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Original Research Paper

Groundwater Pollution Due to Urbanization and Industrialization in Tumkur District, Karnataka, India

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ABSTRACT

The present study aims at the assessment of groundwater quality in and around Tumkur district and in an erstwhile freshwater stream carrying huge quantities of domestic, agricultural and industrial effluents. Groundwater samples have been collected from bore wells and open wells and subjected to a comprehensive physicochemical and bacteriological analysis. The study reveals that 52.13% of the samples were non-potable due to the presence in excess of several water quality parameters as per the standards laid out by the Bureau of Indian standards (BIS). Nitrate, total hardness and iron were found to be the chief culprits. Nitrates account for 50%, and total hardness and iron for 33.3% of the non-potability of samples. 50% of the samples examined indicated bacterial contamination of the groundwater.

INTRODUCTION

Environment is the life support system that includes air, water and land. Nature is the valuable asset possessed by earth, that provides all the basic requirements such as food, air, water and shelter for the livelihood of living beings. Nearly 75% of our rural population is primarily dependent on groundwater and about 25% of the people's needs in urban areas of our country are met with by groundwater. For obvious reasons, surface water is unavailable everywhere and hence groundwater becomes the only alternate source of good quality of water. The groundwater exploration and development have gained momentum not only in our country, but also the world over to cope up with the increase in demand on the quality and quantity of freshwater due to population explosion, industrial expansion and rapid agricultural development.

Tumkur city has Hemavathi river as major water resource in its neighbourhood. The city has been heading towards freshwater crisis mainly due to improper management of water resources and environmental degradation, which has led to lack of access of safe water supply.

The department of Mines and Geology carried out investigations to evaluate the groundwater quality in Tumkur city. It has reported that 51% of the samples were found to be non-potable due to the presence in excess of one or more water quality parameters. But in this investigation nitrate was found to be the major cause, accounting for 45% of nonpotability.

In recent past, Tumkur has witnessed phenomenal industrial growth and increase in pollution. This has taken heavy toll of the groundwater resources in the city. The water requirement of the city is partly met with by the supplies from Hemavathi river and Bugudanahalli lake. The requirement has, however, outstripped these supplies. To quench the insatiable thirst of the city, groundwater has been tapped as a supplementary and wholesome resource. Therefore, there has been an increasing spurt in the activity of drilling of borewells. Several government agencies are responsible for digging owned by industries over 5000 such bore wells. Besides, there are more than 5000 borewells in the city. A huge quantity of groundwater is also being extracted for industrial requirements and construction activities. Large number of borewells are being drilled by private people for supplying water through tankers in the city and its outskirts. This rapid urbanization and industrialization has also resulted in drying up of various freshwater tanks, which were earlier sound groundwater recharge zones. Whatever few tanks are remaining now have become dumping grounds for solid and liquid wastes giving rise to serious concern for air and water pollution. Groundwater resources are, thus, threatened with contamination with the demographic change such as spread of human settlement and industrial activity. The monitoring of groundwater quality, therefore, has become the need of the hour.

Details of the study area: Tumkur city is located in the southeastern corner of Karnataka state in an area characterized by gently rolling granitic hills and seasonal water courses. It is geographically located between 13°06'30'' to 13°31'00'' north latitude and 76°59'00' to 77°19'00' east longitude. The Taluk comes under semi-arid region. It is surrounded by Sira taluk in the north-west, Gubbi taluk in the west, Koratagere in the north-east, Nelamangala in the south-east, Magadi in the south-east and Kunigal in the south-west.

The area comprising Sadashivanagara, Saraswathipuram and Guluru come under the existing sewerage zone, that is, sewage from Bugudanahalli, Yallapura all drain into Belagumba tank. This wastewater goes to Hanumanthapura treatment plant. Since, the auxiliary tank is dry, it has become dumping ground for the sewage they have become a storehouse for the sewage coming from different parts of the city.

Thirty water samples were collected from the borewells and open wells in the study area during 2009 in two-litre PVC containers, sealed and later analysed for the major physicochemical parameters. Ten samples were analysed for bacterial contamination in the wake of reported bacterial contamination of groundwater causing water-borne diseases such as cholera, typhoid, etc.

MATERIALS AND METHODS

The parameters like pH and electrical conductivity were determined in the field at the time of sample collection, while the remaining chemical analysis including metals and bacteriological analysis was carried out in the laboratory as per the standard methods (APHA 1995). The results obtained were evaluated in accordance with the standards prescribed by BIS (1991)

RESULTS AND DISCUSSION

The results of the physicochemical analysis of the water samples collected are presented in Table 1. Out of the 30 samples analysed, 16 samples (53.33%) were found to be non-potable as per drinking water standards (BIS 1991). At least one or more parameters such as nitrates, total hardness, iron, total dissolved solids (TDS), calcium, magnesium and chlorides accounted for the non potability of more than half the number of samples examined. The main causative constituents for the non potability of the samples are nitrates which accounted for 50% of unsafe samples. They are followed by factors total hardness and iron as a result of which 33.33% of the samples were found to be unsafe. Total dissolved solids and calcium each accounted for 26.67% of the samples being non potable. Chlorides and magnesium each rendered 6.67% of the samples nonpotable.

Table 1: Results of physico-chemical analysis of groundwater sample.

Sample	pH	Turbidity	Hardness	Ca, mg/l	Mg, mg/l	Na, mg/l	K, mg/l	Fe mg/l	HCO_3 mg/l	CO_3 mg/l	CL mg/l	NO_3 mg/l	SO_4 mg/l	PO_4 mg/l	TDS mg/l	E_c mg/l umhos	F mg/l	Cu mg/l	Pb mg/l	Cr mg/l
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	6.82	0.2	1012	270	52	560	8.0	1.36	376	Nil	552	254	32	1.1	2015	2900	0.22	-	-	-
2	7.5	2.5	340	84	32	65	2.0	-	336	-	200	40	49	1.4	725	1250	0.3	-	-	-
3	7.77	1.3	468	126	38	74	2.0	0.3	260	-	224	40	77	2.0	735	1150	0.22	-	-	-
4	7.97	0.8	896	135	140	446	8.0	0.1	1318	88	1272	82	252	1.2	3484	6500	0.6	-	-	-
5	7.26	3.6	1236	298	115	119	24	1.12	456	10	760	104	76	5.2	2456	3400	-	-	-	-
6	6.8	-	320	68	36	46	2.0	-	244	-	195	28	45	0.9	525	900	0.3	-	-	-
7	7.44	1.9	304	88	21	460	11	2.5	361	-	214	28	68	1.8	804	1320	0.38	-	-	-
8	6.70	0.8	1064	301	78	301	28	1.29	608	-	582	224	265	1.8	2120	3550	0.5	-	-	-
9	7.8	0.8	180	53	12	58	1.0	0.4	211	-	31	41	64	0.9	390	620	0.4	-	-	-
10	6.81	4.0	1272	374	84	309	1.2	1.16	440	-	764	335	233	14	2330	3900	0.4	-	-	-
11	7.19	2.0	864	250	60	309	7.0	3.12	588	-	496	292	147	3.8	1880	3000	0.56	-	-	-
12	7.05	0.1	424	94	47	100	7.0	0.2	373	-	190	42	45	3.1	740	1160	0.22	-	-	-
13	7.55	0.9	452	114	42	92	4.0	0.7	364	-	196	62	41	2.6	755	1160	0.65	-	-	-
14	7.03	0.2	620	174	48	234	16	0.12	436	-	330	52	270	3.0	1370	2300	0.6	-	-	-
15	8.01	1.5	488	112	52	59	1.0	0.3	343	-	196	35	36	3.0	685	1080	0.6	-	-	-
16	7.65	1.2	424	112	36	152	5.0	21	343	-	290	68	60	1.2	920	1440	0.36	-	-	0.42
17	7.01	0.5	312	75	31	72	1.0	0.16	255	-	112	27	74	0.2	550	940	0.1	-	-	-
18	7.22	1.6	888	276	48	440	14	2.8	584	6.0	412	252	142	6.1	2008	2950	0.46	-	-	-
19	7.47	1.4	448	192	25	183	4.0	0.91	373	-	240	33	60	0.4	965	1270	0.5	-	-	-
20	7.41	0.8	200	62	11	97	2.0	0.35	226	14	115	20	38	1.8	500	820	0.38	-	-	-
21	7.67	2.8	528	170	26	141	4.0	0.1	348	-	238	56	69	1.1	910	1420	0.4	-	-	-
22	6.95	0.4	120	32	10	25	2.0	0.94	116	-	31	40	10	0.2	240	350	0.12	-	-	-
23	7.42	2.2	1288	411	65	370	26	0.12	440	-	1066	97	176	2.2	2490	4000	0.8	0.12	-	-
24	7.67	1.8	160	51	8.0	102	4.0	0.05	190	-	110	10	68	0.8	480	770	0.7	-	-	-
25	7.65	4.8	460	134	31	188	4.0	0.12	383	-	246	155	90	3.4	1066	1660	0.36	-	-	-
26	7.1	0.6	144	42	10	47	0.6	0.7	147	-	70	44	52	1.6	407	1550	0.3	-	-	-
27	6.99	-	92	26	7	60	6.0	0.71	161	-	30	6	14	0.2	310	460	0.72	-	-	-
28	7.9	5.2	1092	339	61	260	24	1.92	505	4.0	557	418	172	6.6	2115	3300	0.88	0.02	-	0.38
29	7.2	1.2	520	168	25	188	20	0.1	294	-	339	92	159	2.0	1170	1910	0.54	-	-	-
30	7.53	1.0	392	104	33	100	2.0	0.83	294	26	224	05	70	1.0	720	1260	0.12	-	-	-

The study area has shown excessive concentration of nitrates which has rendered most waters as nonpotable. The maximum, minimum and average concentration of nitrates was found to be 418 mg/L, 6 mg/L and 100.83 mg/L (Table 2). Nitrates in several samples were alarmingly high, when compared to BIS permissible limit of 50 mg/L. In the study area, organic origin is probably the cause for most of such occurrences which can be assigned to drainage of water through soil containing domestic and industrial wastes, vegetable and animal matter. Septic tanks and garbage dump disposal may also be responsible for the high nitrate content in the study area. Beyond 50 mg/L, this may cause methaemoglobinaemia or blue baby disease in infants. It may also be carcinogenic in adults. Fig. 1 shows the nitrate values of the water samples.

Table 2: Maximum, minimum and average concentrations of critical parameters.

Sl No	Parameter	Maximum, mg/L	Minimum, mg/L	Average, mg/L
1	pH	8.01	6.70	7.351
2	Chlorides	1272	30	343.4
3	TDS	3484	240	1195.47
4	Total Hardness	1288	92	566.94
5	Calcium	374	26	157.83
6	Magnesium	140	7.0	43.73
7	Nitrate	418	6.0	100.83
8	Iron	21.0	Nil	1.45

Table 3: Critical water quality parameters exceeding the permissible limits.

S. NO	Parameter	Number exceeding the permissible limits	Percentage of samples exceeding the permissible limits
1	Chlorides	2	6.67
2	TDS	8	26.67
3	Total Hardness	10	33.33
4	Calcium	8	26.67
5	Magnesium	2	6.67
6	Nitrate	15	50.0
7	Iron	10	33.33

Total hardness attributing to 33.33% of non potability of samples has shown maximum, minimum and average concentration of 1288 mg/L, 92.0 mg/L and 566.94 mg/L respectively. The maximum permissible limit as per BIS is 600 mg/L. The high degree of hardness in the study area may be attributed to the disposal of untreated/improperly treated sewage and industrial wastes besides the natural factors (Haniffa & Jeevaraj 1994). Fig. 2 shows the total hardness values of the samples.

Total dissolved solids concentration varied from 240mg/L to 3484 mg/L and accounted for 26.67% of the nonpotability. Waters with high total dissolved solids (>2000mg/L) are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer and gastrointestinal irritation.

Iron accounted for 33.33% of nonpotability of samples. Iron concentration showed an alarmingly high concentration of 21 mg/L and 10 samples were found to have iron in excess of the maximum permissible limit of 1 mg/L (Fig. 3). The higher value may be due to rusting of casing pipes, nonusage of bore wells for long periods and disposal of scrap iron in open areas due to industrial activity besides natural factors.

Chlorides resulting in 6.67% of the nonpotability have a peak value of 1272 mg/L, as against the BIS limit of 1000mg/L. The high value can be attributed to the discharge of industrial effluents in the area. With regard to heavy metals, only one sample was affected by excess chromium and the area did not show the presence of excess lead or excess copper in the groundwater (Purandara & Varadarajan 2003).

Out of ten samples analysed for bacteria, five samples (50%) were found to be contaminated, mainly in sewage contaminated and slum areas, with an alarmingly high peak MPN value of 800 in an open well as against the maximum limit of 10/100mL (Table 3).

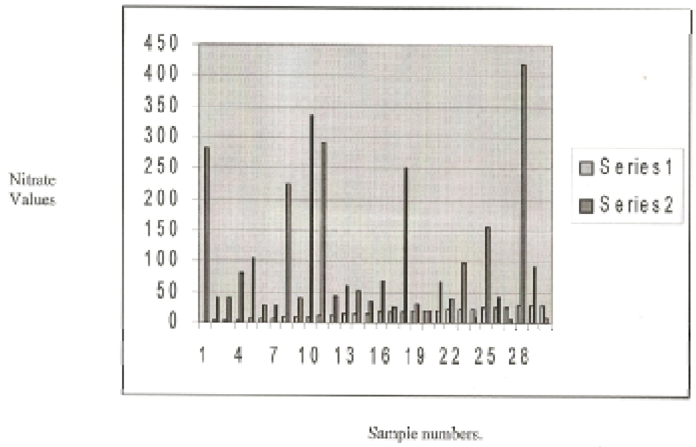

Fig. 1: Nitrate values (mg/L) v/s sample numbers.

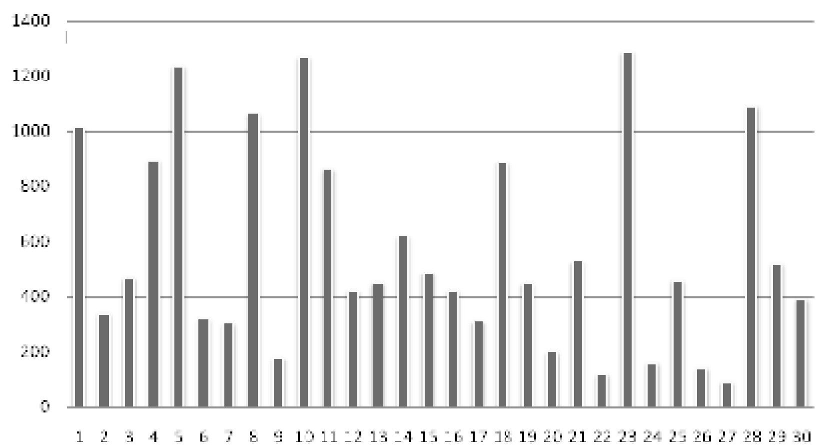

Fig. 2: Total hardness values v/s sample numbers.

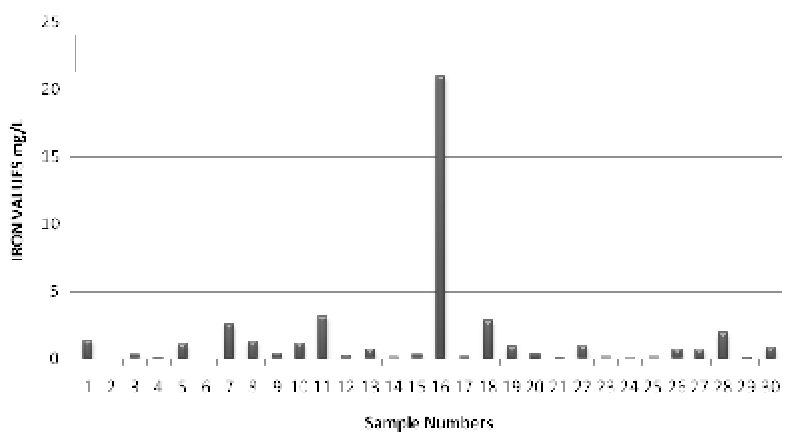

Fig. 3: Iron (mg/L) values v/s sample numbers.

Table 4: Results of bacteriological analysis (MPN).

Sample.No	Coliform Organisms/100 mL of water
2	800
4	Nil
5	2
7	23
11	Nil
14	Nil
16	14
18	350
20	Nil
26	23

CONCLUSION

The wastewater generated from various sources should be properly treated and disposed off and strict legislation on industries setting up and operating their effluent treatment plants should be enforced mandatory. Replacement of damaged pipelines and lining of sewer drains is a must. Augmenting the groundwater resources by recharging the groundwater aquifer through rain water harvesting and, thus, reducing the high concentration of chemical parameters is an important measure. Use of biofertilizers by farmers instead of chemical fertilizers in agricultural activities is another important point. The public should be instructed to use boiled water for drinking, as the study area has shown considerable hardness, mostly of temporary type. Public awareness programmes should be initiated to create a sense of awareness in the public to safeguard against the perils of waterborne diseases.

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