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Solid Waste Disposal Sites Detrimental To Groundwater Using Geoinformatics

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Abstract

Illegal dumping is one of the major environmental problems of major cities. Household and other waste disposal in and around city streets has many negative health, economic, and environmental consequences. Illegal dump sites were identified, quantified, characterised, and mapped through urban census block groups with varying median family income levels. To check the detrimental of the extent of pollution derived from waste disposal sites, groundwater testing was taken in the pre-monsoon season. The samples collected from different zones of the dumping site on the availability of waste disposal in and around study area of Hebbal, Bangalore city. Tests on representative samples from groundwater were analysed for a number of different water quality parameters, such as pH, turbidity, total hardness, major cations (Ca, Mg, Na, K) and major anions (HCO3, SO4, Cl, NO3, F). Concentrated ions distributions are represented through contours using GIS for easy and better understanding of the groundwater pollution. Analysis of the samples are carried out for assessing the impact of solid waste on groundwater characteristics and check is it within the permissible limits following the guidelines of Standard for drinking water, if not proper segregation of solid waste need to be done at the source, minimizing the generation of waste, improving the methods of handling it, converting the generated waste into usable source etc.

Keywords: Urbanisation, Heavy metals, Contours, Anthropogenic, Decentralized

Introduction

India is the most populated country and stands second in economic growth in the world. In India during 2001-2026, the population is projected to grow from 1029 million to 1400 million (Vikash Talyan et al., 2007). As per the latest population census 2020, the urban population grew at a rate of 31.16 percent during the last decade 2011-2020. Roughly 285,000,000 residents live in urban areas and 742,000 in rural areas. The pace of urbanisation in the country is projected to grow from 28% in the last 50 years, up from 18% to 40% by 2026. A significant element of India's urbanisation is the phenomenal concentration of population in first-class (metropolitan) cities with more than 1 million inhabitants, as increased by number of metropolitans over the last few decades, from 25 to 40. Among these metropolitans, Bangalore, the capital of India's southern state of Karnataka, has a population of 12.3 million people, followed by Delhi, Mumbai, and Calcutta.

The higher the economic prosperity and the more urban population rises, the higher the volume of solid waste production. Urban Municipal solid waste is usually generated from human settlements, small industries and commercial activities. Bangalore generates 5000 tonnes of waste, out of which 30% waste is collected by BBMP directly and 70% of municipal solid waste (diverse urban wastes mixture of paper, plastic, cloth, metal, glass, organic matter etc.) is collected and transported through contractors (Subramani et al., 2014).

Improperly secured and controlled municipal solid waste poses a grave threat to the environment, especially surface and ground water. The magnitude and the distance between the leachate and the water sources are determined by the amount, quality and composition of this hazard. Solid waste leachate is a complex effluent consisting of dissolved minerals and organic materials, inorganic macro elements, heavy metals, organic xenobiotic compounds and a host of other toxic chemicals (human substances, fatty acids and aromatic compounds etc.). Leachate ends up in water held in soil or washed into underground water depending on the contaminant tendency. Groundwater is one of the most important and widely distributed natural resources. The precious resource has to be well understood in terms of its occurrence, behaviour and quality. Quality of water is a function of its physical, chemical and bacteriological characteristics which depends upon many factors like natural and anthropogenic activities.

Geographic information systems (GIS) have emerged as a critical tool for urban and resource planning and management in the last decade. GIS can assist individuals and organisations in better understanding spatial patterns and relationships in order to solve complex resource management problems. GIS will make use of any data that includes a position. The position can be defined in a variety of ways, including latitude and longitude. GIS allows you to compare and contrast several different types of data. With GIS technology, a single map could include information about the landscape, such as the location of streams, terrain undulations and different types of rocks and soils. Also it includes attribute data about people such as population, residential areas that are sensitive to pollution and industrial activity sites that produce pollution. Such GIS maps related to spatial and attribute data would help to determine where natural resources are most at risk.

During the early interlude, solid wastes were unremarkably disposed, as the density of population was low with large open space. Due to low waste disposal budgets and a lack of qualified labour in developing countries, open dumpsites are popular. Developing countries are often more deeply at risk of dumping, because they lack financial resources to upgrade their disposal facilities to make them more vulnerable to environmental risks.

The present work is aimed in assessing the impact on ground water quality from waste disposal in surrounding areas using geoinformatics.

Study area

Bangalore has unique topography terrain. North Bangalore is a flat plateau with an average elevation of 839 to 962 metres above sea level. Doddabettahalli, at 962 metres (3.156 feet) is the highest point on this plateau. The Peninsular Gneissic Complex (PGC) is the dominant rock group, accounting for two-thirds of the area and consisting of granites, gneissis, and migmatites. Bangalore's soils range from red laterite to clayey soil due to weathering of these PGC. There are seasonal rivers flowing through the city. Groundwater occurs in 10 to 20m thickness of weathered zone fractures and joints of granitic gneiss terrain. The area chosen is restricted within Longitude 77° 32’ 32.71’’ to 77° 36’ 19.44’’ N and latitude 13° 05’ 42.25’’ to 13° 00’ 39.88’’ E of the Hebbal city, located in the North zone of Bangalore. This area covers an approximately of 64 sq.km. as shown in (Fig. 1) bearing toposheet number 57H/9.

Drastic Horizontal growth of Bangalore exceeded the milestone of 13°05’06” N - 78°0’0” E from the establishment of International Airport, IT sectors and apartment dominances under Hebbal constitution. Local governments, however, are unable to provide adequate services such as solid waste management, water supply, road maintenance, and so on, due to a growing population and the rising demands of the Information Technology (IT) market (Ramachandra & Shruthi Bachamanda, 2007) (Fig. 2).

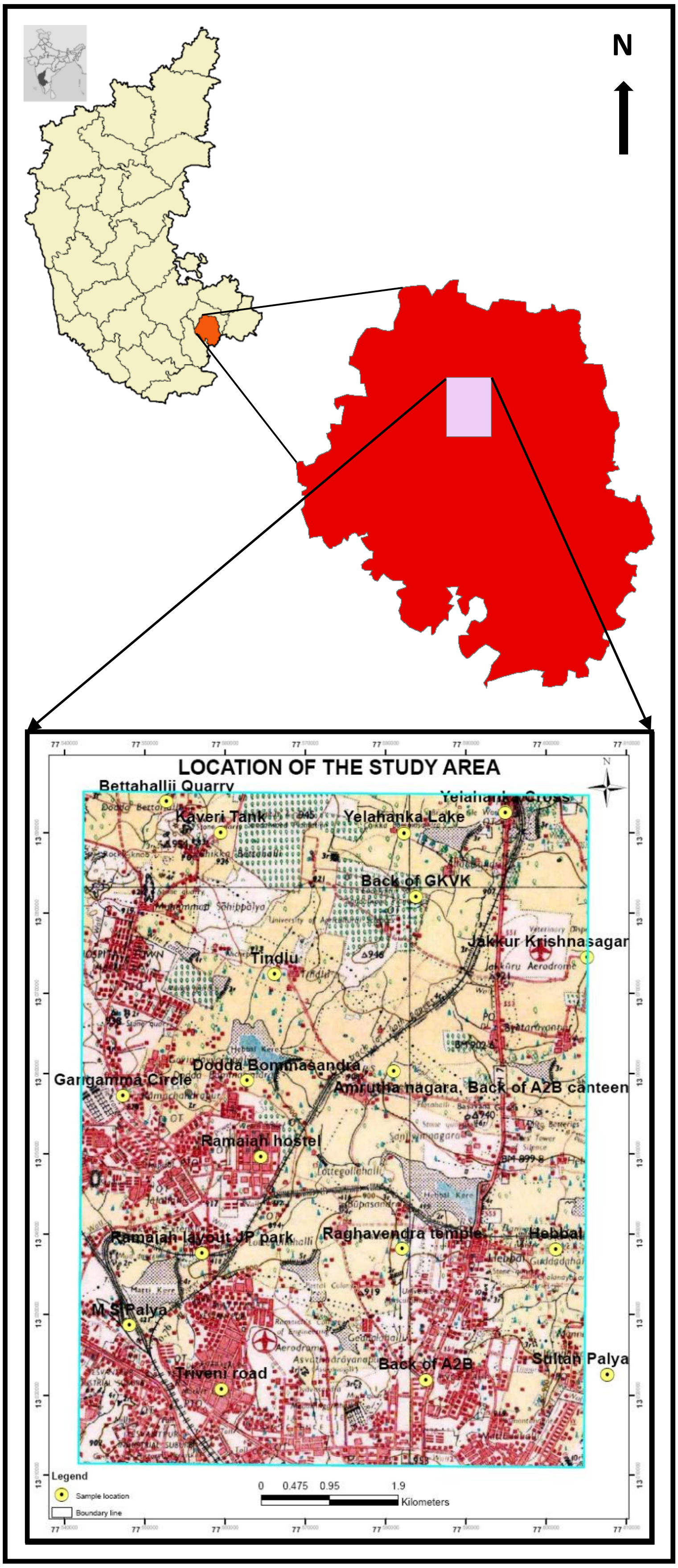

Figure 1. Location map of the study area

Figure 2. Waste disposal sites in the study area of the Hebbal city

Methodology

The derivation of any database is usually based on periodic in-situ investigation (Fig. 3). To determine the changes occurring in the underground water, a total of 20 groundwater samples were collected in and around the waste disposal sites during post-monsoon season of March 2020. After flushing water for 3–5 minutes to remove stagnated water, the wells outlets were sampled for groundwater. For sample storage, we used high-quality polyethylene bottles with tight lids. The bottles were cleaned with distilled water before use. Thereafter, for quality control purposes, samples were transported to a laboratory for examination (Table 1). The study of spatial distribution maps of the chemical constituents gives an idea about the temporal change and helps to correlate with characteristics of the groundwater systems. The maps of concentrations of different geochemical species with spatial variation in the study area have been plotted with the help of Arc view software.

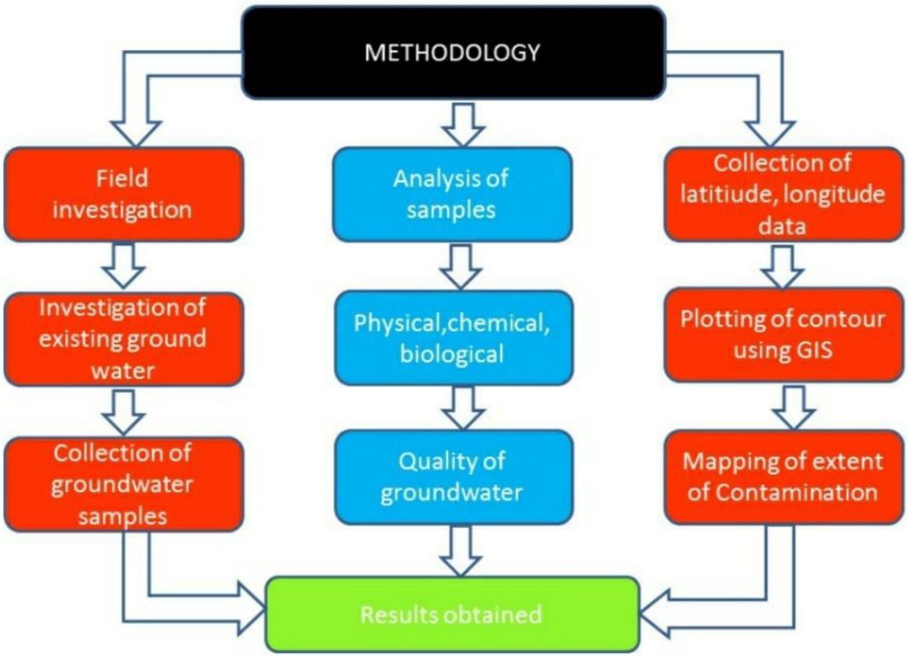

Figure 3. Flow chart showning the methodology adopted

Sl. No.	Name	Lat	Long	pH	EC	TDS	Ca	Mg	TH	HCO3	Na	K
1	Govardhan Theatre	13.0206	77.5596	7.5	1770	800	305	125	530	298	123	11
2	Triveni road	13.0207	77.5596	7.6	1040	620	130	50	388	312	112	10
3	Back of A2B	13.0219	77.5850	7.1	1641	950	155	55	383	389	145	15
4	Sultan Palya	13.0226	77.6076	7.6	909	650	185	65	268	245	106	10
5	Ramaiah layout JP park	13.0377	77.5571	7.7	1521	920	195	135	419	345	112	21
6	Ramaiah hostel	13.0497	77.5645	7.3	1630	830	285	85	370	326	107	10
7	Raghavendra temple	13.0382	77.5821	6.8	859	530	140	40	228	278	123	16
8	Hebbal	13.0382	77.6012	7.1	1320	550	290	52	342	178	96	11
9	Gangamma Circle	13.0573	77.5473	7.4	1880	1000	215	165	720	412	156	22
10	Dodda Bommasandra	13.0592	77.5628	7.6	930	450	280	138	418	378	105	10
11	Amrutha nagara	13.0604	77.5810	7.9	940	580	130	134	319	286	112	16
12	Sahakarnagar	13.0226	77.6076	7.1	1184	690	170	164	334	245	84	19
13	M S Palya	13.0287	77.5481	7.3	817	470	270	152	422	358	102	12
14	Tindlu	13.0724	77.5662	7.5	723	460	280	104	384	386	126	10
15	Back of GKVK	13.0821	77.5838	7.1	653	520	114	96	298	345	105	11
16	JakkurKrishnasagar	13.0746	77.6051	7.1	810	480	76	56	278	314	85	12
17	Bettahallii Quarry	13.0939	77.5527	8.1	930	680	325	75	400	289	225	10
18	Kaveri Tank	13.0900	77.5594	7.2	997	650	50	20	450	354	145	16
19	Yelahanka Lake	13.0900	77.5823	7.6	1309	890	169	47	363	342	119	19
20	Yelahanka Cross	13.0926	77.5949	7.5	1104	722	222	92	338	329	86	14
	Min.			6.8	653	450	50	20	228	178	84	10
	Max.			8.1	1880	1000	325	165	720	412	225	22

Avg.	7.4	1148	672	199	93	383	320	119	14

Table 1. Hydrochemical data of the Groundwater samples

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All parameters are expressed in mg/l except pH and EC

Table 1. Hydrochemical data of the Groundwater samples

Sl. No.	Name	SO4	Cl	F	NO3	Zn	Cu	Fe	Mn	Pb	DO	Total Acidity
1	Govardhan Theatre	74	196	0.36	6.24	0.89	0.016	1.21	0.22	0.00	7.20	76
2	Triveni road	18	312	0.65	10.12	0.36	0.000	2.60	0.10	0.06	2.80	40
3	Back of A2B	41	278	0.41	14.44	0.21	0.017	0.39	0.33	0.15	6.80	104
4	Sultan Palya	21	202	0.39	2.14	0.19	0.000	0.25	0.15	0.00	6.00	46
5	Ramaiah layout JP park	20	286	0.61	20.23	0.95	0.060	0.88	0.21	0.00	7.90	30
6	Ramaiah hostel	6	245	0.51	11.86	0.61	0.000	0.35	0.18	0.00	6.10	60
7	Raghavendra temple	10	211	0.45	12.10	0.45	0.000	0.74	0.17	0.00	7.80	76
8	Hebbal	39	430	0.35	37.12	2.10	0.030	3.26	0.38	0.09	6.10	60
9	Gangamma Circle	21	312	0.78	19.65	1.86	0.005	1.21	0.15	0.07	8.30	70
10	Dodda Bommasandra	15	186	0.65	4.12	0.45	0.000	0.26	0.18	0.00	6.80	44
11	Amrutha nagara	16	245	0.42	3.14	0.26	0.000	2.22	0.30	0.00	7.70	60
12	Sahakarnagar	20	212	0.79	8.11	0.11	0.000	0.31	0.19	0.00	7.10	24
13	M S Palya	31	178	0.96	19.24	0.19	0.000	0.25	0.18	0.00	6.80	58
14	Tindlu	45	221	0.45	5.64	0.36	0.000	0.36	0.24	0.00	5.80	100
15	Back of GKVK	24	178	0.89	3.24	0.14	0.000	0.24	0.18	0.00	1.40	70
16	JakkurKrishnasagar	21	158	0.26	2.11	0.26	0.000	0.29	0.19	0.00	7.20	50
17	Bettahallii Quarry	21	178	0.85	6.24	0.45	0.000	0.36	0.15	0.00	6.00	80
18	Kaveri Tank	29	341	0.96	2.56	0.36	0.000	0.21	0.20	0.00	6.90	48

19	Yelahanka Lake	39	256	0.56	3.48	0.78	0.047	1.26	0.31	0.02	3.50	76
20	Yelahanka Cross	25	205	0.43	5.12	0.15	0.000	2.20	0.26	0.00	0.20	70
	Min.	6	158	0.26	2.11	0.11	0.000	0.21	0.10	0.00	0.20	24
	Max.	74	430	0.96	37.12	2.10	0.060	3.26	0.38	0.15	8.30	104
	Avg.	27	242	0.59	9.85	0.56	0.009	0.94	0.21	0.02	5.92	62

All parameters are expressed in mg/l

Results and Discussion

Water quality maps

The spatial distribution maps of ionic constituents are delineated in the study area to represent the regions of high and low concentrations along with the extent of spread. Seasonally, the concentration of groundwater varies, as does the depth and position of the well and also these may be compared with anthropogenic activities related to relief, land use, rainfall, lithology, groundwater movement etc. The pH of water is used to calculate solubility since it is a measure of its consistency and geochemical equilibrium (Hem, 1985). Most natural groundwater have pH of 4 to 9; the pH value depends on the carbondioxide-carbonate-bicarbonate equilibrium. pH also changes due to the variation in temperature and pressure. The pH value in groundwater samples ranges 6.8 to 8.1 with an average of 7.4. Maximum concentration of pH (Fig. 4a) found in northern and central part of the study area. The spatial change in pH may be due to the variation in lithology and the chemical reactions of water during its flow.

The capacity of a solution to neutralise bases is measured by its acidity. Total Acidity value for ground water is 50mg/l. In the study area, Total acidity values range from 24 to 104 mg/l with an average value of 62 mg/l. The spatial distribution map (Fig. 4b) suggests that the water is prone to acidic in the southern part of the area. Groundwater affected by industrial activities may show high in concentrations.

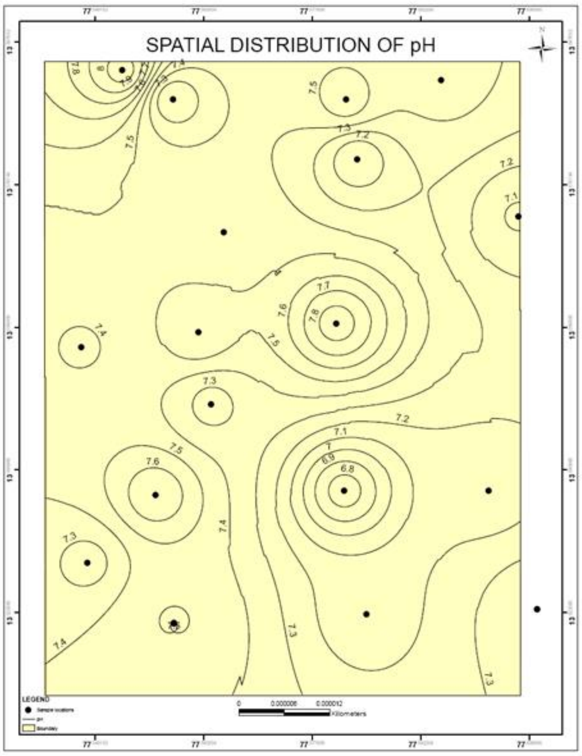

Figure 4a. Spatial distribution of pHin study area

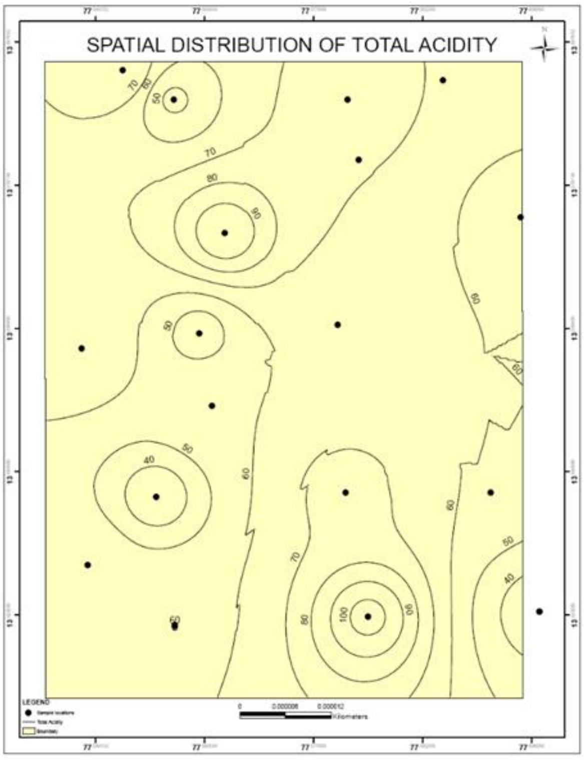

Figure 4b. Spatial distribution of Total Acidityin study area

The electrical conductivity of water is affected by temperature, concentration, and the type of ions present (Hem, 1985). The EC value varies from 653 to 1880 µS/cm with an average of 1148 µS/cm. This is a general range for relatively un-mineralized to mineralized zones ranging in greater than 1000 µs/cm. The spatial distribution maps (Fig. 4c) of the area suggests that anomalous zones are observed in southern and western part of the study area. The difference in the groundwater values (Table 1) may reflect the wide variation in the activities and chemical processes prevailing in the region.

Total dissolved solids (TDS) comprise concentration of all dissolved minerals of inorganic salts that are dissolved in water. TDS ranges from 450 to 1000 mg/l with an average of 672 mg/l. According to BIS (Indian Standard for Drinking Water, 1991), 85% of the study area samples fall under permissible limit for drinking than the desirable limit (Table 2). The spatial distribution map (Fig. 4d) suggests that anomalous zones are in southern, western and northern part of the study area. The disposal of untreated waste from the manufacturing environment is likely to increase TDS.

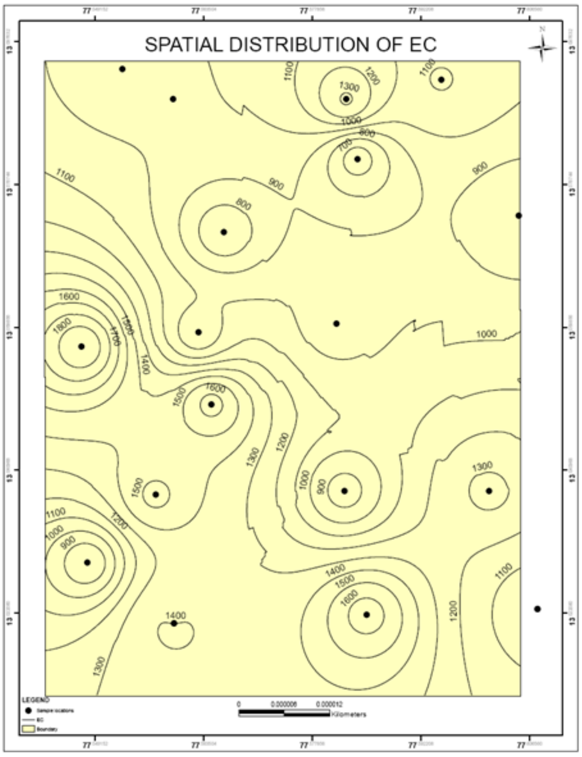

Figure 4c. Spatial distribution of Electrical Conductivityin study area

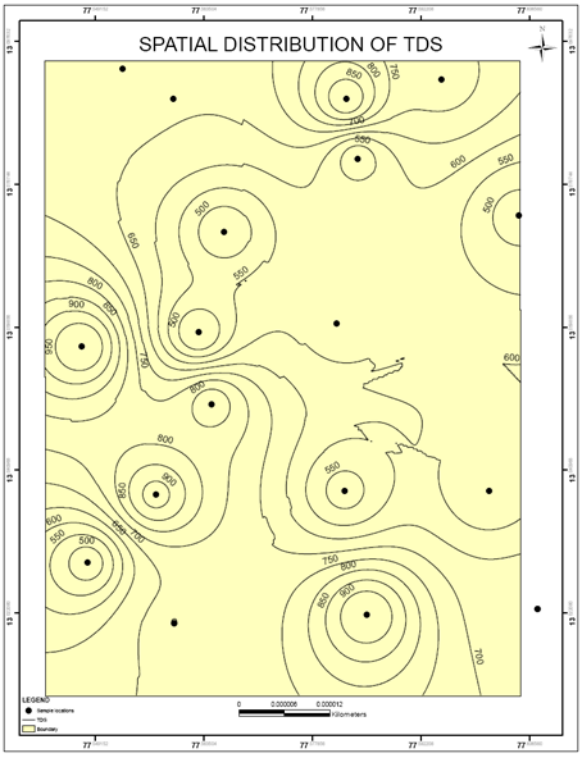

Figure 4d. Spatial distribution of Total dissolved solidsin study area

The Ca concentration is varying from 50 to 325 mg/l with an average of 199 mg/l. The principal sources of calcium in the study area are due to interaction of minerals like plagioclase, pyroxene, amphibole and weathering process happens in granitic-gneiss terrain. Mg is most common in ferromagnesium minerals such as hornblende and biotite. Mg concentrations range from 20 to 165 mg/l, with an average of 93 mg/l. Magnesium carbonate is almost ten times more soluble in water in the presence of CO_2 than calcium carbonate under normal atmospheric conditions. This means that the Mg concentration should be more than that of calcium. But, waters that have undergone Base Exchange may be abstracted of magnesium (Karanth, 1987). In the study area, the magnesium concentration in all the samples is less than that of calcium. This suggests that Base Exchange is one of the processes of weathering. Mg along with Ca is the principal source of hardness in water.

The temporary hardness (carbonate hardness) is caused due to the presence of high alkalinity. Non-carbonate hardness, also known as permanent hardness, is caused by sulphate and calcium and magnesium chlorides. The BIS limit for Total Hardness is 600 mg/l. According to the Sawyer and Mc Carty (1967) classification, the samples of the area fall under hard and very hard water conditions. The spatial distribution of hardness in the area is presented in (Fig. 4e) and the maximum value is recorded in the western part of the study area.

Bicarbonate is the dominant anion and also a constituent along with carbonate that contribute to alkalinity. Alkalinity determinations has quite high values (Table 1) with an average for HCO_3 is 320 mg/l. Silicate weathering may be to blame for the higher concentrations, particularly in the south and west (Fig. 4f). The concentration of HCO_3 in groundwater rises as a result of silicate weathering (ArtimesGhassemiDehnavi et al., 2011).

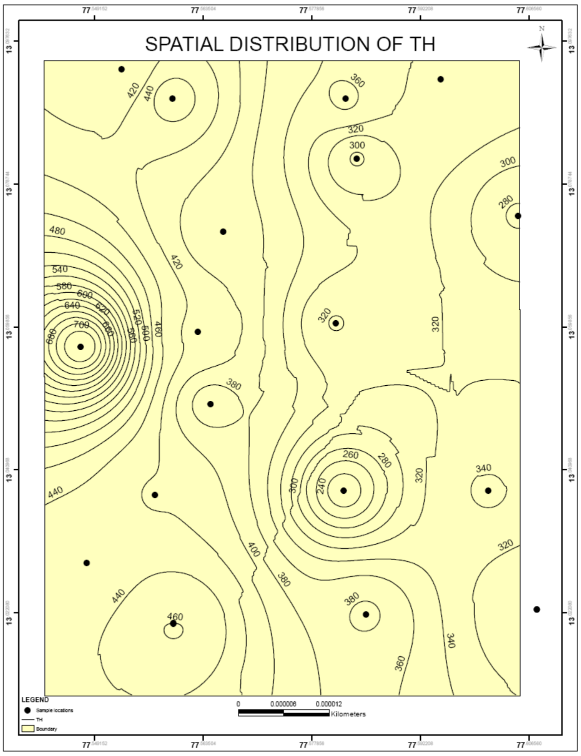

Figure 4e. Spatial distribution of Temporary Hardnessin study area

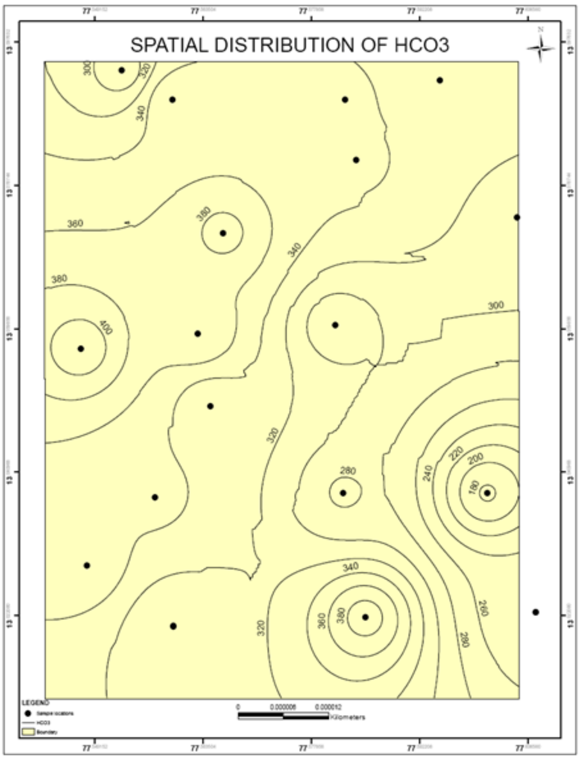

Figure 4f. Spatial distribution of Bicarbonatein study area

Sodium is released into groundwater as a result of weathering. Certain clay minerals, such as sodic feldspars ($NaAlSi_3O_8$), that weather easily, can increase the sodium content of groundwater via the Base Exchange reaction. Concentration increases from 84 to 225 mg/l with an average of 119 mg/l in the study area and comprises more in northern part (Fig. 4g). The area consist primary source minerals of plagioclase feldspar and hornblende that are present in the granite rocks exposed for quarry works.

The principal sources of potassium in groundwater are the silicate minerals. Potassium generally appears to be within 10 mg/l in ground water due to its higher solubility (Bouwer, 1978). K concentration is varying from 10 to 22 mg/l with an average of 14 mg/l. The anomalous zones in the area are the northern and western part. High K in such area which is above the permissible range may include sources such as weathering of potash silicate minerals, rain water and application of potash fertilizer (Jain et al., 2010).

Nitrogenous materials are rare in the geological record (Subba Rao et al., 2007). Natural nitrate levels in groundwater are generally very low but nitrate concentrations grow due to anthropogenic activities. Nitrate concentrations range from 2.11 to 37.12 mg/l in the study area, with an average of 9.85 mg/l, and BIS allows for Nitrate concentrations of up to 45 mg/l in groundwater. Nitrate is highly mobile in aerated groundwater (Foster & Crease, 1974). The potential sources of pollution include household wastes, septic tanks, human waste lagoons and animal feed-lots as point sources and manure applied to property, agricultural fertilisers, industrial effluents, natural soil organic matter etc., as non-point sources (Lang et al., 2006). The maximum values are recorded (Fig. 4h) in south eastern part suggest that the presence of increasing nitrate is doubtless a pathfinder for organic pollutants. Nitrate has long been linked with the occurrence of methanemoglobinemia in young children (World Health Organization, 1992) when beyond permissible limits and it is therefore recommended that high NO_3 water is not fed to infants (Table 3).

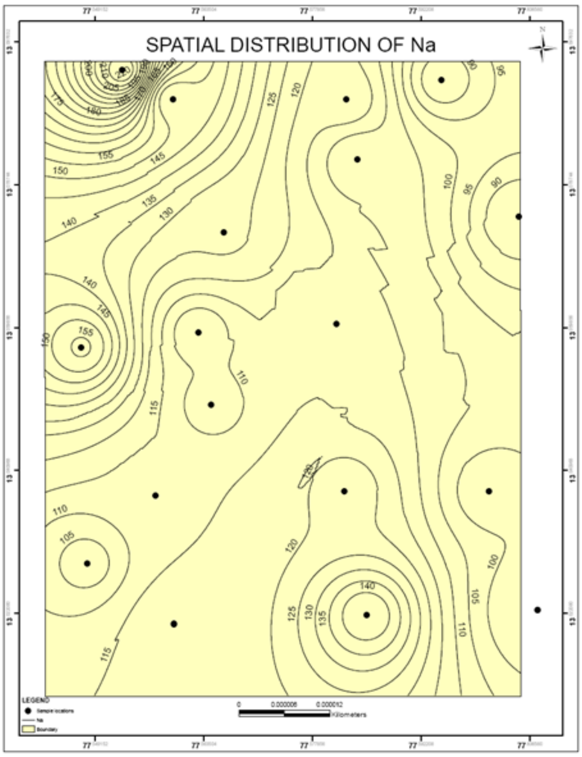

Figure 4g. Spatial distribution of Sodiumin study area

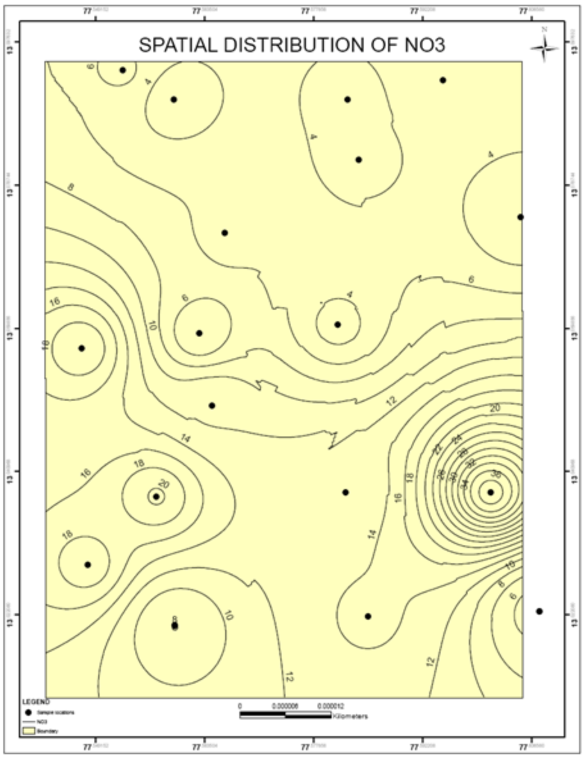

Figure 4h. Spatial distribution of Nitratein study area

Chloride is often attached to sodium, in the form of sodium chloride (NaCl). It is present in the rare mineral sodalite and as minor component of the phosphate mineral, apatite (Hem, 1985). The Cl concentration is varying from 158 to 430 mg/l with an average of 242 mg/l. The desirable range of chloride in natural water is 250 mg/l, however it is permissible up to 1000 mg/l. The spatial distribution of chloride of inconsistent zones in the study area is shown in (Fig. 4i) and maximum values are recorded in the north east and south west part. Higher value of the chloride range in the groundwater is due to the influence of domestic sewage, industrial waste effluent discharge and some extent of weathering of rocks (Craig & Anderson, 1979; Karanth, 1987).

All natural groundwater contains some dissolved iron in traces. Iron is mostly present in the form of complex silicate minerals like pyroxenes, amphiboles and micas in igneous and metamorphic rocks. The desirable range of iron in natural water is 0.3 - 1.0 mg/l. The Fe variation starts from 0.21 to 3.26 mg/l with an average of 0.94 mg/l. May be due to long residence time, the iron is high in concentration in the northern, eastern and southern part of the area (Fig. 4j) or iron may be developed in groundwater due to the contact of iron objects like well casings, delivery pipes etc.

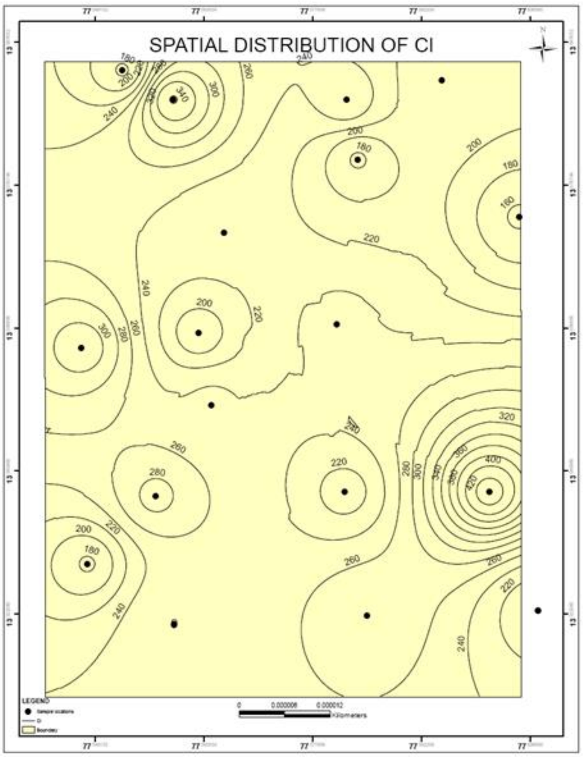

Figure 4i. Spatial distribution of Chloridein study area

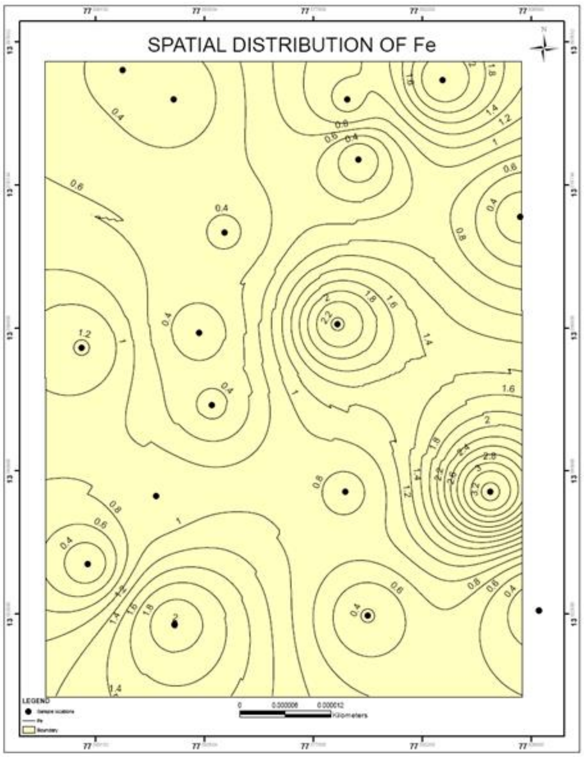

Figure 4j. Spatial distribution of Ironin study area

Zinc is generally associated with igneous and metamorphic rocks in same proportions as copper. However, Zn is more soluble in water. The BIS limit for zinc is 5mg/l. All the samples of the study area are within the desirable limit. The spatial distribution map (Fig. 4k) suggests that the zinc concentration is observed increasing in west and east part of the study area. The host rocks of groundwater situated are granite and gneiss and may lead into the increase of zinc concentration.

The level of copper in groundwater is generally very low due to its co-precipitation by oxides or adsorption on mineral surfaces (Hem, 1989). The permissible limit of copper in drinking water is 1.5 mg/l. 95% of the samples of the study area is within desirable limit of 0.05 mg/l. The spatial distribution of Cu is presented in (Fig. 4l). The source of high Cu in the study area may be due to the septic systems, industrial waste and food processing waste.

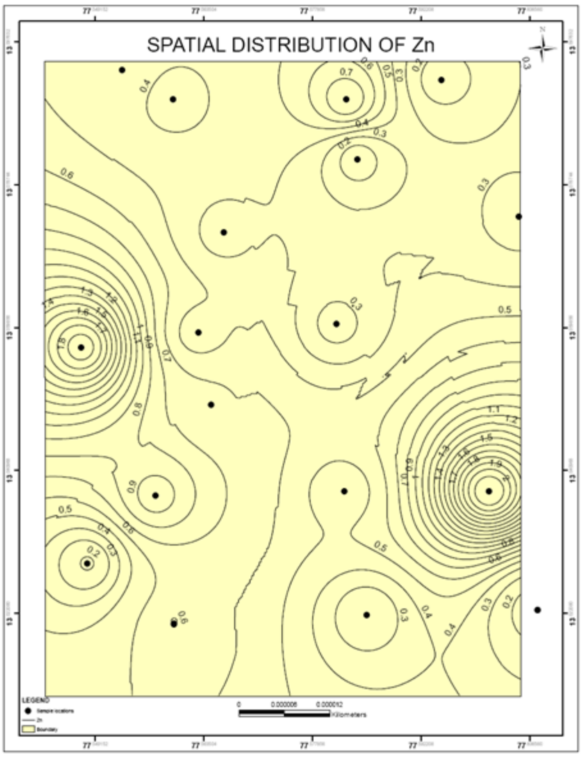

Figure 4k. Spatial distribution of Zinc in study area

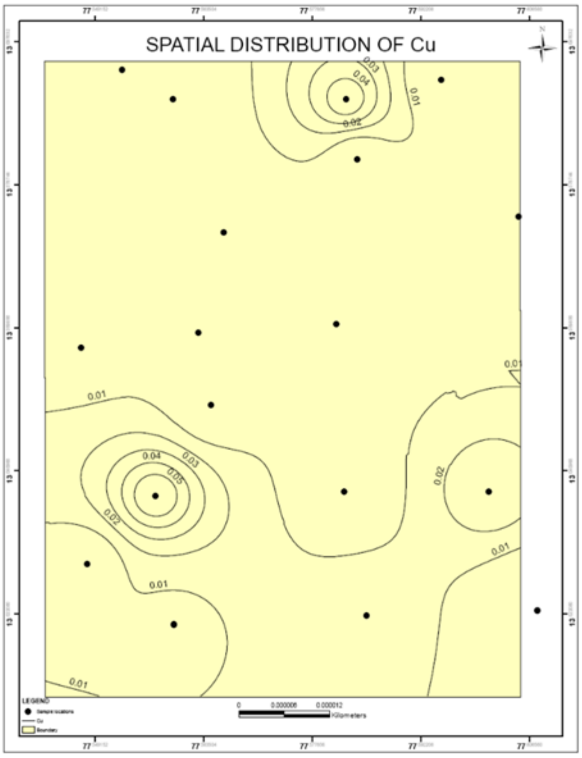

Figure 4l. Spatial distribution of Copper in study area

Manganese contain negligible amount in igneous rocks. When solid waste is dissolved, it usually contains a lot of manganese (Hughes, 2004). Manganese stains are more objectionable and difficult to remove than iron stains (Omofonmwan&Eseigbe, 2009). According to BIS drinking water regulations, 75 % of Mn is below detectable limit in most of the samples as the permissible limit for the manganese is 0.3 mg/l. Taste and appearance are affected beyond this stage, and it has a negative impact on domestic uses and water supply systems. The maximum values are recorded (Fig. 4m) in south eastern and northern part of the study area. Increasing zones of Mn indicates the possible sources from industrial waste and mining.

Lead in natural water is normally present at low concentrations because Pb containing minerals is less soluble in water (Rai &Saha, 2015). The permissible limit for lead with respect to BIS is 0.05 mg/l. Lead is a trace element of interest because the natural background in groundwater generally exceeds depending on the aquifer material or pollutants from the surface. The higher lead concentrations have been found (Fig. 4n) in south eastern and western part of the boundary. The unevenly distributed of Pb in the study area indicates the severe contamination is due to waste of electric and electronic equipment's, used batteries, tires, hazardous waste used in industries, automobiles and in construction and demolition works.

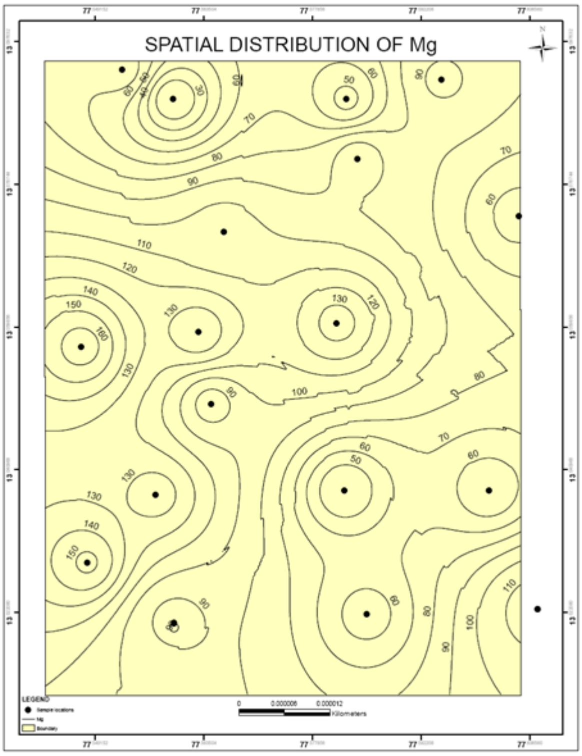

Figure 4m. Spatial distribution of Manganesein study area

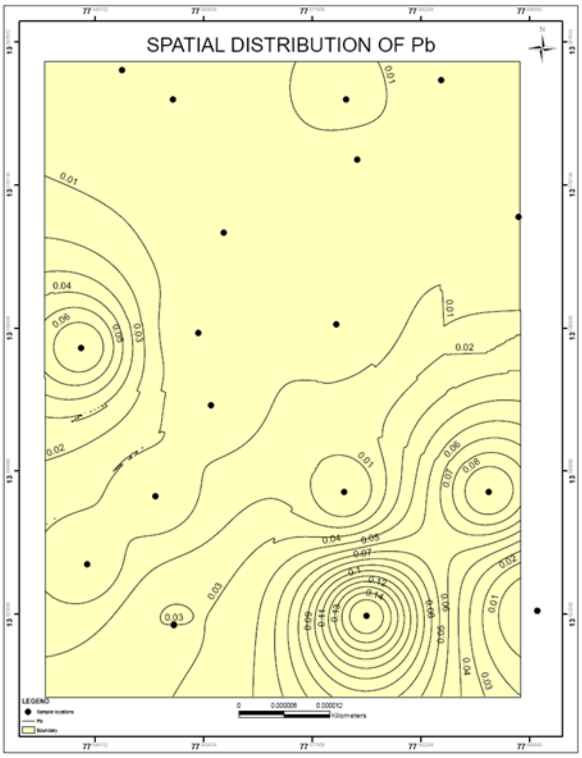

Figure 4n. Spatial distribution of Lead in study area

Table 2. The groundwater samples suitability for drinking purpose by BIS standards

Chemical constituents	Limits#	No. of samples falling in the limit	Percentage of the total
pH	Desirable 6.5 to 8.5	20	100%
	Permissible 8.5 to 9.2	0	0%
	Not suitable >9.2	0	0%
TDS	Desirable <500	3	15%
	Permissible 500-2000	17	85%
	Not suitable >2000	0	0%
Ca	Desirable <75	1	5%
	Permissible 75-200	11	55%
	Not suitable >200	8	40%
Mg	Desirable <30	1	5%
	Permissible 30-100	11	55%
	Not suitable >100	8	40%
TH	Desirable <300	4	20%
	Permissible 300-600	15	75%

	Not suitable >600	1	5%
	Desirable <30	0	0%
HCO3	Permissible 30-150	0	0%
	Not suitable >150	20	100%
	Desirable <200	20	100%
SO4	Permissible 200-400	0	0%
	Not suitable >400	0	0%
	Desirable <250	13	65%
Cl	Permissible 250-1000	7	35%
	Not suitable >1000	0	0%
	Desirable <1.0	20	100%
F	Permissible 1.0-1.5	0	0%
	Not suitable >1.5	0	0%
	Desirable <45	20	100%
NO3	Permissible 45-100	0	0%
	Not suitable >100	0	0%
	Desirable <5	20	100%
Zn	Permissible 5-15	0	0%
	Not suitable >15	0	0%
	Desirable <0.05	19	95%
Cu	Permissible 0.05-1.50	1	5%
	Not suitable >1.50	0	0%
	Desirable <0.30	6	30%
Fe	Permissible 0.30- 1.0	7	35%
	Not suitable >1.0	7	35%
	Desirable <0.1	1	5%
Mn	Permissible 0.1 – 0.3	15	75%
	Not suitable >0.3	4	20%
	Desirable <0.01	15	75%
Pb	Permissible 0.01-0.05	2	10%
	Not suitable >0.05	3	15%

All parameters are expressed in mg/l except pH and EC

#BIS standards (Indian Standard for Drinking Water, 1991).

Table 3. Standards for drinking water and their potential impact on human health

Chemical constituents	**BIS+**		**WHO-**		**Undesirable effects**
	Desirable limit	**Permissible limit**	**Acceptable**	**Allowable**	
pH	6.5	8.5	7.0-8.5	6.5-8.5	Affects taste, corrosivity and supply system.
EC	750	-	750	1400	Causes increased blood pressure in susceptible people, upset the salt balance in our bodies, unsafe to drink.
TDS	500	2000	500	1500	Irritation, corrosion and laxatives in the gastric arteries for new users.
Ca	75	200	75	200	Excessive cause's incrustations, deficiencies lead to ricketing, indispensable for nervous, muscle, cardiac and blood coagulation work.
Mg	30	100	50	150	His salts are diuretic and cathartic.
Total Hardness	300	600	-	500	Excessive use of soap, artery calcification.
HCO3	30	150	30	150	Unpleasant taste in the presence of high pH, TDS and hardness that are harmful to humans.
Na	-	-	175	200	Harmful to people with heart disease, kidney and blood circulation.
K	-	-	-	12	Nutritional elements are essential, but in abundance,

					they are cathartic.
SO4	200	400	200	400	Irritates the stomach and intestines. It has a cathartic effect when combined with Mg and Na.
Cl	250	1000	250	1000	Effects on patients with heart disease and kidney disease. Taste, indigestion, corrosion, and palatability all suffer as a result of this.
F	1.0	1.5	-	1.0	Causes crippling skeletal fluorosis.
NO3	45	100	45	100	Causes child methaemoglobinemia and gastric cancer, as well as having an effect on the central nervous and cardiovascular systems.
Zn	5	15	3.0	5.0	Imparts astringent taste to water.
Cu	0.05	1.50	1.0	1.5	It harms the liver, irritates the central nervous system and makes people depressed. Corrosion of Al in water supply systems is accelerated.
Fe	0.30	1.0	0.3	-	Laundry and porcelain are stained as a result of this substance.
Mn	0.1	0.3	-	-	Causes laxative effect.
Pb	0.01	0.05	-	-	Burning in the mouth, extreme gastro-intestinal inflammation, vomiting and diarrhoea.
DO	-	5.0	-	-	Speed up corrosion in water

					pipes.
TOTAL ACIDITY	-	-	-	-	It gives unpleasant taste.

All parameters are expressed in mg/l except pH and EC

+BIS standards (Indian Standard for Drinking Water, 1991).

-WHO standards (World Health Organization, 1992).

Conclusions

The contamination of ground water is the major environmental risk related to urban sprawl as well as land use change. In the study area, all the groundwater quality parameter showed a variation in hydro-chemical composition. The spatial variation of groundwater contamination is caused mainly due to localized industrial activities and improper disposal of solid waste. Crude dumping of solid waste in open spaces which constantly block both primary as well as secondary drainage networks and pools of stagnant water. The leachate from solid waste polluted not just the groundwater, but also the surface water.

The presence of high concentrations of the above parameters indicates that the groundwater sample obtained from the dump site is unfit for human use, as the groundwater samples exceeded both the appropriate and allowable limits set by BIS drinking water requirements. The quality of groundwater is not suitable for drinking and domestic purposes before treating it. Use of RO filters, Active carbon filters, Ceramic filters can make the ground water potable but the root cause of the pollution has to be taken care for a permanent solution and hence care to be taken for proper disposal of solid waste by providing impermeable strata at the dump site and select suitable dumping sites which do not interfere the ground water. The decentralised approach has the potential to minimise waste volume and pollution of ground water by leachate seepage, making it one of the most successful approaches for solving waste management problems in the study area.

References

Vikash Talyan,R.P.,Dahiya, T.R., & Sreekrishnan. (2007). State of municipal solid waste management in Delhi, the capital of India.

Subramani, T., Umarani, R.,& Bharathi Devi, S.K. (2014). Sustainable Decentralized model for solid waste management in urban India. Int. Journal of Engineering Research and Applications, 4(6), 264-269.

Ramachandra, T.V.,& Shruthi Bachamanda. (2007). Environmental audit of Municipal solid waste management.Int. J. Environmental Technology and Management, 7.

Hem, J.D. (1985).Study and interpretation of the chemical characteristics of natural water.U.S. Geological Survey, Water Supply Paper.

Water quality standards. Indian Standard for Drinking Water - Specification IS 10500, 1991.

Karanth,K.R. (1987). Groundwater assessment, development and management.Tata McGraw Hill, New Delhi.

Sawyer,G.N.,& Mc Carthy,D.L. (1967).Chemistry of sanitary Engineers. 2nd Ed., McGraw Hill, New York, 1967.

Artimes Ghassemi Dehnavi, Ramin Sarikhani,& Nagaraju, D. (2011). Hydro Geochemical and Rock water interaction studies in east of Kurdistan, N-W of Iran.Int. Journal of Environmental Sciences and research, 1, 16-22.

Bouwer,H. (1978). Groundwater hydrology.Int. student edition, McGraw-Hill, Kogakusha Ltd., Tokyo.

Jain,C.K.,Bandyopadhyay, A., & Bhadra,A. (2010). Assessment of ground water quality for drinking purpose, District Nainital, Uttarakhand. India. Environ. Monit. Assess., 166, 663–676.

Subba Rao,N., Prakash Rao, J.,& Subrahmanyam,A.(2007). Principal Component Analysis in Groundwater quality in a developing urban area of Andhra Pradesh.Journal of Geological Society of India, 69, 959-969.

Foster, S.S.D.,& Crease,R.I.(1974). Nitrate pollution of chalk groundwater in east Yorkshire - A hydrogeological appraisal.J. Inst. Water Engrs., 28, 178-194.

Lang,Y.C., Liu,C.Q., Zhao,Z.Q., Li, S.L.,& Han,G.L.(2006). Geochemistry of surface and groundwater in Guiyang, China: water/rock interaction and pollution in a karst hydrological system.Appl. Geochem., 21, 887–903.

World Health Organization.International Health Regulations, 3rd annotated ed., Geneva, 1992.

Craig, E., & Anderson,M.P.(1979). The effects of urbanization of ground water quality. A case study of ground water ecosystems.Environ. Conserve, 30(2), 104–130.

Hem, J.D. (1989). Study and Interpretation of Chemical Characteristics of Natural water. 3rd edition, United States Govt. Printing office.

Hughes,J.L.(2004).Evaluation of groundwater Degradation Result from Waste Disposal to Alluvium Near Barstow, California, U.S. Geological survey professional paper, 878.

Omofonmwan, S.I., & Eseigbe,J.O.(2009). Effects of Solid Waste on the Quality of Underground Water in Benin Metropolis, Nigeria.Journal of Human Ecology, 26.

Rai, S.C., & Saha, A. K. (2015).Impact of urban sprawl on groundwater quality: a case study of Faridabad city, National Capital Region of Delhi.Arabian Journal of Geosciences, 8, 8039–8045.