Groundwater Quality Assessment for Drinking Purpose in Hisar City, Haryana

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***Abstract*- In arid to semi-arid regions of the world, groundwater is the main source for drinking, irrigation and industrial uses. The availability and good quality of groundwater play vital role in agriculture and industrial development in an area. Remote sensing satellite data, geographical information system and global positioning system are highly useful for searching potential groundwater sites as well as providing clues for groundwater quality. In the present study, groundwater quality in Hisar city has been assessed using primary groundwater quality data, remote sensing satellite data (Worldview-2), geographical information system(GIS) and GPS.Hisar city boundary has been demarcated with the help of satellite data and prepared a base map. The sample location sites were marked on the base map. GPS was used to locate the sample location sites. 40 groundwater samples were collected in the months of January-February 2015. The sources of groundwater sample were hand pumps and tube well. The samples were analysed using Field Water Testing Kit prepared by Tamilnadu Water Supply and Drainage Board, Chennai for pH, alkalinity, hardness, chloride, total dissolved solids, iron, fluoride, nitrate and ammonia parameters. The groundwater analysis result show that pH ranges 7 to 8; alkalinity 50 mg/l to 400 mg/l; hardness 100 mg/l to 900 mg/l; chloride 50 mg/l to 900 mg/l; fluoride 0.5 mg/l to 5 mg/l; iron nil to 2 mg/l; ammonia nil to 5 mg/l; nitrate 45 mg/l to 75 mg/land total dissolved solids 240 mg/l to 2172 mg/l in the city area. The groundwater analysis data were entered in ArcGIS 9.3 software and inverse distance weighted (IDW) interpolation technique was applied to know the spatial scenario of quality parameters in the study area. The data were categorised in to desirable, permissible and non-potable classes according to IS 10500:2012 drinking water standards. The pH is under desirable;alkalinity under desirable and permissible; hardness under desirable, permissible and non-potable; chloride under desirable and permissible; fluoride under desirable, permissible and non-potable; iron under desirable and non-potable; nitrate under desirable and non-potable; ammonia under desirable and non-potablein the study area.The study is highly useful for planning and management of groundwater for drinking purpose in the study area.**

Keywords: Groundwater, quality, drinking, GIS, Hisar

I. INTRODUCTION

In the present context of global changing in natural and cultural environment, it becomes need of hour to sustainably use the natural resources for fulfilling the needs. Of all the natural resources, water is prime requirement for living beings. In arid to semi-arid regions of the world, groundwater is the main source for drinking, irrigation and industrial purposes. The use of modern technology like remote sensing, GIS and GPS facilitate in better planning and management of resources. Many workers have done good work on groundwater resource mapping using satellite data, GIS and GPS technologies [1, 2, 3, 4].

II. STUDY AREA

In the present study, Hisar city area has been demarcated on World View-2 satellite data for the year 2009.The study area is situated in south-western part of Haryana state. The geographical coordinates of the study area are $29^0$06'3.177"N-$29^0$12'9.617"N latitude and $75^0$40'14.425E-$75^0$52'15.298E longitude which covers 89.27sq.km area.

III. MATERIALS AND METHOD

Worldview-2 satellite data for the year 2009 have been used to demarcate the Hisar city area. 40 groundwater samples have been collected from city area (Fig.1) in the months of January-February 2015 and location recorded in Garmin 72 GPS. Field Water Testing Kit prepared by Tamilnadu Water Supply and Drainage Board,Chennai has been used for groundwater samples analysis for various parameters (Table 1).ArcGIS 9.3software has been used for Inverse Distance Weighted (IDW) interpolation of groundwater samples and categorised as per IS 10500:2012 drinking water standards (Table 2).

Table 1. Details of groundwater sample analysis

Location Name	Sampling Date	pH	Alkalinity (mg/l)	Hardness (mg/l)	Total Dissolved Solids(mg/l)	Chloride (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Ammonia (mg/l)	Nitrate (mg/l)
Gate No.3, HAU	03.02.2015	8	400	200	1320	500	5	0	0	75
Balsamand Road, Near Railway Crossing	03.02.2015	8	200	560	1392	400	0.5	0	1	45
Gate No.1, HAU	03.02.2015	8	230	400	1116	300	1.5	0	2	45
Fountain Chowk	10.01.2015	8	220	200	564	50	1.5	0	0.5	45
Jat College	10.01.2015	8	130	130	372	50	1.5	0	0	75
Sabzi Mandi	10.01.2015	8	150	140	444	80	1.5	0	1	45
Govt. Women ITI	10.01.2015	8	250	200	720	150	1	0	1	45
Parmanand Arya Chowk, JahajPul	10.01.2015	8	200	400	1056	280	1	0	1	45
Laheria Chowk	10.01.2015	8	350	120	684	100	3	0	5	45
O.P. Jindal Memorial Park	10.01.2015	7	50	100	240	50	0.5	0	1	45
Water Works, Sector 1-4	10.01.2015	7	130	190	456	60	0.5	0	1	45
Dubra Chowk	03.02.2015	8	240	200	708	150	5	0	2	75
DC Colony Market	10.01.2015	8	300	250	960	250	1	0	0	75
Jindal Institute of Medical Sciences	10.01.2015	8	130	250	696	200	1	0	1	45
Old Industrial Area, Delhi Road	10.01.2015	7.5	220	690	2172	900	1.5	0	1	45
Ganesh Market, Vidhyut Nagar	10.01.2015	8	150	560	1872	850	1	0	0.5	45
Baba Gorakhnath Mandir, Satrod Bypass	10.01.2015	8	180	330	864	210	1	2	1	45
Bhanu Chowk, Delhi Road	10.01.2015	8	250	280	936	250	1	0	1	45
Main Gate, Army Cantt.	10.01.2015	8	200	800	1704	420	0.5	0	0.5	45
Delhi Bypass, Near Hyundai Showroom	10.01.2015	8	100	100	324	70	0.5	0	1	45
Delhi Bypass, Near Canal	10.01.2015	8	180	400	984	240	1	0	1	45
Govt. Polytechnic	10.01.2015	7	60	180	360	60	3	0	5	45
Police Line	10.01.2015	8	180	250	588	60	0.5	0	0	45
GJU City Gate, Near Fire Station	10.01.2015	8	180	420	936	180	0.5	0	1	45
Barwala Chungi	10.01.2015	8	250	330	828	110	0.5	0	0	45
Auto Market	10.01.2015	8	280	560	1260	210	0.5	0	0.5	45
Cloth Market	10.01.2015	7	100	490	1008	250	0.5	0	1	45
Civil Hospital	10.01.2015	8	150	400	1020	300	0.5	0	0.5	75
Sector-14	10.01.2015	8	190	260	720	150	0.5	0	1	45
Grain Market	10.01.2015	7	230	300	816	150	1.5	0	1	45
Bus Stand	10.01.2015	8	130	400	876	200	1	0	0.5	45
Firoz Shah Complex	10.01.2015	7	140	900	1668	350	0.5	0	1	45
Nagori Gate	10.01.2015	8	180	600	1260	270	0.5	0	0.5	45
Parijat Chowk	10.01.2015	8	230	400	1056	250	1	0	0	75
Red Square Market	10.01.2015	8	150	580	1596	600	1	0	0	45
Railway Station	10.01.2015	8	180	400	1092	330	1.5	0	0.5	45
PLA	03.02.2015	8	220	460	996	150	2	0	1	75
Rajgarh Road, Opp. Court Complex	03.02.2015	8	150	400	900	200	0.5	0	2	45
Azad Nagar	03.02.2015	8	400	700	1500	150	1	0	0	20
Gate No.4,HAU	03.02.2015	8	150	800	1920	650	1	0	0.5	45
Shopping Complex, HAU	03.02.2015	8	230	250	756	150	1	0	0.5	45

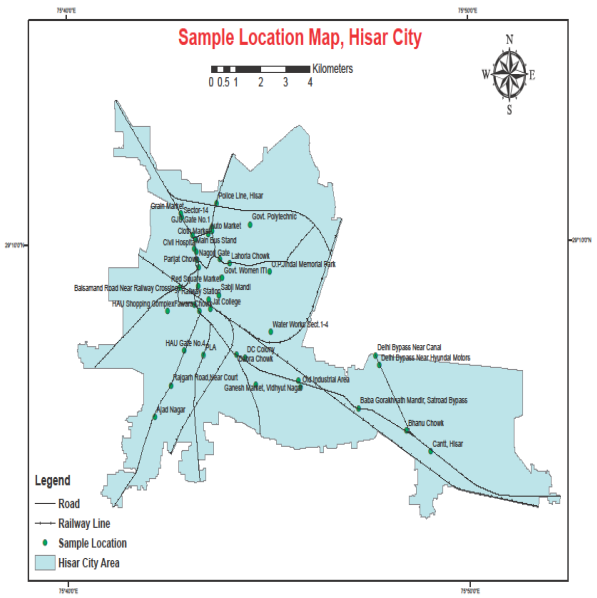

Fig.1. Sample location map

Table 2. Drinking water parameters standard (is 10500:2012)

Parameter	Desirable	Permissible	Non-potable
pH	6.5-8.5	-	-
Alkalinity (mg/l)	< 200	200-600	> 600
Hardness (mg/l)	< 200	200-600	> 600
Iron (mg/l)	< 0.3	-	-
Chloride (mg/l)	< 250	250-1000	>1000
Total Dissolved Solids (TDS) (mg/l)	< 500	500-2000	>2000
Nitrate (mg/l)	< 45	-	-
Fluoride (mg/l)	< 1.0	1.0-1.5	>1.5
Ammonia (mg/l)	0.5	-	-

IV. RESULTS AND DISCUSSION

In the study drinking water quality of groundwater has been assessed based on pH, alkalinity, hardness, chloride, total dissolved solids, fluoride, iron, ammonia and nitrate.

pH

In the study area, pH ranges between 7 to 8 which is under desirable limit (6.5-8.5)of drinking water parameters of IS 10500:2012. As the pH in whole study area is under desirable limit, hence, covers 100% area falls under desirable limit. (Fig.3 and Table3).

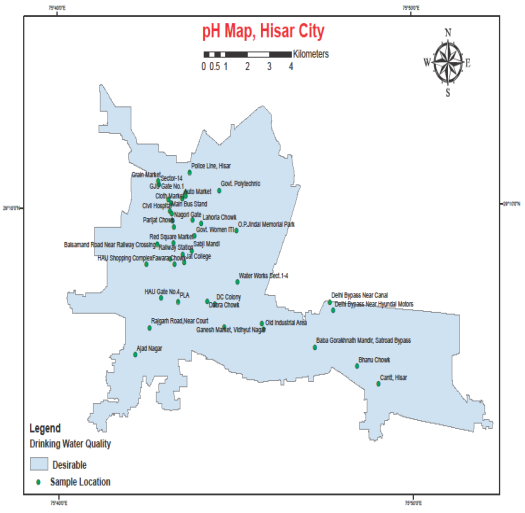

Fig.3. Spatial scenario of pH in Hisar city

Table 3. Area of ph under various drinking water categories

Drinking water Category (pH)	Area (sq.km)	Percentage of Total Area
Desirable	89.27	100
Total	89.27	100

Alkalinity

Alkalinity in the study area ranges between 50mg/l to 400mg/l which falls under desirable (<200mg/l) and permissible (200-600mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 57.66 sq.km (64.59%) and permissible limit covers 31.61 sq. km. (35.41 %) (Fig.4 and Table 4).

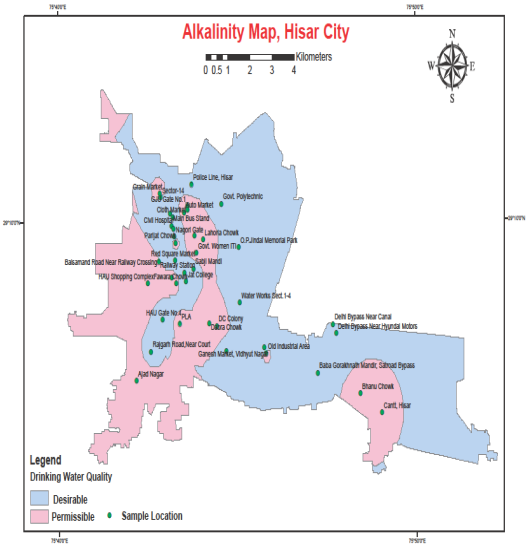

Fig.4. Spatial scenario of alkalinity in Hisar city

Table 4. Area of alkalinity under various drinking water categories

Drinking water Category (Alkalinity)	Area (sq.km)	Percentage of Total Area
Desirable	57.66	64.59
Permissible	31.61	35.41
Total	89.27	100.00

Hardness

Hardness in the study area ranges between 100mg/l to 900mg/l which falls under desirable (<200mg/l), permissible (200-600mg/l) and non-potable (>600mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 4.59 sq.km (5.14%); permissible limit covers 71.90 sq. km. (80.54 %) and non-potable limit covers 12.78 sq.km. (14.32%) (Fig.5 and Table 5).

Fig.5. Spatial scenario of hardness in Hisar city

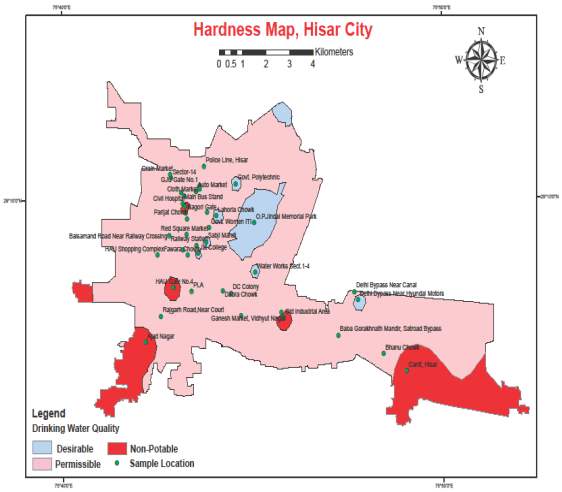

Table 5. Area of hardness under various drinking water categories

Drinking water Category (Hardness)	Area (sq.km)	Percentage of Total Area
Desirable	4.59	5.14
Permissible	71.90	80.54
Non-potable	12.78	14.32
Total	89.27	100.00

Chloride

Chloride in the study area ranges between 50 mg/l to 900mg/l which falls under desirable (<250mg/l) and permissible (200-1000mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 47.60 sq.km (53.32%) and permissible limit covers 41.67 sq. km. (46.68 %) (Fig.6 and Table 6).

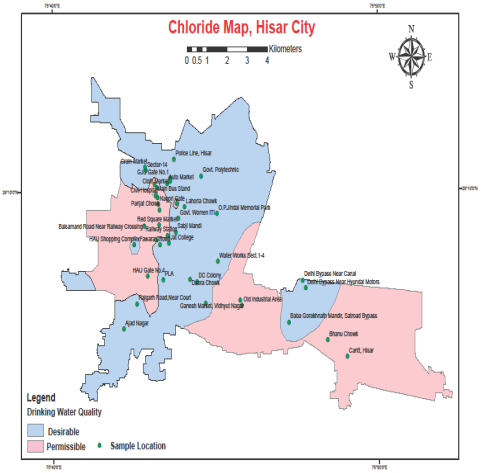

Fig.6. Spatial scenario of chloride in Hisar city

Table 6: Area of chloride uder varrious drining water categories

Drinking water Category (Chloride)	Area (sq.km)	Percentage of Total Area
Desirable	47.60	53.32
Permissible	41.67	46.68
Total	89.27	100.00

Total Dissolved Solids

Total Dissolved Solids (TDS) in the study area ranges between 240 mg/l to 2172 mg/l which falls under desirable (<500mg/l), permissible (500-2000mg/l) and non-potable (>2000mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 3.96 sq.km (4.44%); permissible limit covers 85.17 sq. km. (95.41%) and non-potable limit covers 0.14 sq.km. (0.15%) (Fig.7 and Table 7).

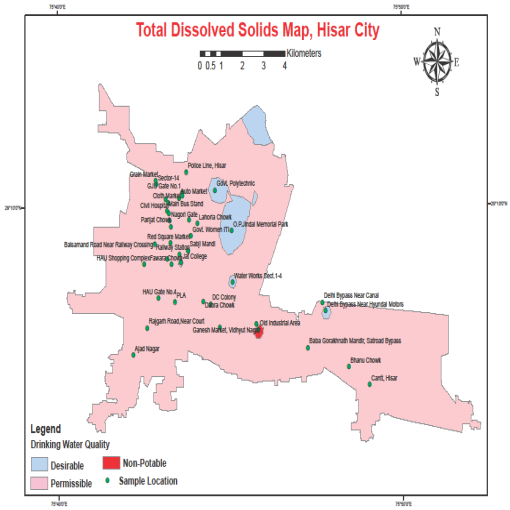

Fig.7. Spatial scenario of total dissolved solids in Hisar city

Table 7: Area of total dissolved solids under various drinkig water categories

Drinking water Category (TDS)	Area (sq.km)	Percentage of Total Area
Desirable	3.96	4.44
Permissible	85.17	95.41
Non-potable	0.14	0.15
Total	89.27	100.00

Fluoride

Fluoride in the study area ranges between 0.5 mg/l to 5 mg/l which falls under desirable (<1mg/l), permissible (1.0-1.5 mg/l) and non-potable (>1.5mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 34.07 sq.km (38.17%); permissible limit covers 32.95 sq. km. (36.91%) and non-potable limit covers 22.25 sq.km. (24.92%) (Fig.8 and Table 8).

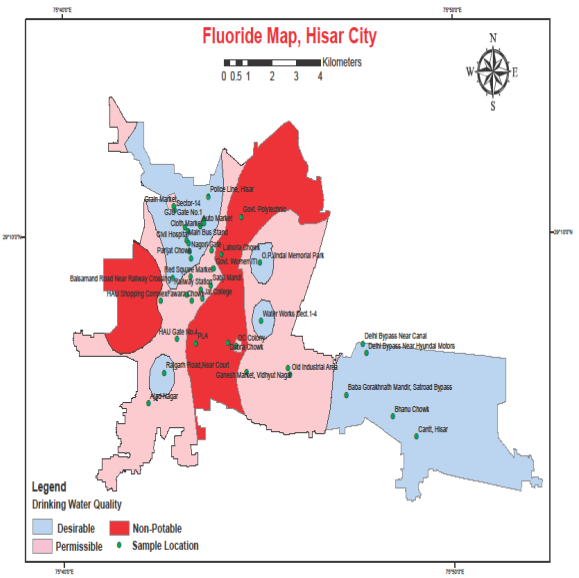

Fig.8. Spatial scenario of fluoride in Hisar city

Table 8. Area of fluoride under various drinking water categories

Drinking water Category (Fluoride)	Area (sq.km)	Percentage of Total Area
Desirable	34.07	38.17
Permissible	32.95	36.91
Non-potable	22.25	24.92
Total	89.27	100.00

Iron

Iron in the study area ranges between nil (0 mg/l) to 2 mg/l which falls under desirable (<0.3 mg/l) and non-potable (>0.3 mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 5.0 sq.km (5.60%) and non-potable limit covers 84.27 sq.km. (94.40%) (Fig.9 and Table 9).

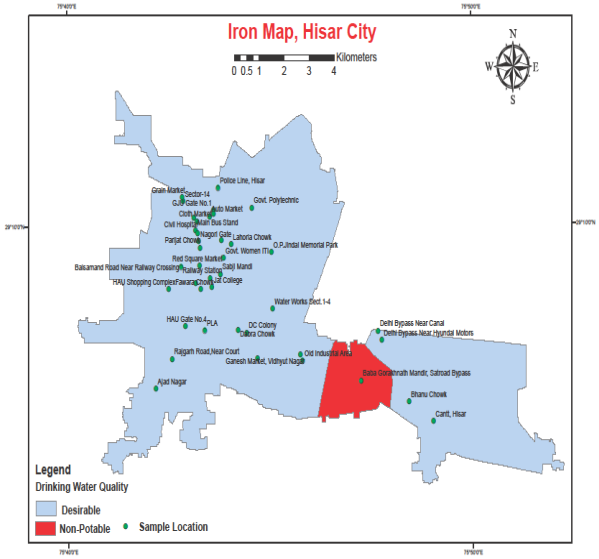

Fig.9. Spatial scenario of iron in Hisar city

Table 9. Area of iron uder various drinking water categories

Drinking water Category (Iron)	Area (sq.km)	Percentage of Total Area
Desirable	5.00	5.60
Non-potable	84.27	94.40
Total	89.27	100.00

Ammonia

Ammonia in the study area ranges between nil (0 mg/l) to 5 mg/l which falls under desirable (<0.5 mg/l) and non-potable (>0.5 mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 10.01 sq.km (11.21%) and non-potable limit covers 79.26 sq.km. (88.79%) (Fig.10 and Table 10).

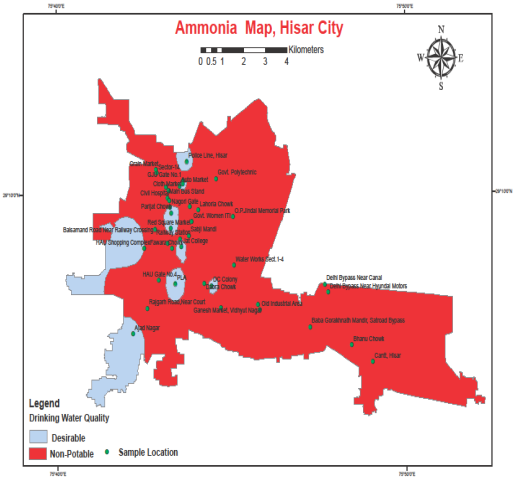

Fig.10. Spatial scenario of ammonia in Hisar city

Table 10. Area of ammonia under various drinking water categories

Drinking water Category (Ammonia)	Area (sq.km)	Percentage of Total Area
Desirable	10.01	11.21
Non-potable	79.26	88.79
Total	89.27	100.00

Nitrate

Nitrate in the study area ranges between 20 mg/l to 75 mg/l which falls under desirable (<45 mg/l) and non-potable (>45 mg/l) drinking water class of IS 10500:2012. In the study area, desirable limit covers an area of 35.76 sq.km (40.06%) and non-potable limit covers 53.51 sq.km. (59.94%) (Fig.11 and Table 11).

Fig.11. Spatial scenario of nitrate in Hisar city

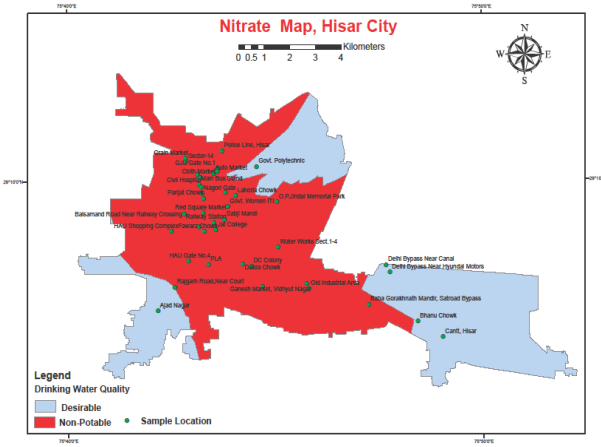

Table11. Area of nitrate under various drinking water categories

Drinking water Category (Nitrate)	Area (sq.km)	Percentage of Total Area
Desirable	35.76	40.06
Non-potable	53.51	59.94
Total	89.27	100.00

V. CONCLUSIONS

The study shows that pH falls under desirable limit; alkalinity and chloride fall under desirable and permissible; hardness, total dissolved solids (TDS) and fluoride fall under desirable, permissible and non-potable limit; ammonia and nitrate fall under desirable and non-potable limit of drinking water class.

VI. REFERENCES

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