250	498	3.8	210	90	159	2
R-9	29.7191° N, 75.6188° E	31.0	7.32	1.463	903	620	125	85	320	245	0.9	546	28	173	4
R-10	29.6709° N, 75.4973° E	32.8	7.78	1.671	1345	460	82	99	350	278	0.7	153	27	124	3
R-11	29.7139° N, 75.5778° E	30.3	7.15	2.931	1395	1200	234	119	440	221	1.9	236	46	175	4
R-12	29.6503° N, 75.6128° E	31.8	7.52	2.305	1484	810	192	150	420	198	1.0	164	39	160	1
R-13	29.6503° N, 75.6128° E	27.7	7.86	1.324	1795	685	99	78	375	232	1.8	242	66	186	3
R-14	29.7110° N, 75.5309° E	27.0	7.45	1.129	697	435	94	44	285	230	1.7	226	39	180	2

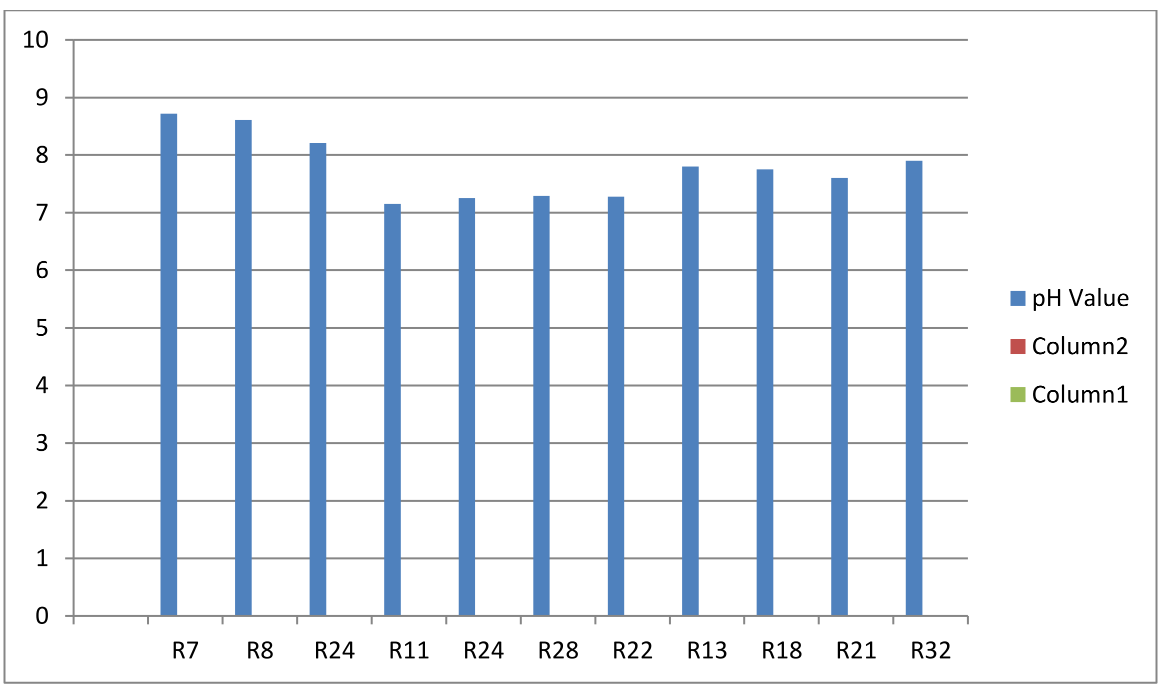
R-15	29.6764° N, 75.5792° E	28.3	7.96	1.562	972	485	88	63	350	450	1.4	257	7	61	1	
R-16	29.6529° N, 75.5823° E	28.5	7.44	1.435	897	460	62	45	250	565	1.7	157	9	155	0	
R-17	29.6898° N, 75.5887° E	31.1	7.64	0.902	1675	452	65	48	242	461	2.9	199	8	147	2	18
R-18	29.6734° N, 75.5158° E	32.2	7.93	0.781	1630	460	78	47	129	233	2.5	221	4	167	5	14
R-19	29.6263° N, 75.4768° E	30.9	7.36	1.106	1807	670	193	79	295	565	2.5	363	21	134	3	19
R-20	29.6308° N, 75.5867° E	28.8	7.35	1.341	1579	710	178	74	270	285	2.6	302	8	159	1	31
R-21	29.6849° N, 75.5541° E	29.5	7.93	0.677	1897	335	88	46	280	450	2.8	217	7	93	2	17
R-22	29.7072° N, 75.6214° E	28.7	7.25	1.782	1292	765	166	61	235	345	2.7	378	22	73	0	17

R-23	29.6380° N, 75.5252° E	29.3	7.62	2.673	1228	268	157	116	310	473	1.6	459	40	146	2	34
R-24	29.6756° N, 75.5624° E	30.7	8.21	1.895	852	835	135	110	410	427	3.9	411	30	159	3	39
R-25	29.6544° N, 75.4869° E	31.0	7.42	1.452	906	410	144	67	320	365	0.7	348	38	163	6	34
R-26	29.6650° N, 75.5522° E	33.8	7.78	1.766	856	580	88	75	410	170	0.8	263	27	124	7	13
R-27	29.7120° N, 75.6393° E	31.3	7.31	2.845	895	857	224	75	480	110	1.3	419	36	315	2	18
R-28	29.6824° N, 75.5442° E	30.8	7.22	2.440	244	910	192	110	447	250	1.6	312	39	280	1	23
R-29	29.7046° N, 75.6480° E	29.3	7.41	1.644	675	905	119	46	465	370	1.9	331	16	256	1	21
R-30	29.6801° N, 75.6257° E	28.0	7.57	1.979	1726	989	84	73	485	340	3.5	427	89	190	2	12
R-31	29.6980° N,	27.3	7.75	1.566	1759	265	72	62	440	330	2.5	352	7	51	2	32

	75.5534° E															
R-32	29.6665° N, 75.6178° E	28.5	7.86	1.785	1230	940	93	47	450	175	2.5	258	6	75	1	22

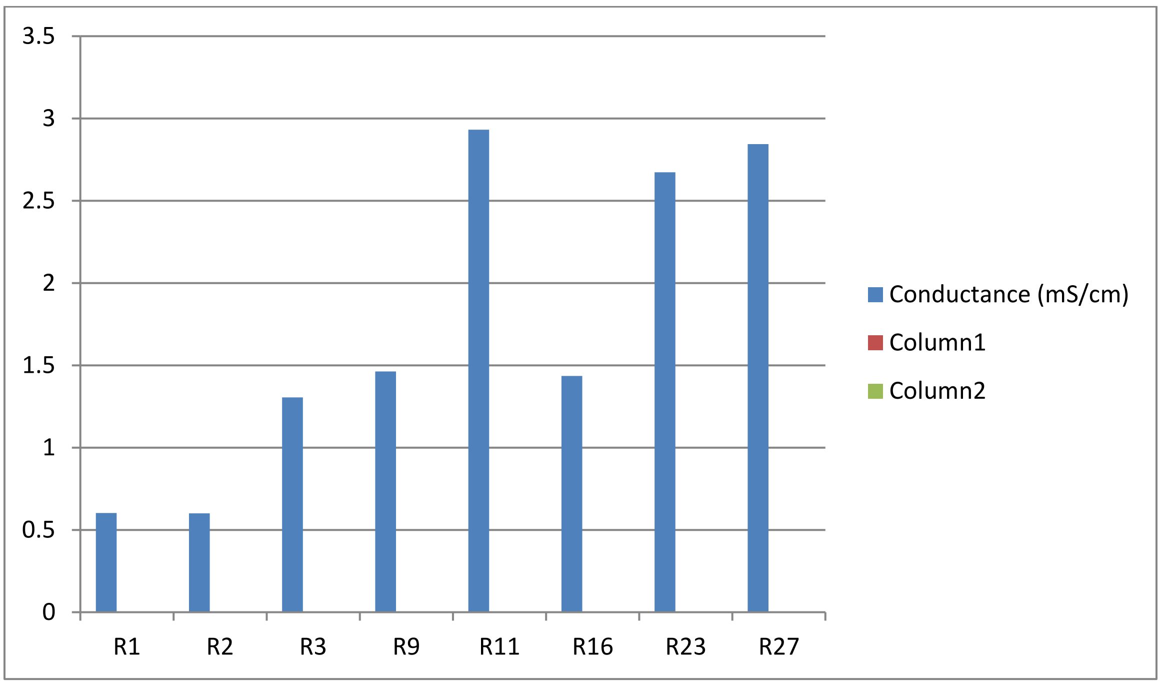
pH –

The pH values of water samples from 32 villages in Ratia block range from 7.15 to 8.72, with most samples falling within a neutral to slightly alkaline range. The highest pH value, 8.72 (R7), indicates the most alkaline water sample, followed closely by R8 at 8.61 and R24 at 8.21. On the lower end, R11 has the lowest pH at 7.15, while R2, R28, and R22 also show slightly acidic values below 7.3. Most values, including R13, R18, R21, and R32, lie between 7.5 and 8.0, reflecting mildly alkaline water, which is typical for many rural water sources. This suggests that water quality in the area is generally stable but with a few variations, especially in villages with higher alkalinity.



Electrical conductance –

The electrical conductance values of water samples of Ratia block show a wide range of readings, indicating variability in water quality across the region. The lowest conductance is recorded at R2 (0.601) and R1 (0.602), while the highest is seen at R11 (2.931), suggesting significant differences in mineral content or salinity between different villages. Most values fall between 1.0 and 2.0, such as R3 (1.306), R9 (1.463), and R16 (1.435), indicating moderate conductance. However, there are several readings above 2.0, including R27 (2.845) and R23 (2.673), which point to higher mineral content or potential pollution in certain areas. These variations could be due to local geological factors or human activity, with certain areas potentially facing higher water quality concerns.

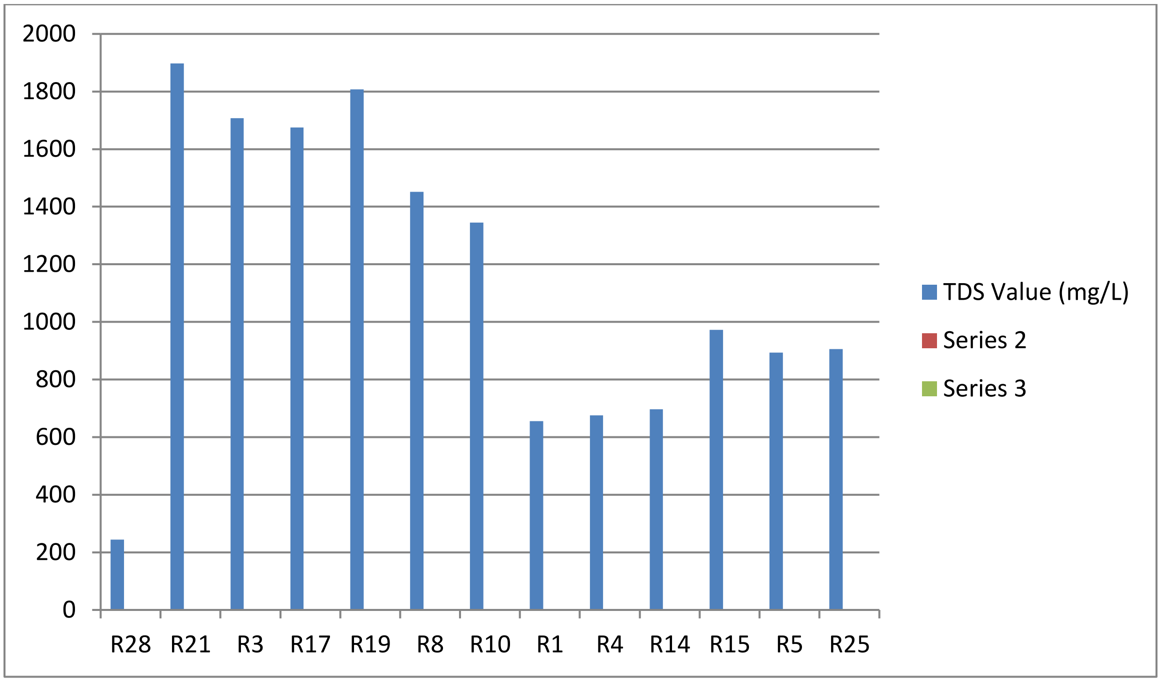


TDS

The TDS (Total Dissolved Solids) values of water samples from of Ratia Block show considerable variation. The lowest value is recorded at R28 with 244, indicating relatively low mineral content, which might reflect softer water. On the other hand, the highest TDS value is found in R21, reaching 1897, which may indicate hard water with a high concentration of dissolved minerals.

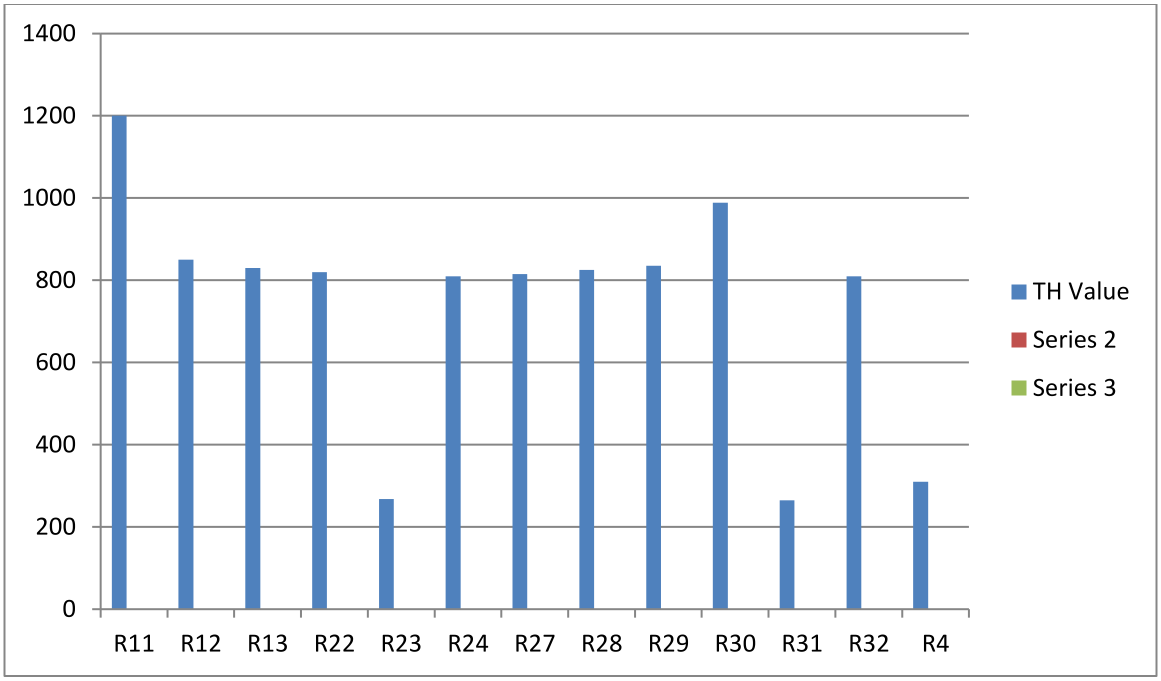
Several villages have moderately high TDS levels, such as R3 (1707), R17 (1675), and R19 (1807), reflecting water with substantial mineral content that could affect its taste and usability. Values ranging between 1200 and 1500, such as R8 (1452) and R10 (1345), suggest higher-than-ideal levels for drinking water but are still somewhat manageable. Meanwhile, samples like R1 (655), R4 (676), and R14 (697) represent the lower end, indicating water with fewer dissolved solids and likely better quality for general use.

In the middle range, values like R15 (972), R5 (893), and R25 (906) reflect more acceptable water quality but still suggest a presence of minerals that may require further treatment for optimal consumption. Overall, the TDS readings indicate a wide range of water quality across the villages, with some areas potentially needing water purification or treatment for safe drinking and daily use.



Total Hardness –

The Total Hardness (TH) values of water samples of Ratia Block show a significant range and variation. The lowest TH value recorded is 265 (R31), while the highest is 1200 (R11). Most samples fall within the moderate to high hardness range, with values between 310 (R4) and 989 (R30). Notably, TH values above 800 (R12, R13, R22, R24, R27, R28, R29, R30, R32) indicate a higher degree of hardness, suggesting that water in several villages may have elevated levels of dissolved minerals. The highest TH value of 1200 (R11) stands out as exceptionally high, possibly pointing to severe water hardness issues in that specific area. In contrast, the lower end of the scale, such as 265 (R31) and 268 (R23), reflects relatively softer water. Overall, the data illustrates considerable variability in water hardness across the villages, which may impact water quality and usage differently in each locality.



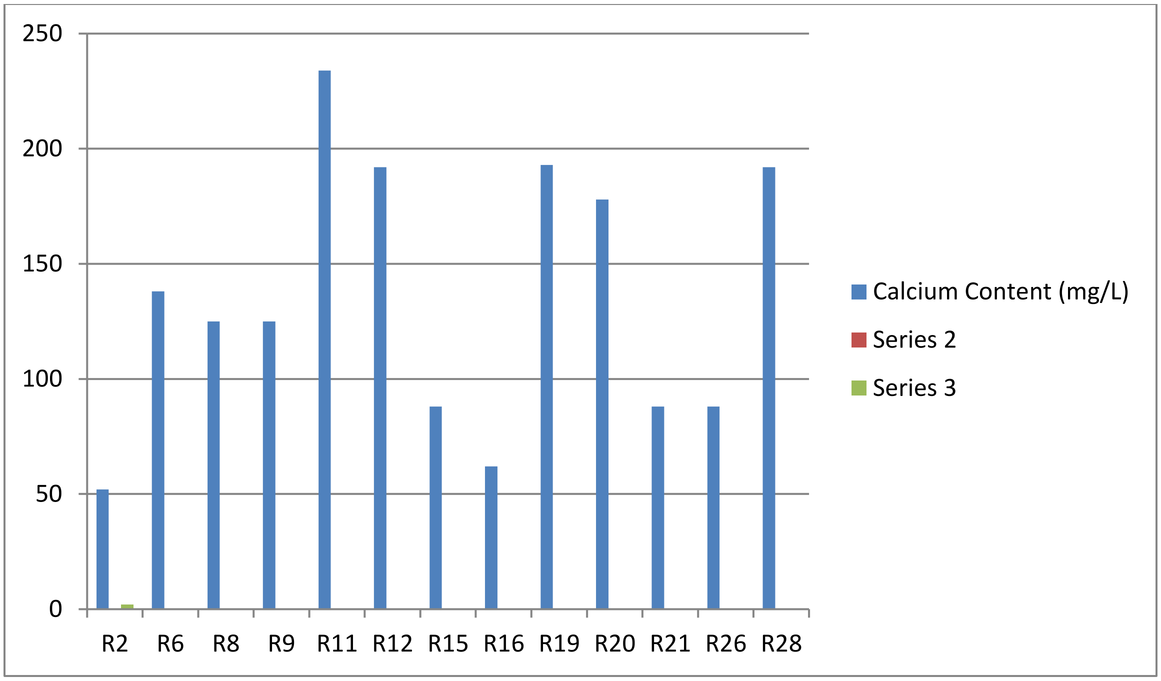
Calcium –

The calcium content in the water samples of Ratia Block exhibits a significant range, reflecting varied mineralization across the region. The values span from a low of 52 (R2) to a high of 234 (R11), indicating a diverse distribution of calcium concentration in the water sources. Notably, R11 stands out with an exceptionally high calcium value of 234, which is more than four times higher than the lowest recorded value, R2.

The majority of the samples show calcium concentrations between 62 (R16) and 193 (R19), with a moderate clustering around values like 88 (R15, R21, R26), 125 (R8, R9), and 192 (R12, R28). This suggests that while some villages experience relatively high calcium levels, many others fall within a more standard range. The presence of several values around 88 indicates a common calcium concentration in the water, but there are also significant outliers with notably higher concentrations, such as R6 (138) and R20 (178).

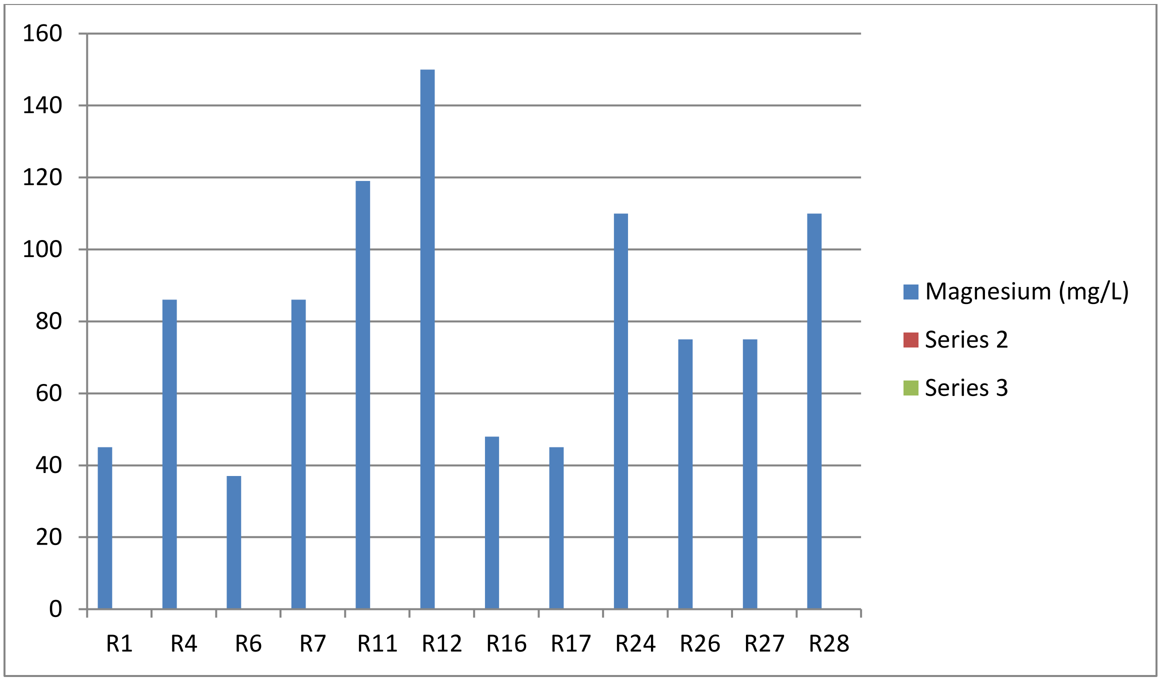
The variability in calcium levels could be attributed to geological differences in the region, which affect the mineral composition of groundwater. Areas with higher calcium levels might experience issues related to hardness in water, which can impact both domestic water use and the ecosystem. In contrast, lower calcium concentrations could imply softer water, which might be less likely to cause scaling and other related problems.

Overall, this range of calcium values underscores the need for targeted water quality management and potential treatment strategies tailored to the specific needs of each village within Ratia Block.



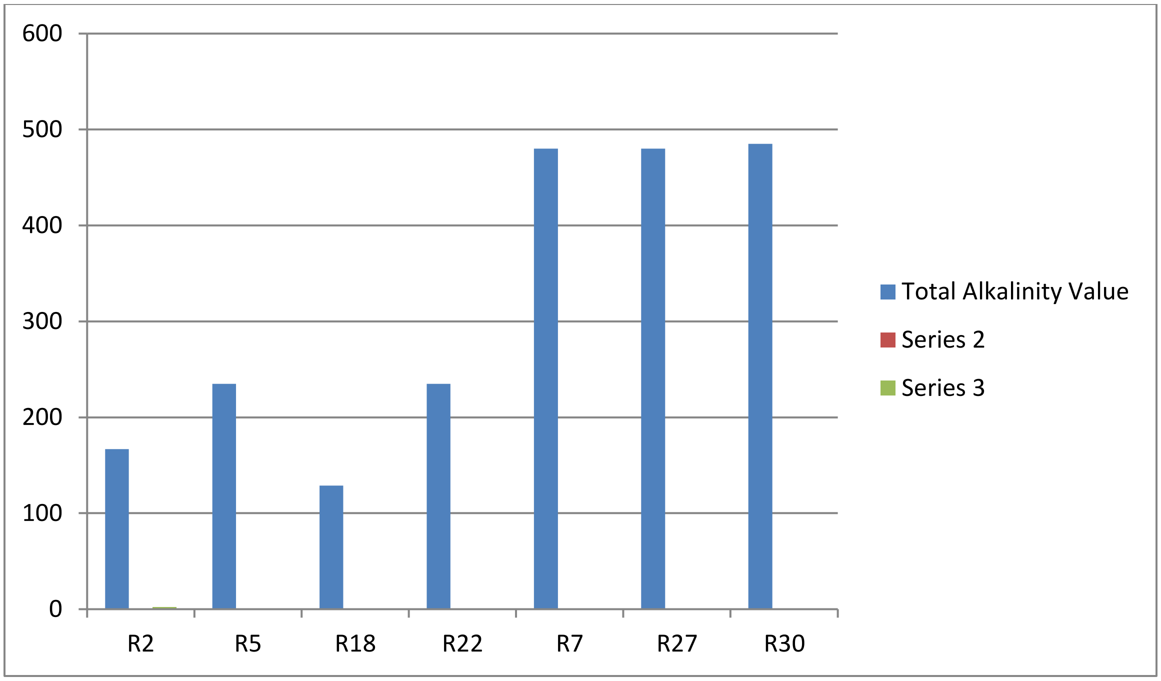
Magnesium –

The magnesium values of water samples of Ratia Block show a significant range of concentrations, indicating considerable variability in water quality across the region. The values span from a low of 37 mg/L (R6) to a high of 150 mg/L (R12). Most values cluster between 45 mg/L and 93 mg/L, suggesting that many villages experience moderately high magnesium levels. For instance, R1, R16, and R17 all have values around 45-48 mg/L, which is on the lower end of the spectrum. On the other hand, villages like R11 and R12 have much higher levels at 119 mg/L and 150 mg/L, respectively, highlighting areas with potentially more concerning mineral concentrations. Notably, some villages, such as R7 and R4, have identical values of 86 mg/L, indicating consistent water quality in these locations. The data also shows multiple instances of 75 mg/L (R26 and R27) and 110 mg/L (R24 and R28), pointing to common mid-range values across several villages. Overall, this variability suggests the need for further investigation into the sources of magnesium and potential impacts on local water usage and health.



Total Alkalinity –

The total alkalinity values of water samples from of villages in Ratia Block reveal a notable range and variation. The lowest recorded value is 129 (R18), indicating a relatively low alkalinity level in that specific village. On the other end, the highest value is 485 (R30), suggesting very high alkalinity in that particular sample. Most villages exhibit total alkalinity values falling between 250 and 450, with several instances clustered around the higher end of this range. For instance, samples R7, R27, and R30 show high alkalinity levels of 480, 480, and 485 respectively. Conversely, several values are on the lower side, such as 167 (R2) and 235 (R5, R22), pointing to a relatively lower alkalinity in those areas. The variation in these values indicates differing water chemistry across the villages, which could be influenced by local geological conditions and environmental factors. This data underscores the need for targeted water management strategies to address the varying alkalinity levels and ensure safe and suitable water quality for all communities in the region.



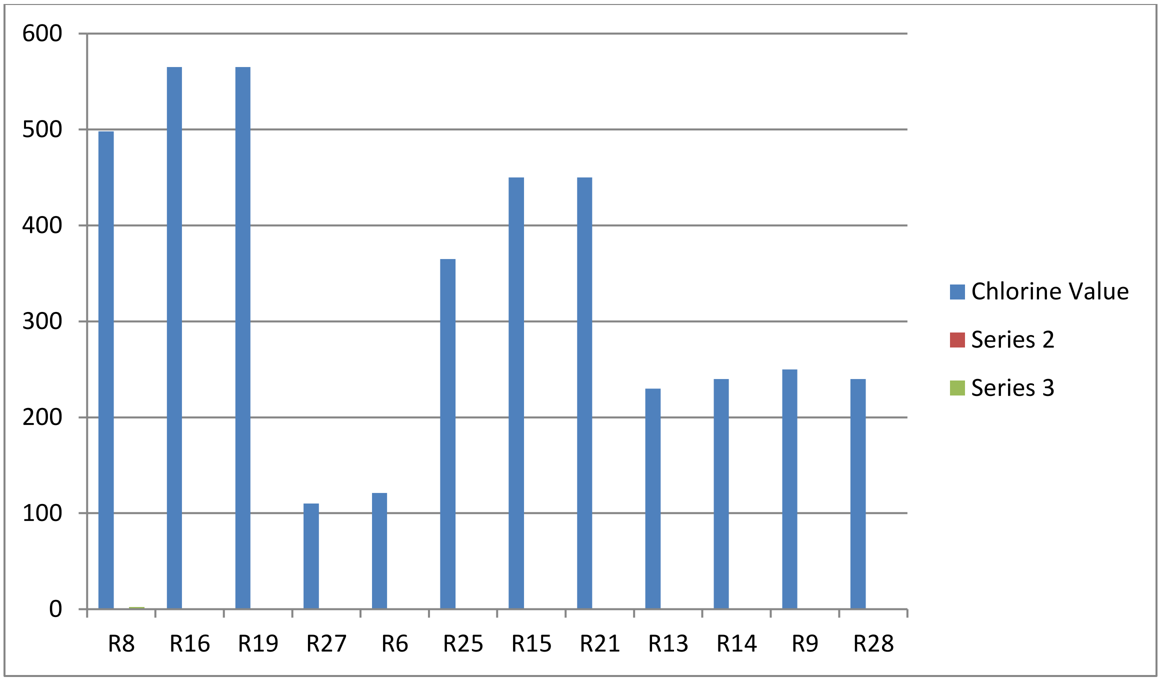
Chlorine -

The chlorine values of water samples of villages in Ratia Block exhibit a wide range of concentrations, highlighting significant variation in water quality across the region. The values range from a low of 110 (R27) to a high of 498 (R8). Notably, R8 stands out with the highest chlorine concentration, indicating potentially high levels of chlorine in the water, which could impact taste and safety if not managed properly. On the other end, R27 shows the lowest chlorine level, suggesting minimal chlorine treatment or natural variance.

A few villages, such as R16 and R19, both show a chlorine value of 565, which is notably high and could raise concerns about over-chlorination. In contrast, values like R6 (121) and R25 (365) fall within a mid-range, reflecting a more typical range of chlorine levels that may be deemed acceptable based on local standards and regulations.

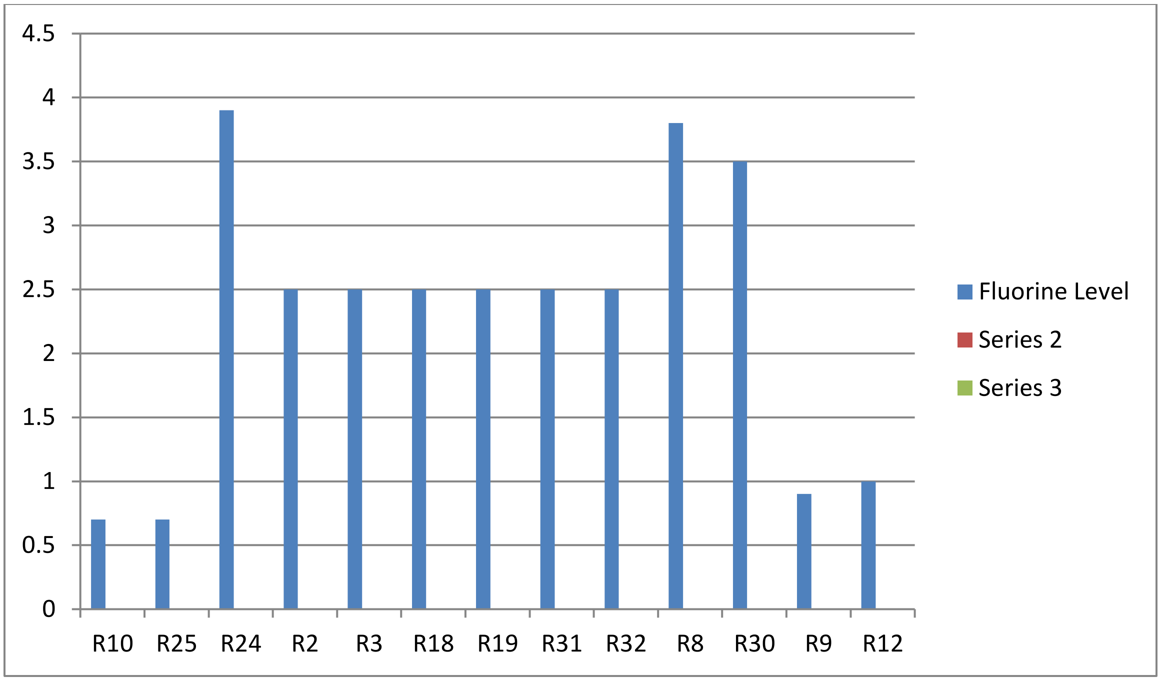
The data also reveals clusters of values, such as the concentration around 450 (R15, R21), which are consistent with each other and indicate a pattern in chlorine treatment practices in those villages. Thevalues around 230-250 (R13, R14, R9, R28) show moderate levels of chlorine, which could suggest a balanced approach to water treatment in these areas.

Overall, the wide range of chlorine values indicates diverse water treatment practices and potential differences in water quality management across the villages. Monitoring and managing these levels are crucial for ensuring safe and palatable drinking water for the residents of Ratia Block.



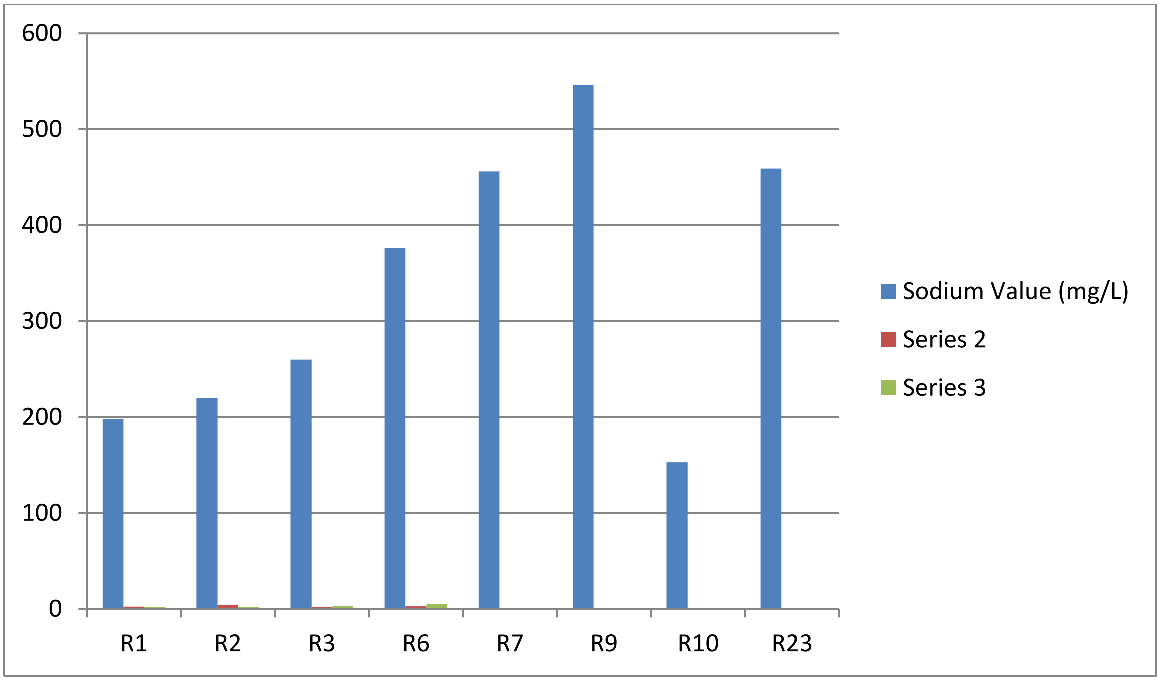
Fluorine –

The fluorine levels in the water samples of villages in Ratia Block exhibit a significant range of values, indicating varied fluorine concentrations across the region. The lowest recorded value is 0.7 (R10 and R25), and the highest is 3.9 (R24). Most samples fall within the range of 1.7 to 2.9, with values such as 2.5 (R2, R3, R18, R19, R31, R32) being quite common. A few outliers show notably high levels, such as R8 with 3.8 and R30 with 3.5, while some samples have lower levels, like R9 with 0.9 and R12 with 1.0. The variation in fluorine levels could be attributed to differences in local water sources or treatment processes, highlighting the need for consistent monitoring to ensure safe drinking water standards across all villages.



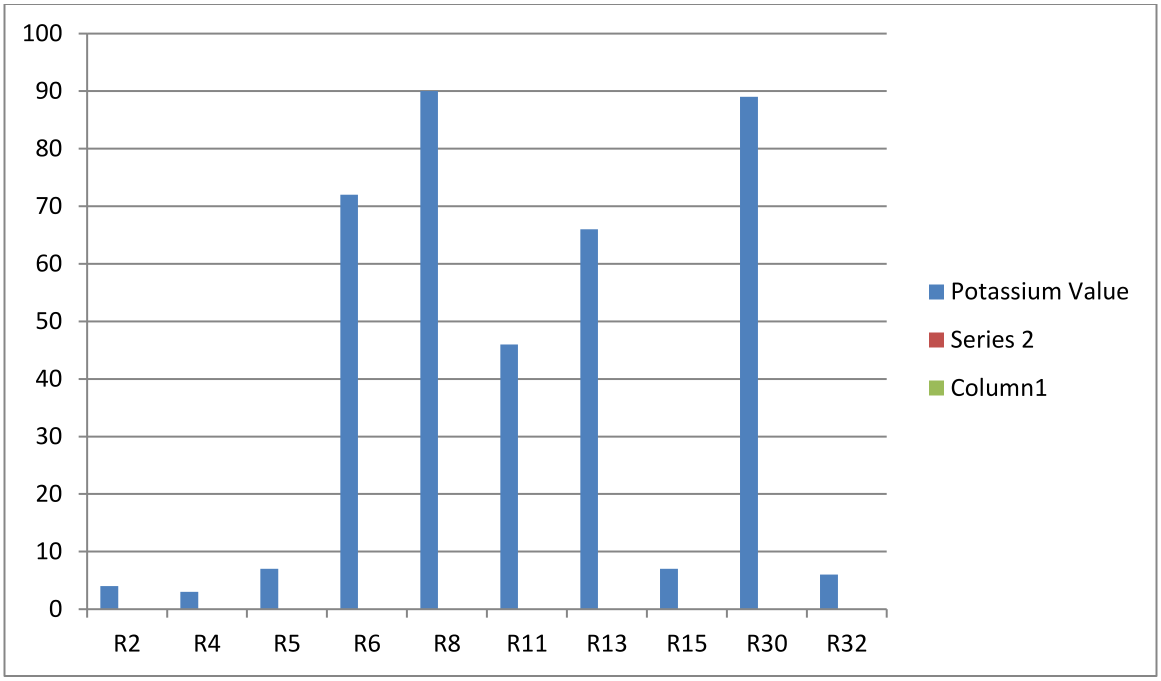
Sodium –

The sodium values from water samples across 32 villages in the Ratia Block exhibit considerable variability. The data ranges from a low of 153 mg/L (R10) to a high of 546 mg/L (R9). The majority of the values fall within a moderate range, with several samples clustered between 200 and 300 mg/L, such as R1 (198 mg/L), R2 (220 mg/L), and R3 (260 mg/L). However, there are significant peaks in the sodium levels, particularly in R6 (376 mg/L), R7 (456 mg/L), R9 (546 mg/L), and R23 (459 mg/L). On the other end of the spectrum, several samples have relatively lower sodium content, with R10 (153 mg/L) being the lowest. The variation in sodium levels suggests differences in water quality and potential contamination sources across the villages. High sodium concentrations could be indicative of saline intrusion or pollution, which may affect the suitability of water for drinking and agricultural purposes. Addressing these disparities will be essential for ensuring the health and safety of the communities in Ratia Block.



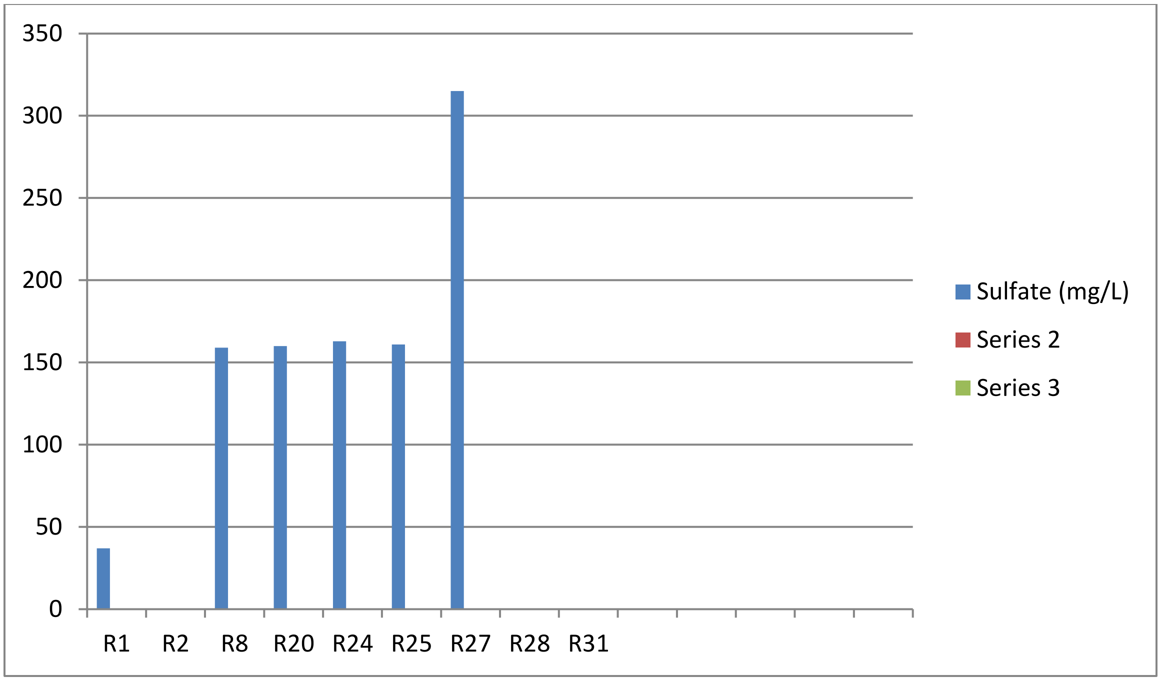
Potassium -

The potassium values of water samples of villages in Ratia Block exhibit significant variability. The lowest value recorded is R4 at 3, while the highest is R8 at 90. Most samples fall within a moderate range, with values such as R2 (4), R5 (7), and R15 (7) representing the lower end, and R11 (46), R13 (66), and R30 (89) indicating higher concentrations. Notably, several samples, including R6 (72) and R8 (90), show particularly high potassium levels, which might suggest localized factors affecting these concentrations. Conversely, values like R4 (3) and R32 (6) indicate very low potassium levels. Overall, the distribution highlights a wide range of potassium concentrations across the villages, pointing to potential differences in soil composition, water sources, or agricultural practices.



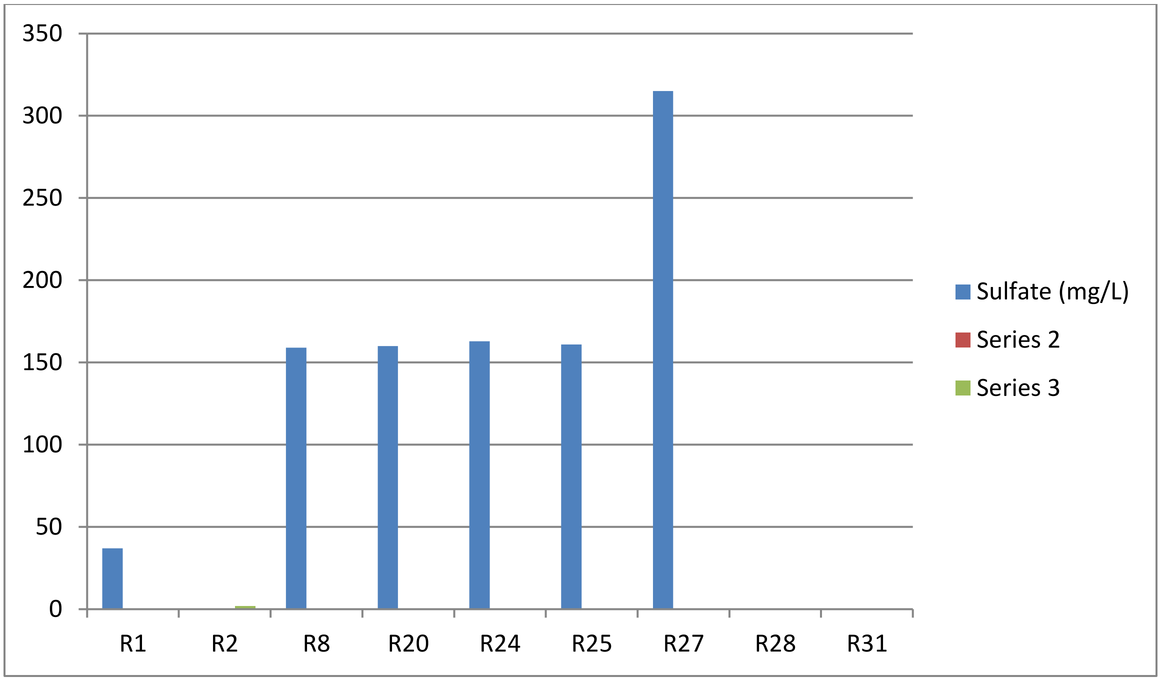
Sulfate –

The sulfate values in the water samples of villages of Ratia Block vary significantly, indicating a diverse range of water quality across the region. The lowest sulfate value recorded is R1 at 37 mg/L, while the highest is a striking R27 at 315 mg/L. The majority of the values fall between 60 and 200 mg/L, suggesting a moderate to high sulfate concentration in most villages. Notably, the samples labeled R8, R20, R24, and R25 show higher sulfate levels, ranging from 159 to 163 mg/L, which could indicate localized issues with water quality. Conversely, R1, R2, and R31 present lower sulfate values, suggesting better water quality in those areas. The extreme values, particularly R27 and R28, highlight potential concerns, as such high sulfate levels may impact water usability and health. Overall, the variability in sulfate concentrations underscores the need for targeted water quality management and treatment strategies across the Ratia Block.



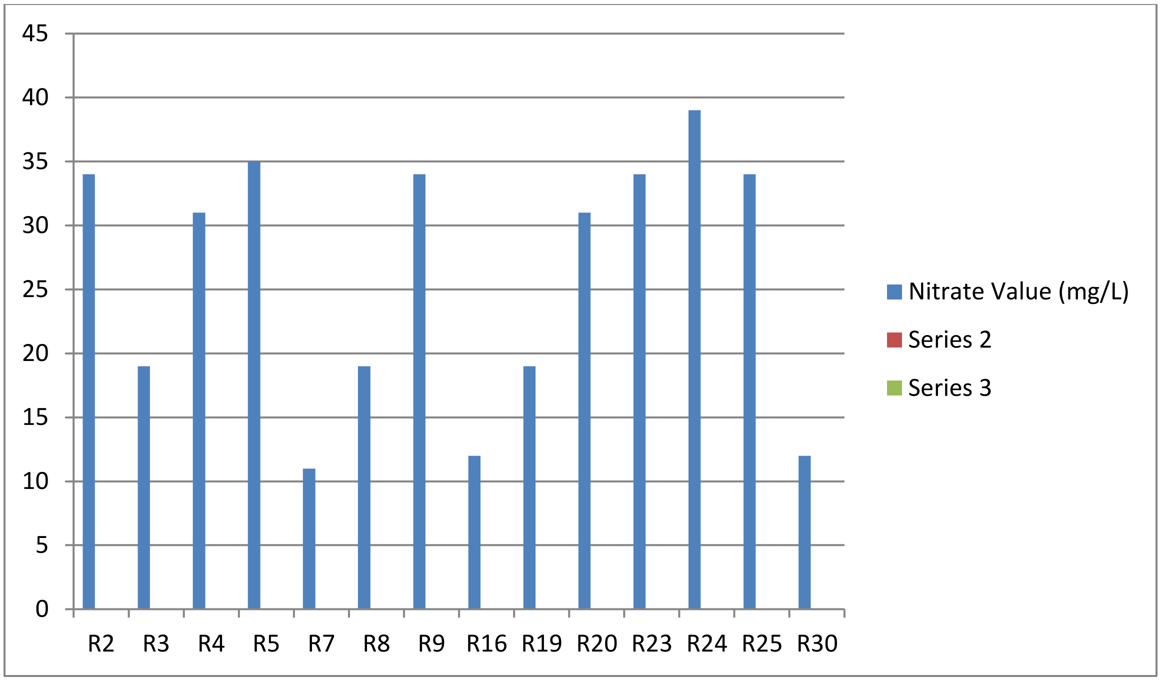
Phosphate –

The phosphate values of water samples of villages in Ratia Block reveal a significant range of concentrations. The highest phosphate level is observed in sample R3 with a value of 8, while the lowest is found in samples R7, R16, and R22, each with a value of 0. Most values cluster around the lower end of the scale, with 1 and 2 being the most frequent values, indicating that a substantial number of villages have relatively low phosphate concentrations. Specifically, 11 out of 32 samples have a phosphate value of 1, and 9 samples have a value of 2. On the other hand, higher concentrations, such as those in samples R3 (8), R25 (6), and R26 (7), suggest that some villages experience significantly elevated phosphate levels. This distribution highlights a notable disparity in phosphate concentrations across the villages, with a considerable portion having low values and a few exhibiting much higher levels, which may require further investigation to understand the underlying causes and implications for water quality and potential environmental impacts.



Nitrate –

Analyzing the nitrate values from water samples across the villages in Ratia Block reveals a range of concentrations. The values exhibit a considerable variation, from as low as 11 (R7) to as high as 39 (R24). The majority of samples fall between 18 and 34, with notable concentrations at 19 (R3, R8, R19), 34 (R2, R9, R23, R25), and 31 (R4, R20). Lower values are observed in samples R7 (11) and R16, R30 (12), while higher values include R5 (35) and R24 (39). The distribution suggests a diverse water quality landscape, with some villages experiencing relatively higher nitrate levels that could potentially impact water quality. It may be beneficial to further investigate the sources of higher nitrate concentrations and address any potential issues related to water safety in those areas.



Results –

The water quality across the 32 villages in Ratia Block shows considerable variability in various parameters. pH values range from 7.15 to 8.72, with most samples falling within a mildly alkaline range, indicating generally stable water chemistry. Electrical conductance varies significantly from 0.601 to 2.931 µS/cm, highlighting differences in mineral content or salinity, with some areas potentially facing higher quality concerns. TDS values span from 244 to 1897 mg/L, showing a wide range of mineral concentrations, which suggests that while some villages have softer water, others may require treatment for high mineral content.

Total hardness ranges from 265 to 1200 mg/L, indicating a mix of soft to very hard water, with several villages experiencing high hardness levels that may affect water usage. Calcium concentrations vary from 52 to 234 mg/L, with significant differences indicating diverse water mineralization. Magnesium levels also show a broad range from 37 to 150 mg/L, with some areas having notably high concentrations. Total alkalinity values span from 129 to 485 mg/L, reflecting differences in water chemistry that may be influenced by local geological conditions.

Chlorine levels range from 110 to 498 mg/L, with some villages showing high concentrations, suggesting variations in water treatment practices. Fluorine values vary from 0.7 to 3.9 mg/L, indicating differences in fluoride concentrations which could impact water safety and health.

Sodium levels range from 153 to 546 mg/L, with high concentrations suggesting potential pollution or saline intrusion in certain areas. Potassium values show a wide range from 3 to 90 mg/L, pointing to variations likely influenced by local factors. Sulfate concentrations vary from 37 to 315 mg/L, indicating diverse water quality across the villages, while phosphate levels range from 0 to 8 mg/L, with significant variation that may require further investigation.

Overall, the data reveals a complex landscape of water quality in Ratia Block, with diverse conditions across villages. Addressing these variations through targeted water management and treatment strategies will be essential for ensuring safe and suitable water quality for all residents.

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