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Analysis of Ground Water Quality in Amroha District Of Uttar Pradesh In India

Swati Dhariwal[1], Dr. Kapil kumar[2] and *Dr. Pallav Singh[3]
[1]*JRF, department of zoology, JSH PG college Amroha;* [2]*PI, department of zoology, JSH PG college Amroha;* [3]*deparment of zoology Bundelkhand University, Jhansi. *Author for correspondence*

ABSTRACT
The present study carried out with the aim of understanding the groundwater quality and its suitability for domestic and irrigation purpose. The quality of water is vital concern for mankind since it is directly linked with human health. Groundwater is highly valued because it constitutes the major drinking and irrigation water source in most of the parts of India. Water quality index for underground drinking water at Amroha for fifty-four different sites among 6 blocks has been calculated with the help of estimated values of water quality physico-chemical parameters and W.H.O. water quality standards. Underground drinking water at eight sites is found to be severely polluted. Only Mohammadpur, Khedka, and Bachhraon have drinking water with a Water Quality Index (WQI) range between 26 and 50 while remaining underground drinking water is poor or very poor for human consumption. Individuals reliant on this water are likely confronting health risks associated with contaminated drinking water, necessitating immediate water quality management in the study's catchment area.
KEYWORDS: *Ground Water Quality, Water Quality Index, Physio-Chemical Parameter*

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I. INTRODUCTION

Groundwater is an essential resource that meets drinking (e.g., 85% of rural drinking water in India), irrigation (87% of groundwater extracted in India) and industrial needs (Kumar et al., 2022; Saha & Ray, 2019). It is often more reliable than surface water, especially during periods of drought. Groundwater quality is declining as a result of geological and anthropogenic activity and hence it is essential to assess its quality before groundwater is distributed for residential or agricultural purposes (Akhtar et al., 2021). Poor quality water adversely affects plant growth and human health. It reduces agricultural productivity, threatens the agricultural economy and hampers the improvement of rural living standards (Yadav & Dagar, 2016; Okorogbona et al., 2018). Groundwater is generally used directly for rural water supply and agricultural purposes most of the year without adequate treatment (Giordano, 2006; Khatri & Tyagi, 2015). Groundwater becomes polluted as a result of weathering of rocks and agricultural chemicals used in irrigation. Conservation of groundwater resources is critical for maintaining human health, supporting groundwater-dependent livelihoods, and sustaining ecosystems (Ravindiran et al., 2023; Hiscock, 2011). It is an accepted fact that clean water is essential for healthy life. An adequate supply of potable and uncontaminated water is an essential requirement for all individuals globally (Edokpayi et al., 2020; Mishra, 2023). The primary groundwater quality issue in India is inland salinity, caused by high levels of fluoride, nitrate, iron, arsenic, total hardness, and certain hazardous metal ions observed over wide areas of several states, including Uttar Pradesh (Singh et al., 2020; Maurya et al., 2021). The study focuses on Amroha, a 'C' class city in western Uttar Pradesh, which had a population of over 1.9 million as per the 2011 census. Amroha district is located to the west of Moradabad district, bordering Meerut, Hapur, Sambhal, and Bulandshahr. The district has 6 blocks, and samples were collected from 9 locations in each block. The area is spread over 2,470 square kilometers. The area extends from latitude 28° 54' N to 39° 6' N and longitude 78° 28' E to 78° 39' E. In the last few decades, Amroha has seen rapid development and population growth and there is also a lot of agricultural work in this area, due to which groundwater pollution has become a major problem, for which immediate action is required. Therefore, in this research work the main objective is to study the ground water quality from different sites of sites of Amroha district.

II. MATERIALS AND METHODS

Sample water was collected tube well, dig wells or India Mark II hand pump from fifty-four different sites located in six blocks at Amroha district.

Standard methods and procedures were followed for water quality physio-chemical parameters (Poojashree et al., 2022). All the chemicals of Analytical Reagent grade were used, unless otherwise stated for analytical purposes. Three samples of each site were collected, analyzed and arithmetic mean of three values is reported here. A blank was also run for all volumetric titrations. The specifications of used instruments are Oakton® Acorn™ series pH 6-meter, Digital Conductivity Meter, Model: LMCM-20 and Hach 2010 (version 6.4) spectrophotometer. The estimated parameters are pH, electrical conductivity, total dissolved solids, calcium, chloride, total alkalinity, magnesium, sulphate, potassium, sodium, and bicarbonates. A brief description of sampling sites, their latitude and longitude are given in Table-1. Water quality index (WQI) of underground drinking water collected at all sites were calculated using data of estimated parameters and WHO standards (Ibrahim, 2019) by methods proposed by Horton and modified by Tiwari and Mishra (Horton, 1965; Tiwari, 1985). According to the role of various parameters on the basis of importance and incidence on overall quality of drinking water, rating scales were fixed in terms of ideal values of different physico-chemical parameters. Even if, they are present, they might not be ruling factor. Hence, they were assigned zero values.

Table 1: A brief description of different sampling sites.

S.No.	Site Name	Latitude	Longitude	Block
1	Gajrola	28.8333	78.24453	Gajrola
2	Janakpuri	28.83826	78.24453	Gajrola
3	Bhekanpur	28.81364	78.26518	Gajrola
4	Khanpur	28.82794	78.25262	Gajrola
5	Tarapur	28.97814	78.2621	Gajrola
6	Kankather	28.7983	78.16968	Gajrola
7	Bijora	28.77104	78.18348	Gajrola
8	Sihalijagir	28.80165	78.26243	Gajrola
9	Tigriya Khadar	28.81014	78.22127	Gajrola
10	Aterna	28.86946	78.3917	Joya
11	Papsara	28.85484	78.43273	Joya
12	Rajabpur	28.83787	78.37662	Joya
13	Sarkada Kamal	28.79748	78.4262	Joya
14	Joya	28.83735	78.47254	Joya
15	Didauli	28.82817	78.52866	Joya
16	Kailsa	28.86406	78.56361	Joya
17	Gangadaspur	28.83112	78.59182	Joya
18	Patai Khalsa	28.80442	78.56137	Joya
19	Amroha	28.90997	78.47512	Amroha
20	Raipur Kalan	28.92892	78.508	Amroha
21	Laloo Nagla	28.95229	78.51077	Amroha
22	Mohammadpur	28.82727	78.38293	Amroha
23	Alehdapur Kalan	28.95599	78.46476	Amroha
24	Saidpur Imma	28.92757	78.46476	Amroha
25	Aiwajabad	28.94374	78.49527	Amroha
26	Nangli Sheikh	28.95033	78.38335	Amroha
27	Khedka	28.98359	78.3649	Amroha
28	Rukhalu	28.66853	78.25561	Gangaswari
29	Jebda Ahtmali	28.62128	78.19916	Gangaswari
30	Hakimpur	28.88131	78.65831	Gangaswari

31	Burawali	28.61337	78.28076	Gangaswari
32	Gangeshwari	28.53857	78.29046	Gangaswari
33	Rehra	28.53463	78.3215	Gangaswari
34	Daurara	28.54884	78.30018	Gangaswari
35	Adampur	28.52689	78.36969	Gangaswari
36	Bartora	28.57093	78.24373	Gangaswari
37	Hasanpur	28.72571	78.28578	Hasanpur
38	Bawan kheri	28.76778	78.33621	Hasanpur
39	Telipura Khalsa	28.97305	78.60038	Hasanpur
40	Luhari Bhoor	28.75233	78.35715	Hasanpur
41	Kala Khera	28.71049	78.32301	Hasanpur
42	Bhadora	28.72795	78.37535	Hasanpur
43	Said Nagli	28.67004	78.38206	Hasanpur
44	Ujhari	28.6347	78.35677	Hasanpur
45	ChakGulam	28.63699	78.38206	Hasanpur
46	Dhanaura	28.96685	78.26059	Dhanaura
47	Bachhraon	28.92554	78.23064	Dhanaura
48	Kadrabad	28.93705	78.16444	Dhanaura
49	Shahbazpur Gurjar	28.9622	78.23975	Dhanaura
50	Rafatpur Mafi	28.97784	78.2456	Dhanaura
51	Ganora	28.98331	78.2495	Dhanaura
52	Rampur taga	28.99317	78.2565	Dhanaura
53	Chuchaila Kalan	29.00239	78.26437	Dhanaura
54	Bhagwantpur	29.08341	78.288	Dhanaura

For calculating WQI following equations are used:
1. Quality rating, $Q_n = 100[(V_n - V_i) / (V_s - V_i)]$
Where,
V_n - Actual amount of nth parameter
V_i - The ideal value of this parameter
$V_i = 0$ except for pH.
$V_i = 7.0$ mg/lit for pH
V_s – Its standard
2. Unit weight (W_n) for various parameters is inversely proportional to the recommended WHO standard (S_n) for the corresponding parameter.
$W_n = K/S_n$
Where, S_n = recommended standard
K = constant
$\sum W_n = 1$, considered here
3. The overall WQI is calculated by taking geometric mean of these sub indices.
$WQI = \text{antilog}_{10} [\sum W_n \log_{10} Q_n]$

The collective influence of numerous physico-chemical characteristics on the overall quality of drinking water is assessed by the estimated values of water quality indices. Based on various water pollution studies, the following assumptions are established to evaluate the degree of contamination or the quality of drinking water. The assumptions are:
WQI value between 0 to 25 = Excellent
WQI value between 26 to 50 = Good
WQI value between 51 to 75 = Poor
WQI value between 76 to 100 = Very Poor
WQI value > than 100 = Unfit for consumption

III. RESULTS AND DISCUSSION

The estimated values of underground drinking water quality characteristics, categorized by site and parameter (Table-2). The W.H.O. standards and corresponding unit weights for each parameter are presented in Table-3. The final computed site-specific values of the water quality index (WQI) are presented in Table 4.

Table 2: The estimated values of underground drinking water quality characteristics, categorized by site and parameter.

Sites	pH	EC (µS/cm)	TDS (mg/L)	Ca (mg/L)	Cl (mg/L)	Total Alkanity (mg/L)	Mg (mg/L)	Sulphate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Bicarbonate (mg/L)
Gajrola	7.04	958	477	50	92	342	94	48	55	31	141
Janakpuri	7.23	577	290	45	70	320	77	34	23	18	188
Bhekanpur	7.62	316	158	48	48	160	29	22	10	8	203
Khanpur	7.12	661	331	33	114	240	65	47	18	21	224
Tarapur	7.14	466	380	55	106	481	100	58	8	28	119
Kankather	7.29	341	230	58	55	232	38	28	32	13	104
Bijora	7.1	290	176	43	44	342	44	42	26	10	209
Sihalijagir	7.4	382	391	54	72	158	71	61	13	11	172
Tigriya Khadar	7.22	397	280	51	34	222	38	43	20	17	153
Aterna	7.32	398	310	51	61	382	76	20	6	30	244
Papsara	7.39	423	280	44	65	502	106	38	8	34	238
Rajabpur	6.85	836	431	40	34	520	64	42	12	22	152
Sarkada Kamal	7.01	810	403	112	68	380	101	21	16	14	251
Joya	7.69	261	130	62	71	200	30	33	9	11	148
Didauli	7.42	383	192	64	70	240	48	34	11	18	228
Kailsa	7.04	252	248	38	42	258	34	54	12	32	134
Gangadaspur	7.12	397	197	42	25	173	28	24	14	34	150
Patai Khalsa	7.19	470	312	37	31	280	51	43	11	30	166
Amroha	6.9	941	473	80	141	520	98	43	14	29	182
Raipur Kalan	7.4	380	191	64	140	480	96	32	9	12	190
Laloo Nagla	7.2	434	215	45	35	310	48	38	6	15	142
Mohammadpur	6.8	925	450	32	70	295	55	49	3	31	122
Alehdapur Kalan	7.2	764	382	56	51	240	36	21	8	17	130
Saidpur Imma	7.1	395	360	71	48	160	50	56	12	36	206
Aiwajabad	7.3	390	372	38	101	325	32	28	7	10	233
Nangli Sheikh	7.8	404	360	42	42	209	44	62	4	18	176
Khedka	7.6	412	380	24	32	237	26	41	4	42	142
Rukhalu	7.16	410	312	52	46	332	33	42	17	22	205
Jebda Ahtmali	7.26	445	220	64	40	305	36	36	11	53	90
Hakimpur	7.08	512	276	61	32	384	42	28	18	20	177
Burawali	7.13	392	360	42	30	285	30	51	3	42	208

Gangeshwari	7.29	540	404	36	53	264	27	47	18	39	240
Rehra	7.34	514	257	32	35	320	30	30	9	22	163
Daurara	7.05	440	380	43	45	372	21	37	17	26	270
Adampur	7.27	332	470	57	38	253	38	45	25	26	208
Bartora	7.1	507	278	36	58	287	40	27	9	33	244
Hasanpur	6.82	879	440	70	144	401	117	40	12	32	173
Bawan kheri	7.16	666	331	63	120	560	30	35	28	12	192
Telipura Khalsa	6.79	1300	653	140	100	720	77	54	9	19	145
Luhari Bhoor	7.34	514	257	32	35	320	100	36	15	29	204
Kala Khera	7.26	445	220	64	40	310	44	43	22	40	138
Bhadora	7.38	519	380	55	48	298	35	15	38	26	234
Said Nagli	7.12	602	291	76	82	315	28	36	8	36	174
Ujhari	7.76	712	404	46	70	408	42	28	13	23	130
ChakGulam	6.94	399	292	38	40	380	51	55	4	18	202
Dhanaura	7.52	702	432	60	30	280	38	32	5	30	190
Bachhraon	7.41	772	427	68	26	242	32	51	3	28	206
Kadrabad	7.68	912	445	57	32	160	30	48	8	39	252
Shahbazpur Gurjar	7.59	832	510	70	28	510	36	56	1	14	216
Rafatpur Mafi	7.68	790	520	64	34	320	32	20	3	38	198
Ganora	7.72	894	426	51	36	200	37	34	2	11	234
Rampur taga	7.74	902	416	58	31	332	33	48	7	47	191
Chuchaila Kalan	7.66	832	404	53	29	217	40	53	12	20	208
Bhagwantpur	7.71	767	515	61	32	371	31	41	4	34	218

Table 3: The W.H.O. standards and corresponding unit weights for each parameter.

S.No.	Properties	WHO standard (Sn)	Assigned Unit Weights (Wn)
1	pH	8.5	0.41182
2	EC (µS/cm)	300	0.011668
3	TDS (mg/L)	500	0.007001
4	Ca (mg/L)	100	0.035005
5	Cl (mg/L)	250	0.014002
6	Total Alkanity (mg/L)	100	0.035005
7	Mg (mg/L)	50	0.070009
8	Sulphate (mg/L)	200	0.017502
9	Potassium (mg/L)	10	0.350047
10	Sodium (mg/L)	200	0.017502
11	Bicarbonate (mg/L)	115	0.030439

Table 4: The final computed site-specific values of the water quality index (WQI).

S.No.	Site	Water Quality Index	Water Quality status	S.No.	Site	Water Quality Index	Water Quality status
1	Gajrola	229.8402	Unfit for consumption	28	Rukhalu	90.2384	Very poor
2	Janakpuri	118.8569	Unfit for consumption	29	Jebda Ahtmali	69.0246	Poor
3	Bhekanpur	70.7229	Poor	30	Hakimpur	94.3247	Very poor
4	Khanpur	95.1574	Very poor	31	Burawali	38.2337	Good
5	Tarapurpur	71.4524	Poor	32	Gangeshwari	95.3200	Very poor
6	Kankather	140.5168	Unfit for consumption	33	Rehra	64.6855	Poor
7	Bijora	121.0031	Unfit for consumption	34	Daurara	88.5413	Very poor
8	Sihalijagir	81.4695	Very poor	35	Adampur	119.3856	Unfit for consumption
9	Tigriya Khadar	97.6277	Very poor	36	Bartora	60.8264	Poor
10	Aterna	64.8063	Poor	37	Hasanpur	79.9837	Very poor
11	Papsara	81.9965	Very poor	38	Bawan kheri	137.6335	Unfit for consumption
12	Rajabpur	75.0800	Poor	39	Telipura Khalsa	77.6316	Very poor
13	Sarkada Kamal	98.6917	Very poor	40	Luhari Bhoor	96.6886	Very poor
14	Joya	69.7169	Poor	41	Kala Khera	110.0429	Unfit for consumption
15	Didauli	76.0389	Very poor	42	Bhadora	170.0798	Unfit for consumption
16	Kailsa	64.6369	Poor	43	Said Nagli	57.3494	Poor
17	Gangadaspur	70.1855	Poor	44	Ujhari	95.7588	Very poor
18	Patai Khalsa	69.4301	Poor	45	ChakGulam	42.2978	Good
19	Amroha	91.5449	Very poor	46	Dhanaura	58.0760	Poor
20	Raipur Kalan	82.9140	Very poor	47	Bachhraon	46.9798	Good
21	Laloo Nagla	52.0486	Poor	48	Kadrabad	70.2504	Poor
22	Mohammadpur	32.7073	Good	49	Shahbazpur Gurjar	55.4788	Poor
23	Alehdapur Kalan	56.4621	Poor	50	Rafatpur Mafi	56.8325	Poor
24	Saidpur Imma	68.4050	Poor	51	Ganora	51.5979	Poor
25	Aiwajabad	59.0301	Poor	52	Rampur taga	73.2434	Poor
26	Nangli Sheikh	58.5818	Poor	53	Chuchaila Kalan	85.2861	Very poor
27	Khedka	50.0500	Good	54	Bhagwantpur	63.2673	Poor

A critical analysis of the Water Quality Index (WQI) results reported in Table 4, along with a comparison to standard assumptions, uncovers significant insights concerning drinking water contamination in Amroha during the study period. The Water Quality Index (WQI) observed in the catchment region ranges from 32.7073 to 229.8402 throughout the study period. The maximum Water Quality Index (WQI) is observed at site Gajrola, while the least is recorded at site Mohammadpur. The subterranean drinking water is significantly contaminated at about eight locations, with a Water Quality Index (WQI) over 100. Ground water is fit for drinking purpose with a Water Quality Index (WQI) value between 26 to 50 for three sites (Mohammadpur, Khedka and Bachhraon) only. The

subterranean drinking water at remaining site are poor or very poor for human consumption, as shown by the Water Quality Index (WQI).

IV. CONCLUSION

Drinking water is contaminated to a great extent at almost all the sampling locations in Amroha. During the investigation, moderate contamination in drinking water was observed at one site. As a result, it can be inferred that drinking water in the sampled catchment area is contaminated to a great extent and unsuitable for human consumption and domestic use. On the contrary, it can be stated that drinking water is contaminated to a great extent regarding the tested water quality parameters. Individuals who depend on this water may face health risks associated with contaminated drinking water. Immediate implementation of stringent and effective measures is necessary for managing drinking water quality in Amroha. The Water Quality Index has once again demonstrated its importance as a tool for evaluating water quality.

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