

Indexing of Under Groundwater Quality in Urban Area of Moradabad District in Northern India

Rajeev Kumar Singh¹, Ritu Singh²

¹ Shri Ram Murati Samarak College of engineering and technology, Bareilly (up)

² Shri Ram Murati Samarak College of engineering, technology & Research Bareilly (up)

Abstract: A study was carried out to assess the ground water quality of urban area of Moradabad, a developing industrial city of Uttar Pradesh. The water samples were collected from bore wells, tube wells and hand pumps in research area. Various physico-chemical parameters were analysed. The pH value was in proximity to benchmarked NPI index value i.e. 1.0, while the NPI value for total alkalinity was found to be above one. The NPI values for calcium, magnesium, phosphate, chlorides, total dissolved solids, total hardness and nitrate were far below the critical NPI value of 1.00

Key Word: Ground water, Moradabad, urban area, water quality

I. Introduction

The quality of water is depleting rapidly with the change in human life style i.e., Massive industrialization, construction activities, utilization of agricultural land and forest Land for other developmental purposes. Most of the groundwater studies focus on the Assessment of quantitative sources and on the identification recharge processes. These Developmental activities generate large quantities of concentrated effluents. These effluents are either dumped into ground or drained into open unlined earthen canals from where they Percolate, resulting groundwater pollution. Moradabad is a developing industrial city situated at a distance of 167 km from the national capital, New Delhi (NH 24), on the bank of river Ram Ganga and is located between 28° 21' to 28° - 16' latitude north and 78° 4' longitude east. It has an average elevation of 186 meters (610 feet) above sea level. The drinking water is available in the form of municipal taps, hand pumps, jet pumps, bore wells etc. but most of the population depends upon the underground water both for domestic and irrigation purposes. undoubtedly the infested pollution load caused by rapid urbanization & industrialization is harming water quality so as to establish a better water management plan and to monitor water quality, it is very important to know different physio chemical parameters of water, namely colour, odour, taste, pH, electrical conductance (EC), total dissolved solids (TDS), turbidity, total hardness (TH), total alkalinity (TA), chloride (Cl⁻), nitrate (NO₃⁻), phosphate (PO₄⁻), sulphate (SO₄⁻), heavy metal. Water quality index (WQI) was calculated which reflects the collective criteria of the drinking water quality of the urban area of the city.

II. Methodology

The samples were collected in triplicates from the sites marked 1 to 10 of experimental zone in three different seasons i.e. summer, monsoon and winters of the year 2014-2015. They were preserved, marked and analysed according to standard methods (APHA, 1992). The pH was measured using pH meter (SYSTRONICS 335) while total dissolved solids and turbidity were measured by conductivity meter and turbidity meter (ELICO CL-52) respectively Chloride was measured argentometrically whereas sulphate, nitrate and phosphates were determined spectrophotometrically, while total hardness, total alkalinity, calcium and magnesium were measured titrimetrically. Analysis of heavy metals in water was done by atomic absorption spectrophotometer Perkin Elmer Model 130. The water quality was assessed using Nemerow's pollution index (NPI), mathematically expressed as

$$NPI = Ci / Li$$

Where Ci and Li are observed concentration and permissible limit of ith parameter respectively. The NPI value exceeding 1.00 indicates the presence of pollutant parameter in water sample.

III. Result And Discussion

All parameters were measured in mg /L except hardness which measured as CaCO₃. Analytical results were compiled and shown in Table 1 and various sample point locations are shown in Table 2. Observed changes in various parameters are discussed below. The pH ranged from 7.55 to 8.03 showing alkaline nature of ground water which was probably due to presence of carbonates and bi carbonates. The highest value was at site 4 and lowest at site 6. The values of PH were found well within the limits of BIS standards. Similar results were shown by Reddy et.al (1999). TDS denote mainly the various kinds of minerals present in water. A higher content of TDS elevates the density of water. The value of TDS is maximum at site 9 (488mg/L) and minimum at site 8 (248mg/L). TDS beyond 500 mg / L. decreases palatability and also favour gastro intestinal diseases.

TDS value up to 1000 mg /L is considered Safe for potable purpose according to WHO (1993).Turbidity refers to the relative clarity of water its maximum value at site 4 (1.166NTU) and minimum value at site 7 (0.600NTU).Turbidity in water acceptable when it used for domestic washing and bathing. Turbidity was found higher in rainy season in compare to other seasons. The NPI value of pH was just below standard index bench mark 1.00, while TDS and Turbidity NPI value are well within the preset standard.As prescribed limit of chloride by WHO are 250mg/L. all samples were within the permissible range. It is found maximum at site 9 (86.13) and minimum at site 4 (36.1). Even Sulphate, which imparts hardness to the water, was maximum at site 9 (58.33) and minimum at site 4, 5 (20). The concentration of phosphate was very less In sub surface water with maximum at site 1,3,10 (0.0166) and minimum at site 7 (0066).No regular pattern of seasonal variation was observed the water containing more than 50 mg /L NO3-N is unsafe for drinking purposes as recommended by WHO .the lowest value was at site 8 (0.0133) and highest at site 9 (0.097). The NPI value calculated for chloride, sulphate, nitrate and phosphate were again found to be well within the critical and alarming presumed index indicator 1.00.Total alkalinity is a measure of an aggregate property of water. The maximum value was at site 1 (280 mg/L) and lowest at site 7 (200 mg/L). The NPI of alkalinity was found to be greater than 1.00 for all the samples. It is found that high alkalinity imparts bitter taste to water making it unpalatable. Hardness of water is mainly due to calcium and magnesium present in it. The maximum and minimum value of total hardness was observed at site 2 (274mg/L) and site 9 (162mg/L) respectively. The calcium content varied from 29.51 (site 5) to 74.16 mg/L (site8) and the magnesium concentration ranged from 58.39 mg/L (site 8) to 133.15 mg/L (site 4). In low concentration these are nontoxic but in high concentration are not desirable washing, laundering & cooking purposes (singh et al 1999). The permissible range for heavy metals like Fe, Pb ,Zn ,Cr ,Ni ,Cu are 0.3 mg/L , 0.05 mg /L , 5mg/L , 0.05 mg/ L , 0.05 mg/ L , 0.05 mg/ L respectively .Most of the samples showed Higher Value of iron content in ground water. Zinc and Chromium concentration exceeded the prescribed limit whereas Copper and nickel concentration were well within the prescribed limit for most of the samples. However, no regular trend was seen in the three seasons

Table 1: Physico-Chemical parameters and NPI of ten sites in densely populated area of Moradabad city.

Parameter	MandiSamiti Site-1						Locoshedbridge Site -2						MDA Site -3						WHO /CPHEEO Std.(mg /L)
	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	
pH	7.21	8.27	7.51	7.66	0.5463	0.9	7.02	8.15	7.67	7.61	0.56712735	0.895	7.29	8.57	7.23	7.69	0.7453858	0.9	8.5-6.5
TDS	273.3	313.3	313.7	299.9	23.0401	0.29	400	413.3	246.6	355.3	92.8438883	0.35	346.6	400	3306.6	351.07	1693.752	0.35	1000
Turbidity	0.2	1.5	0.4	0.7	0.7	0.14	0.5	1.7	0.4	0.87	0.72341784	0.17	0.2	2	40.1	0.77	22.53464	0.15	5 NTU
Cl	73.8	42	62.5	59.63	15.796308	0.23	71	36.9	62.5	56.8	17.7502117	0.22	79.5	31	42.6	51.1	25.24698	0.20	250
SO ₄	40	15	95	50	40.9267645	0.12	50	40	65	51.66	12.5830579	0.12	30	15	10	18.33	10.408336	0.04	400
TA	240	460	140	280	163.707063	2.33	260	420	140	275.3	140.47538	2.28	220	300	120	213.3	90.184995	1.78	120
TH	188	250	280	239.3	46.918369	0.47	188	350	284	274	81.4616478	0.54	96	240	320	218.67	113.51358	0.43	500
NO ₂	0.06	0.0	0.03	0.043	0.0152753	0.00	0.1	0.0	0.05	0.057	0.0404145	0.00	0.19	0.0	0.08	0.097	0.0862168	0.00	50
PO ₄	0.01	0.0	0.02	0.016	0.0057735	0.16	0.01	0	0.03	0.013	0.0152753	0.13	0	0.0	0.03	0.016	0.0152753	0.16	0.1
Mg	36.03	74	184	98.36	76.759157	0.65	35.27	110	161	102.3	63.4390782	0.68	45.08	76	219	113.4	92.790671	0.07	150
Ca	44.69	52	45.4	47.68	4.5341409	0.23	76.28	68	60.0	68.43	8.1115658	0.34	22.4	33	39.6	31.89	8.7404634	0.15	200

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Parameter	Civil Lines Site -4						Moradabad Club Site-5						Harthala Colony Site -6						WHO /CPHEEO Std.(mg /L)
	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	
pH	7.4	8.89	7.81	8.03	0.7696969	0.94	7.44	8.79	7.48	7.9	0.7681363	0.9	7.36	8.47	6.83	7.55	0.836919	0.8	8.5-6.5
TDS	200	333	306.6	279.9	70.528174	0.27	306.6	400	253.3	319.9	74.257817	0.3	300	366	253.3	306.6	56.94052	0.3	1000
Turbidity	0.1	1.6	0.1	0.6	0.8660254	0.12	0.4	2	0.2	0.87	0.9865766	0.1	0.2	1.9	1	1.033	0.85049	0.2	5 NTU
Cl	31.6	28	48.3	36.1	10.68597	0.14	65.3	25.6	39.7	43.53	20.125688	0.1	65.3	56	455	55.87	227.4868	0.2	250
SO ₄	15	30	15	20	8.660254	0.05	25	10	25	20	8.660254	0.0	80	35	45	53.33	23.62908	0.1	400
TA	260	240	140	213.3	64.291005	1.78	220	320	160	233.3	80.829038	1.9	300	320	160	260	87.177979	2.1	120
TH	150	300	324	258	94.297402	0.51	170	240	252	220.6	44.286943	0.4	160	270	356	262	98.244593	0.5	500
NO ₂	0.09	0.0	0.11	0.08	0.0360555	0.00	0.08	0.0	0.04	0.06	0.02004	0.0	0.07	0.0	0.04	0.06	0.0173205	0.0	50
PO ₄	0	0.0	0.03	0.013	0.0152753	0.13	0	0.0	0.02	0.01	0.01	0.1	0	0.0	0.02	0.01	0.01	0.1	0.1
Mg	84.05	96	219	133.1	74.702904	0.88	98.85	78	141	106.3	32.466058	0.7	22.44	86	207	105.4	94.244861	0.7	150
Ca	48.2	36	40.5	41.88	5.7752258	0.20	26.48	22	39.6	29.51	8.9770764	0.1	84.01	33	56.2	57.62	25.220925	0.2	200

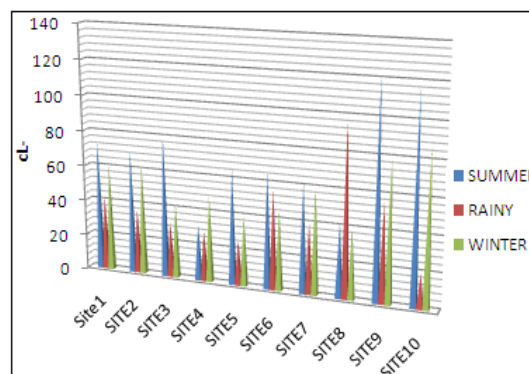
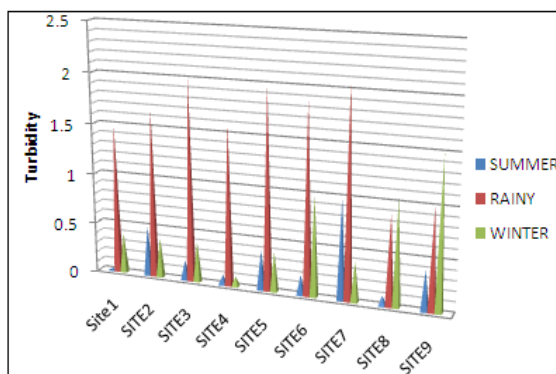
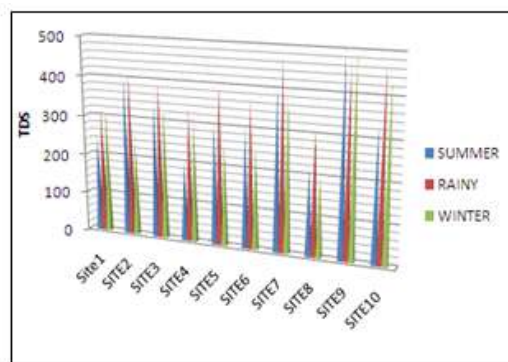
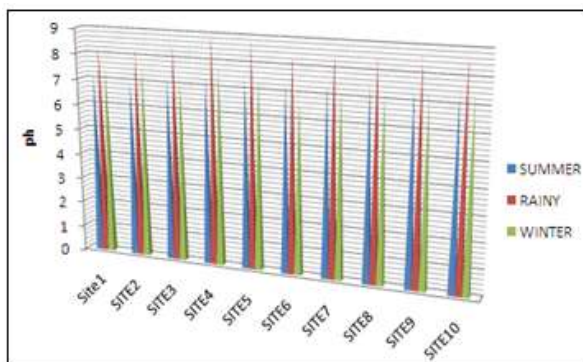
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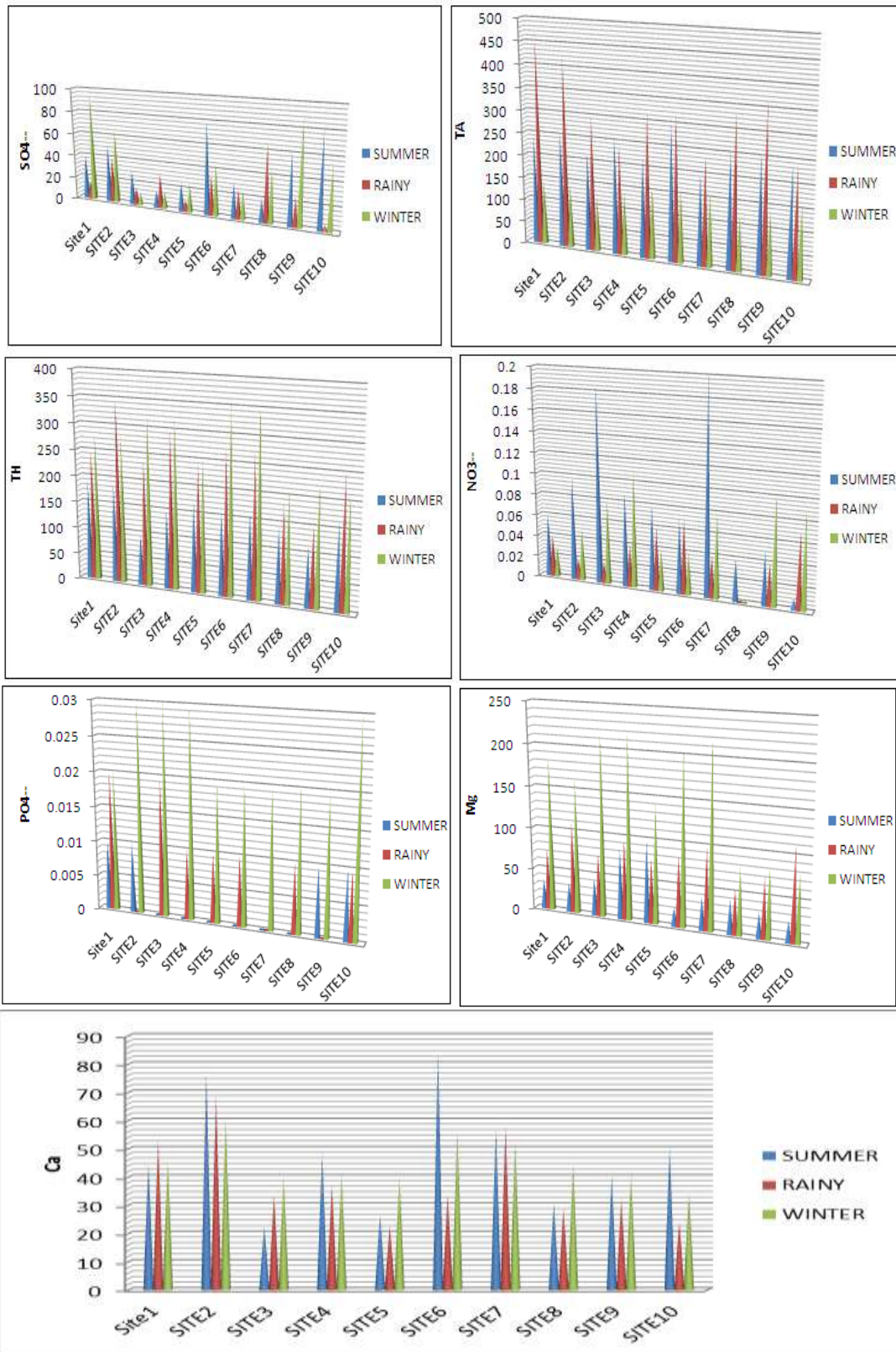
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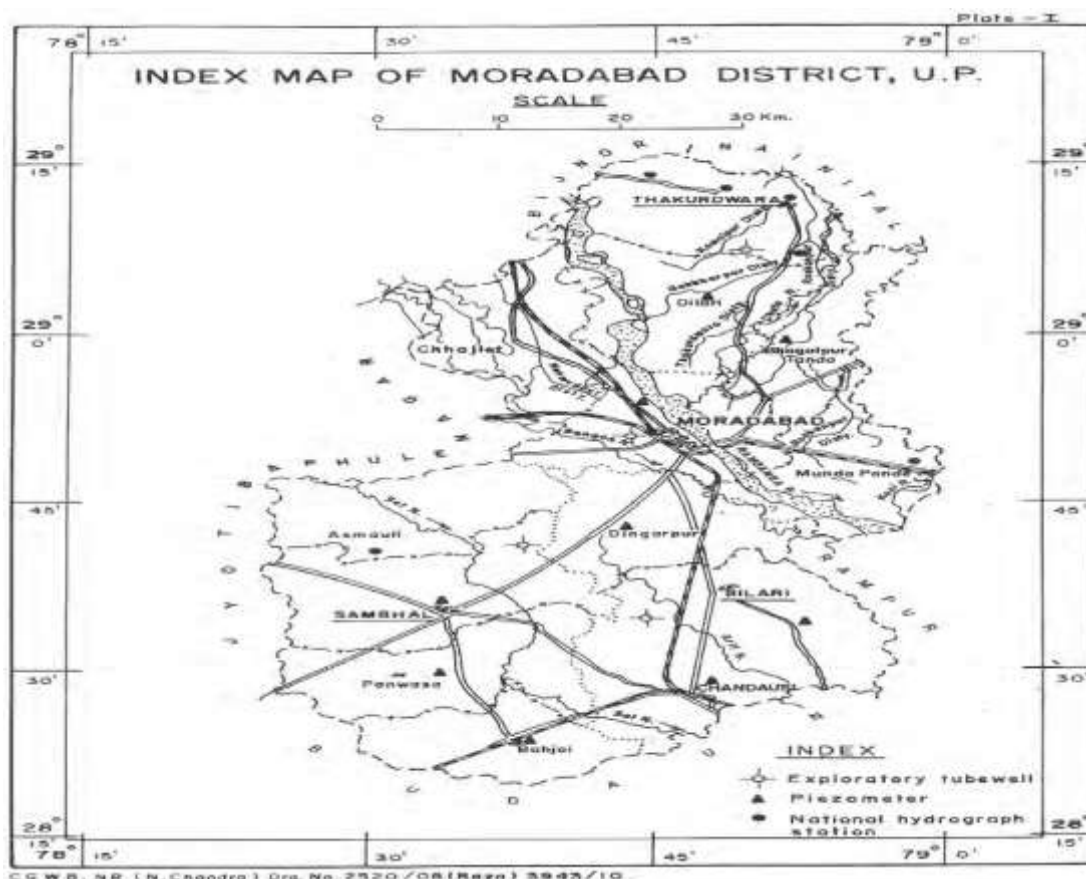
Parameter	Mahila Thana Site -7						DyptiGanj Site -8						Jain Mandir Site -9						WHO/CPHE EO Strd.(mg/L)
	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	Summer	Rainy	Winter	Average	SD ±	NPI	
pH	7.39	8.64	7.16	7.73	0.7964295	0.9	7.57	8.72	7.3	7.86	0.7540778	0.9	7.54	8.84	7.37	7.82	0.68942	0.92	8.5-6.5
TDS	406.6	466.6	393.7	422.1	39.050779	0.4	220	320	206.6	248.87	61.96655	0.2	500	466.6	500	488.86	19.283499	0.48	1000
Turbidity	1	2.1	0.4	1.166	0.8621678	0.2	0.1	0.9	1.05	0.833	60.334429	0.1	0.4	1	1.5	0.97	0.5507571	0.19	5 NTU
Cl ⁻	62.4	39.7	59.6	53.9	12.376995	0.2	42.6	99.4	39.7	60.56	33.661897	0.2	122.1	56.8	79.5	86.13	33.151521	0.34	250
SO ₄ ⁻⁻	30	25	25	26.66	2.8867513	0.0	20	66	45	43.66	23.028967	0.1	60	25	90	58.33	32.532035	0.14	400
TA	200	240	160	200	40	1.666	260	340	120	240	111.35529	2	260	360	140	253.33	110.15141	2.11	120
TH	164	270	360	264.66	98.108783	0.5	140	185	204	176.33	32.868425	0.3	112	150	224	162	56.956123	0.32	500
NO ₃ ⁻⁻	0.2	0.04	0.08	0.046	0.0832666	0.0	0.04	0	0	0.0133	0.023094	8.6E-05	0.05	0.04	0.1	0.063	0.0321455	0.00	50
PO ₄ ⁻⁻	0	0	0.02	0.0066	0.011547	0.0	0	0.01	0.02	0.01	0.01	0.1	0.01	0	0.02	0.01	0.01	0.1	0.1
Mg	39.23	98.42	224.3	120.65	94.516432	0.8	41.22	54.28	79.69	58.39	19.562603	0.3	30.84	70.86	84.12	61.947419	27.733	0.41	150
Ca	56.82	57.71	52.28	55.6	2.91229	0.2	30.48	28.85	44.49	74.16	8.597932	0.3	40.26	32.06	40.46	37.59	4.7930505	0.18	200

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Harpal Nagar Site -10							WHO/CPHE O Strd.(mg/L)
Parameter	Summer	Rainy	Winter	Average	SD ±	NPI	
pH	7.52	8.77	7.5	7.93	0.72753	0.93	8.5-6.5
TDS	340	473.3	446.6	419.96	70.52817	0.419	1000
Turbidity	0.2	1.2	1.5	0.97	0.680686	0.194	5 NTU
Cl ⁻	116.4	19.8	88	74.73	49.64769	0.299	250
SO ₄ ⁻⁻	80	5	55	46.66	38.18813	0.117	400
TA	240	240	160	213.33	46.18802	1.78	120
TH	168	250	216	211.33	41.19871	0.423	500
NO ₃ ⁻⁻	0.01	0.07	0.09	0.057	0.041633	0.00038	50
PO ₄ ⁻⁻	0.01	0.01	0.03	0.0166	0.011547	0.166	0.1
Mg	25.84	110.3	82.5	72.87	43.03525	0.486	150
Ca	50.28	24.04	34.61	36.31	13.20234	0.182	200







Trace Metal concentration of densely populated area of Moradabad city

MandiSamiti Site-1							Locoshedbridge Site -2					
Parameter	Summer	Rainy	Winter	SD±	Average	NPI	Summer	Rainy	Winter	SD±	Average	NPI
Fe	0.409	0.398	0.51	0.0617	0.439	1.46	0.544	0.614	0.46	0.0771	0.54	1.8
Pb	0	0.024	0	0.0138	0.008	0.16	0	0.029	0.33	0.1827	0.12	2.4
Cr	0.03	0.02	0.01	0.01	0.02	0.4	0.03	0.02	0.01	0.01	0.02	0.4
Ni	0.01	0.01	0.01	0	0.01	0.2	0.01	0.011	0	0.006	0.007	0.14
Zn	1.178	1.96	0	0.9866	1.046	0.21	2.622	0.204	1.173	1.2169	1.333	0.27
Cu	0.02	0.01	0.02	0.0057	0.0166	0.332	0.02	0.024	0.061	0.0226	0.035	0.7

MDA Site -3							Civil Lines Site -4					
Parameter	Summer	Rainy	Winter	SD±	Average	NPI	Summer	Rainy	Winter	SD±	Average	NPI
Fe	0.919	0.643	0.31	0.3049	0.624	2.08	0.432	0.425	0.12	0.1781	0.326	1.08
Pb	0	0.031	0.026	0.0166	0.019	0.38	0.013	0	0.028	0.014	0.0136	0.27
Cr	0.03	0.01	0.03	0.0115	0.023	0.46	0.03	0	0.02	0.0152	0.0166	0.33
Ni	0.01	0.022	0.01	0.0069	0.014	0.28	0.03	0.018	0.01	0.01	0.0193	0.38
Zn	0.452	0.755	0.38	0.199	0.529	0.11	0.199	0.699	0	0.3601	0.299	0.06
Cu	0.01	0.026	0.04	0.015	0.025	0.5	0.01	0.036	0.002	0.0177	0.016	0.32

Moradabad Club Site-5							Harthala Colony Site -6					
Parameter	Summer	Rainy	Winter	SD±	Average	NPI	Summer	Rainy	Winter	SD±	Average	NPI
Fe	0.484	0.28	0.34	0.104	0.368	1.23	0.612	0.779	0.62	0.0941	0.67	2.23
Pb	0.024	0	0.009	0.0121	0.011	0.22	0.047	nt	0.034	0.0091	0.027	0.54
Cr	0.07	0.01	0.02	0.0321	0.033	0.66	0.01	0.04	0.01	0.0173	0.02	0.04
Ni	0	0	0	0	----	----	0.01	0.026	nt	0.0113	0.012	0.24
Zn	0.467	0	0	0.2696	0.156	0.03	0.944	0.867	nt	0.0544	0.604	0.12
Cu	0.02	0.039	0.007	0.016	0.022	0.44	0.01	0.03	nt	0.0141	0.0133	0.27

Mahila Thana Site -7							DyptiGanj Site -8					
Parameter	Summer	Rainy	Winter	SD±	Average	NPI	Summer	Rainy	Winter	SD±	Average	NPI
Fe	2.08	0.872	0.847	0.7047	0.15	0.623	0.958	0.666	0.031	0.4739	0.55	1.84
Pb	0.39	0.018	0.011	0.2168	0.029	0.019	0	0	0.034	0.0196	0.0113	0.23
Cr	0.27	0.02	0.01	0.1473	0.01	0.013	0.03	0.02	0.02	0.0057	0.023	0.47
Ni	0.066	0.01	0	0.0355	0	0.003	0	0.019	0.01	0.0095	0.0097	0.19
Zn	0.095	0.186	0.867	0.4219	0	0.475	3.848	2.004	0	1.9245	1.95	0.39

Cu	0.05	0.01	0.03	0.02	0.007	0.016	0.03	0.01	0.035	0.0132	0.025	0.5
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Jain Mandir Site -9							Harpal Nagar Site -10					
Parameter	Summer	Rainy	Winter	SD±	Average	NPI	Summer	Rainy	Winter	SD±	Average	NPI
Fe	0.642	0.636	0.032	0.3504	0.436	1.45	0.499	0.59	0.45	0.071	0.513	1.71
Pb	0	0	0.03	0.0173	0.01	0.2	0.016	0.026	0.038	0.011	0.026	0.53
Cr	0.02	0	0	0.0115	0.0066	0.133	0.01	0.02	0.02	0.0057	0.016	0.33
Ni	0	0	0.01	0.0057	0.0033	0.066	0.01	0	0.04	0.0208	0.0166	0.33
Zn	2.717	0	0	1.5686	0.906	0.18	2.385	1.296	0	1.1939	1.227	0.25
Cu	0.02	0.056	0.051	0.0195	0.042	0.85	0.09	0	0.006	0.0503	0.032	0.64

TABLE 2: Various samples point location to serial number in less densely populated area of Moradabad city

S.No.	Location	Source	Depth (In Feet)
1	MandiSamiti Site-1	Hand Pump	40
2	Locoshedbridge Site -2	Hand Pump (Indian Mark – II)	120
3	MDA Site -3	Hand Pump (Indian Mark – II)	120
4	Civil Lines Site -4	Hand Pump	45
5	Moradabad Club Site-5	Hand Pump (Indian Mark – II)	120
6	Harthala Colony Site -6	Hand Pump	35
7	Mahila Thana Site -7	Hand Pump	40
8	DyptiGanj Site -8	Hand Pump	40
9	Jain Mandir Site -9	Hand Pump	40
10	Harpal Nagar Site -10	Hand Pump (Indian Mark – II)	120

All values in mg/L except pH and turbidity (in NTU) S = Summer R= Rainy W= winter WHO = World Health Organization CPHEEO = Central Public Health and Environmental Engineering Organization

IV. Conclusion

Groundwater is the main source of potable water of Moradabad City. A number of people have installed water purifier in their houses in order to get rid of any contamination in water. The main source of groundwater contamination is from domestic and a number of Electroplating, pulp and paper,dairy and sugar industries etc.

These industries pour their effluents directly into open drain, unlined earthen drain and openpits in several places from where polluted water percolates into soil and finally reaches theaquifers. The data collected led to the conclusion that concentration of indicative parameters in ground water are site specific and are highly variable. A water quality index give effects of various parameters. To sum up the findings the sub surface water of the experimental Area of Moradabad is moderately fit for drinking purposes. However, parameters varied even from sample to sample. The NPI index of most of the parameters in ground water quality did not exceed limits of 1.00 with a few exceptions. The seasons also influenced the ground water quality of the region. It seems that on precautionary basis, the measures could be taken at this stage before the pollution status deepens in the outskirts of the Moradabad city in coming times and passes the stage of irreparable rectification.

References

- [1]. APHA 1992.Standard methods for the examination of water and waste. American Public Health Association, New York, USA.
- [2]. Maduri Usha T., Srinivas, T. and Sireesha, K. 2004. Pollution Res., 23(2): 565-568.
- [3]. Mohan Anuraag., Singh.R.K, Pandey Kirti., Kumar Vineet., Jain.V.,2007.IJEP 27(11):1031-1035.
- [4]. Singh Rajeev Kumar, Mohan Anuraag., Jain.,V.2016,IOSR-JAC 9,(4 Ver,1):32-36
- [5]. WHO 1993.International standards for drinking water. World Health Organization, Geneva

Authors:

- [6]. Dr. *Rajeev Kumar Singh, Assistant professor, SRMSCET,BAREILLY (919411004262)Email, katheria.rajeev@gmail.com
- [7]. Dr. Ritu Singh,Assistant professor, SRMSCETR,BAREILLY:Email, singh.ritu1001@gmail.com