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Assessment of Groundwater Quality for Drinking Purposes Using GIS Approach in Fatehabad District of Haryana

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Abstract: ***Groundwater is needed in every sphere of human activity. Hence, this study highlights the groundwater quality and its suitability for drinking purposes in Ratia block of Fatehabad district, Haryana. Twenty samples were collected from different locations of study area from hand pumps and tube wells using Garmin 72 H GPS in the month of February-March, 2017. All the collected samples were analyzed using Field Water Testing Kit prepared by Tamilnadu Water Supply and Drainage Board, Chennai. The result shows that pH ranges between 6.5 to 8, alkalinity 140 mg/l to 450 mg/l, Hardness 130 mg/l to 600 mg/l, Chloride 10 mg/l to 410 mg/l, Fluoride 0 mg/l to 2 mg/l, Iron nil (0 mg/l), Ammonia nil (0 mg/l) to 0.5 mg/l, Nitrate 45 mg/l to 100 mg/l and Total Dissolved Solids 336 mg/l to 1740 mg/l in Ratia block of Fatehabad district. Total dissolved solids (TDS) calculated with the help of alkalinity, hardness and chloride. ArcGIS 10 software have been used for Inverse Distance Weighted (IDW) interpolation of groundwater samples to know the spatial scenario of quality parameters in the study area and categorized as per IS 10500: 2012 drinking water standards. The study shows that pH, iron and Ammonia falls under desirable limit; alkalinity, Hardness, chloride and TDS fall under desirable and permissible; fluoride falls under desirable, permissible and non-potable limit; nitrate falls under desirable and non-potable limit of drinking water class.***

Keywords: Concentration, Groundwater, Samples, TDS, ArcGIS

1. Introduction

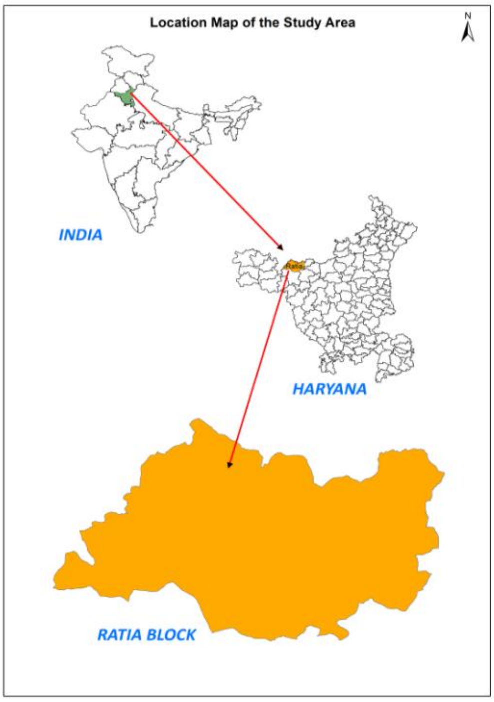
The water is the basic need for all human life & other living organisms on the earth's surface. The total volume of water is estimated at 1.386 billion km^3 with 97.5 % being salted water and 2.5 % fresh water, only 0.3 % the least volume of water is in liquid form on the surface for life. The ground water quality & volume depends on the geology, lithological, structural, geomorphology/landforms of that area, run-off, slops of ground, volume & periods of precipitations in the area, soil conditions, vegetation cover, agricultural activities, human inferences etc. The ground water storage volume depends on the recharge or discharge activities by their living populations & their activities in which these are; primary, secondary & tertiary activities doing by human. Remote sensing & GIS is the very faithful technology in the ground water study. GIS tool helps in the ground water mapping. Remote sensing cannot direct contact the ground water under the surface. A lot of factors help in the mapping of ground water. Geology mapping, geomorphology/Landforms mapping, lithological mapping, geological structural mapping, soil mapping, & vegetation cover mapping etc. helps in the ground water mapping. The precipitations data, Recharge conditions & Checks / canals can be helped in the ground water study. In addition to optical sensor data, microwave data have also been used at experimental level for deriving information on lithology, landforms and structures (Ghoneim and El-Baz, 2007). The launch of Earth Resources Technology Satellite (ERTS-1), later renamed as Landsat-1 with the multispectral Scanner System in 1972 ushered in a new era in mapping and updating of geological, geomorphological and structural features using the optical sensors data. Subsequently, Landsat-Thematic Mapper and the Indian Remote Sensing Satellite (IRS-1A LISSs-II) sensors have been operationally used in India to generate ground water potential maps at 1:250,000 scale. Remote sensing data have been widely used in groundwater prospecting (Sreedevi et al., 2005; Dinesh et al., 2007; Chandra et al., 2006; Per Sander, 2007). The quality of ground water is highly related to environmental and geological conditions. The quality of soil, rock and the water table determines the quality of ground water (Ravi Kant Pareek et al., 2015). Different factors like ground water level, area under rice cultivation, fertilizers consumption pattern and electric set were studied for the period between 2005 to 2013 in the Fatehabad district. The area under rice cultivation has increased from 31.67 to 40.36% with increased number of electric sets from 18542 to 31163 in 2005-06 to 2012-13, respectively. Area under pearl millet cultivation has also declined to 22.6 % in 2012-13 as compared to 2005-06. The district showed the second largest decline of 17.19 meters after district Mahenderagarh since June 1999 to June, 2014 in Haryana (Sandeep Kumar et al., 2016). Industries and heavy metals in groundwater affected the water quality. Hisar district has highest value of TDS while High fluoride concentration in Faridabad, Fatehabad and Sonepat districts,which is serious concern for fluorosis as there are few sites having fluoride ion more than 6mg/L, which may cause skeletal flurosis risk. Ground water of Smalkha is not fit for drinking and domestic purposes due to high value of WQI. Gurgaon ground water is also not safe for drinking water. Results indicate that ground water of Yamuna Nagar is good enough for irrigation purpose and after proper disinfection can be used for drinking and domestic purposes. Defluoridation is required for the groundwater of Dabwali area of Sirsa District. Result concludes that there is a requirement of treatment of ground water (Amanjeet et. al., 2017). The groundwater quality of various blocks of Agra district is characterized as Naz - Cl_, Ca2+- Na+-HCO3_, Ca^{2+} - Mg^{2+} - Cl-, Ca^{2+} - HCO3-, Ca^{2+} - Cl-,Na+ - Cl-, Ca^{2+} - Mg^{2+} - Cl- - SO4²-, Ca²- - Naz - HCO3-type. It is also concluded that the quality of water for the block Barauli Ahir, Fatehapur Sikari, Saiyan, Achhnera, Shamsabad, Khandouli, Pinahat, Jaitpur Kalan and Bah falls under Medium to Very Good category and can be used for the irrigation purpose. However, the quality of water for the blocks Bichpuri, Akola, Fatehabad, Khairagarh, Etmadpur and Jagner falls under Medium to Very Bad category and hence must be used with caution for the irrigation purpose depending on the soil types and salinity resistant crops (Vinod Kumar et al., 2017). The canal irrigation is mainly done in those areas which are mainly underlain by poor quality groundwater. About 30% of the area is irrigated by ground water through 30,164 shallow tubewells. These tube wells are located in areas where groundwater is fresh at shallow depths and can be used for irrigation. Maximum groundwater irrigation is done in Tohana and Ratia blocks. The Present study synthesized of Ratia Block of Fatehabad district. Fatehabad district can be classified into tropical desert and steppe, arid and hot which is mainly dry with hot humid summer and cold winter except during monsoon season. The hot weather season starts from mid-march to last week of June followed by south west monsoon which lasts till September. The transition period from September to October forms the post monsoon season. The normal annual rainfall is 373 mm & Normal monsoon Rainfall 297 mm of the district The winter starts late in November and remains up to first week of March. The mean minimum and maximum temperature reaches to maximum up to 41.60C during May–June and 5.50C in January (Central Ground Water Board (CGWB), 2013). The study shows the ground water quality of the Ratia block of the Fatehabad district and their effects on the daily human activities like drinking, agriculture.

2. Objectives

The study deals with the following objectives:
1) Specifying spatial distribution of groundwater quality parameters such as pH, total dissolved solids (TDS), Iron, Ammonia, Nitrate etc.
2) Mapping groundwater quality for drinking purpose in the study area using GIS.
3) Identify the ground water effects on the human activities like drinking & agriculture.
4) Give the suggestions to improve the Ground Water Quality in study area.

3. Study Area

Fatehabad is one of the smallest district of the state Haryana and covers 5.69% area of the state. It is covering an area of 2490 sq km. It has divided into five blocks namely Tohana, Ratia, Bhuna, Bhattu Kalan, and Fatehabad. The Ratia block is bounded by 29°35’11” to 29°48’28” North latitude and 75°19’14” to 75°41’55” East longitude. Tohana, Jakhal, Bhuna & Fatehabad blocks cover east & south part of the Ratia block and west & north part is covered by Punjab state.



4. Methodology

Samples were collected from twenty different locations of study area using Garmin 72 H GPS (Fig. 1) in the month of February-March and satellite data for the year 2017 have been used to demarcate the Ratia block area. The sample location sites were marked on the base map. Field Water Testing Kit made for water quality monitoring and surveillance of drinking water resources by Tamilnadu Water Supply and Drainage Board (TWAD), Chennai have been used for groundwater samples analysis for various parameters. Details of groundwater sample analysis are mentioned in Table 1. ArcGIS 10 software have been used for Inverse Distance Weighted (IDW) interpolation of groundwater samples and categorized as per IS 10500: 2012 drinking water standards (Table 2).

5. Results & Discussion

Table 1: Details of groundwater sample analysis

Sr. No.	Village Name	Sampling Date	Sample No.	pH	Alkalinity	Hardness	Chloride	Total Dissolved Solids	Fluoride	Iron	Ammonia	Nitrate
1	Alawalwas	14.03.2017	I	8.0	190	550	210	1140	0	0	0.5	45
		14.03.2017	II	7.5	220	300	50	696	0	0	0.5	75
2	Khai	14.03.2017	I	7.5	220	250	80	660	0	0	0	75
		14.03.2017	II	8.0	180	280	90	660	0	0	0	75
3	Khundan	14.03.2017	I	8.0	450	150	400	1200	2	0	0	45
		14.03.2017	II	7.5	440	600	410	1740	2	0	0	75
4	Madh	14.03.2017	I	7.5	300	210	70	696	2	0	0	100
		14.03.2017	II	7.5	330	400	80	972	1	0	0	45
5	Mehmra	14.03.2017	I	7.5	200	200	20	528	0	0	0	45
		15.03.2017	II	7.5	200	170	30	480	0	0	0	45
6	Mohammadpur	15.03.2017	I	7.5	140	130	10	336	0	0	0	45
		15.03.2017	II	7.0	170	240	50	552	0	0	0	45
7	Nathwan	15.03.2017	I	7.5	250	340	40	756	0	0	0	45
		15.03.2017	II	6.5	350	400	50	960	0	0	0	45
8	RattaKhera	15.03.2017	I	7.5	430	290	100	984	0	0	0	75
		15.03.2017	II	7.5	400	350	90	1008	0	0	0	45
9	Rattangarh	14.03.2017	I	8.0	400	300	90	948	0	0	0.5	75
		14.03.2017	II	7.5	380	340	80	960	0	0	0.5	75
10	Sehnal	15.03.2017	I	7.5	370	400	150	1104	0	0	0.5	45
		15.03.2017	II	7.0	230	380	120	876	0	0	0.5	75

Unit of all parameters is mg/l except pH which is dimensionless

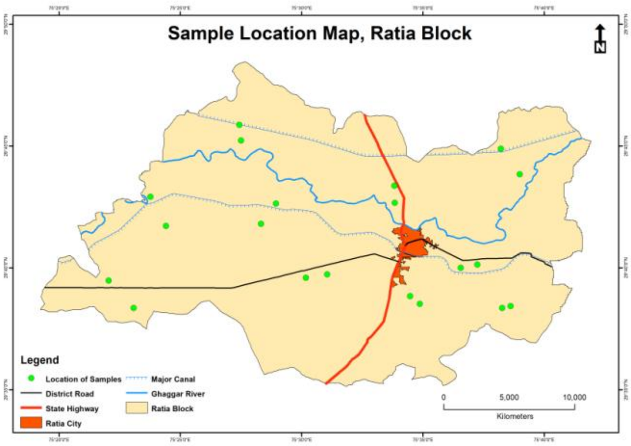


Figure 1: Sample Location Map

Table 2: Drinking water parameters standard (is 1 0500:201 2)

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

Unit of all parameters is mg/l except pH which is dimensionless

In study area, **pH** ranges between 6.5 to 8 is under desirable limit (6.5-8.5) of drinking water parameters of IS 10500:2012 which covers 535.38 sq.km (100%) area (Fig 2 and Table 3).

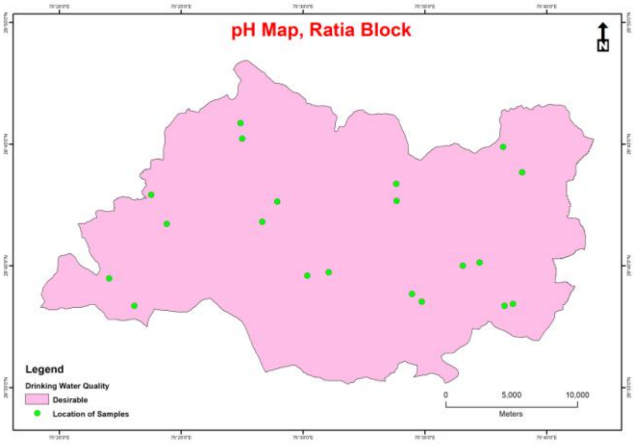


Figure 2: Spatial scenario of pH map in Ratia Block

Table 3: Area of pH under various drinking water categories

Drinking water Category (pH)	Area (sq.km)	Percentage of Total Area
Desirable	535.38	100
Total	535.38	100

In the study area, **Alkalinity** ranges between 140 mg/l to 450 mg/l which falls under desirable limit (<200 mg/l) and permissible (200-600 mg/l) drinking water class of IS 10500: 2012. Desirable limit covers an area of 19.11 sq.km (3.57%) and permissible limit covers 516.27 sq. km. (96.43%) in the study area (Fig 3 and Table 4).

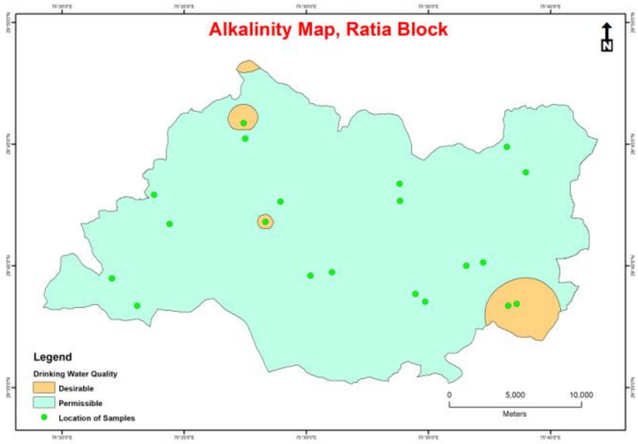


Figure 3: Spatial scenario of Alkalinity map in Ratia Block

Table 4: Area of Alkalinity under various drinking water categories

Drinking water Category (Alkalinity)	Area (sq.km)	Percentage of Total Area
Desirable	19.11	3.57
Permissible	516.27	96.43
Total	535.38	100

In the study area, **Hardness** ranges between 130 mg/l to 600 mg/l which falls under desirable (<200 mg/l) and permissible (200-600 mg/l) drinking water class of IS 10500: 2012. Desirable limit covers an area of 12.08 sq. km. (2.26%); permissible limit covers 523.30 sq. km. (97.74%) in the study area (Fig 4 and Table 5).

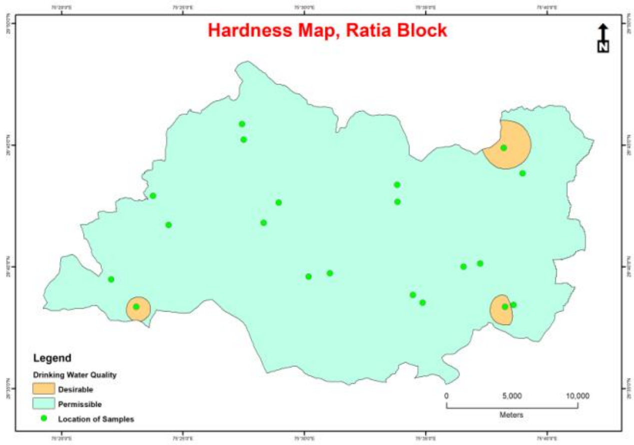


Figure 4: Spatial scenario of Hardness map in Ratia Block

Table 5: Area of Hardness under various drinking water categories

Drinking water Category (Hardness)	Area (sq.km)	Percentage of Total Area
Desirable	13	2
Permissible	522	98
Total	535	100

In the study area, **Chloride** ranges between 10 mg/l to 410 mg/l which falls under desirable (<250 mg/l) and permissible (250-1000 mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 496.55 sq.

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km. (92.74%); permissible limit covers 38.83 sq. km. (7.26%) in the study area (Fig 5 and Table 6).

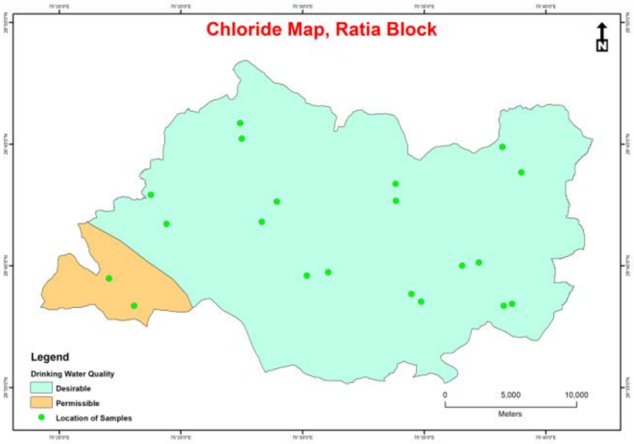

Figure 5: Spatial scenario of Chloride map in Ratia Block

Table 6: Area of Chloride under various drinking water categories

Drinking water Category (Chloride)	Area (sq.km)	Percentage of Total Area
Desirable	496	93
Permissible	39	7
Total	535	100

In the study area, **Total Dissolved Solids (TDS)** ranges between 336 mg/l to 1740 mg/l which falls under desirable (<500 mg/l) and permissible (500-2000 mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 4.82 sq. km. (0.90%) and permissible limit covers an area of 530.56 sq. km. (99.10%) in the study area (Fig 6 and Table 7).

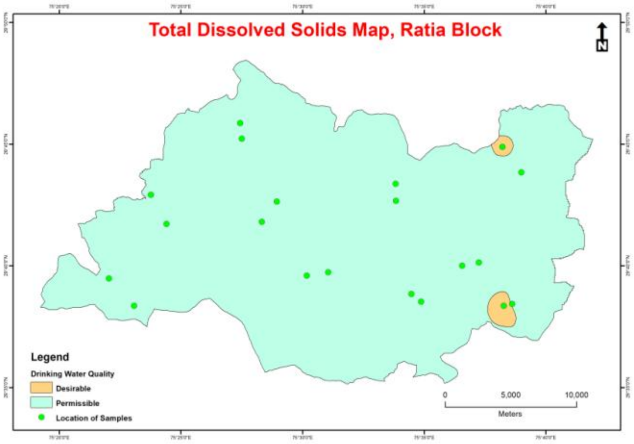

Figure 6: Spatial scenario of Chloride map in Ratia Block

Table 7: Area of Total Dissolved Solids under various drinking water categories

Drinking water Category (TDS)	Area (sq.km)	Percentage of Total Area
Desirable	5	1
Permissible	530	99
Total	535	100

In the study area, **Fluoride** ranges between 0 mg/l to 2 mg/l which falls under desirable (<1 mg/l), permissible (1.0-1.5 mg/l) and non-potable (>1.5 mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 454.83 sq. km. (84.96%), permissible limit covers an area of 27.96 sq. km. (5.22%) and non-potable limit covers an area of 52.59 sq. km (9.82%) in the study area (Fig 7 and Table 8).

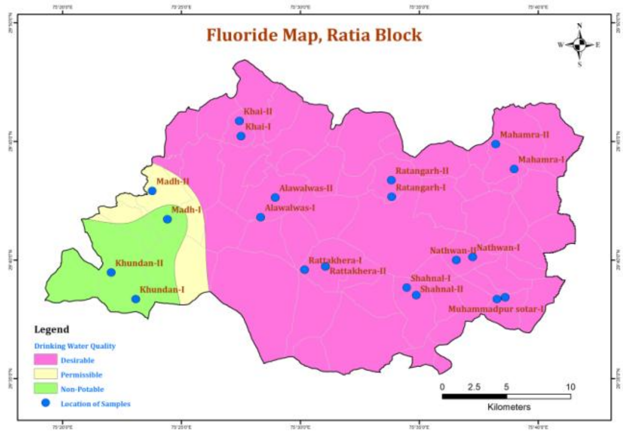

Figure 7: Spatial scenario of Fluoride map in Ratia Block

Table 8: Area of Fluoride under various drinking water categories

Drinking water Category (Fluoride)	Area (sq.km)	Percentage of Total Area
Desirable	454.83	84.96
Permissible	27.96	5.22
Non-Potable	52.59	9.82
Total	535	100

In the study area, **Iron** nil (0 mg/l) which falls under desirable (<0.3 mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 535.38 sq. km. (100%) in the study area (Fig 8 and Table 9).

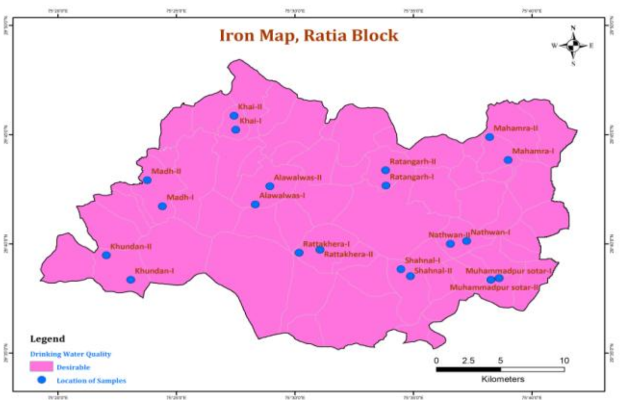

Figure 8: Spatial scenario of Iron map in Ratia Block

Table 9: Area of Iron under various drinking water categories

Drinking water Category (Iron)	Area (sq.km)	Percentage of Total Area
Desirable	535.38	100
Total	535.38	100

In the study area, **Ammonia** ranges between nil (0 mg/l) to 0.5 mg/l which falls under desirable (0.5 mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 535.38 sq. km. (100%) in the study area (Fig 9 and Table 10).

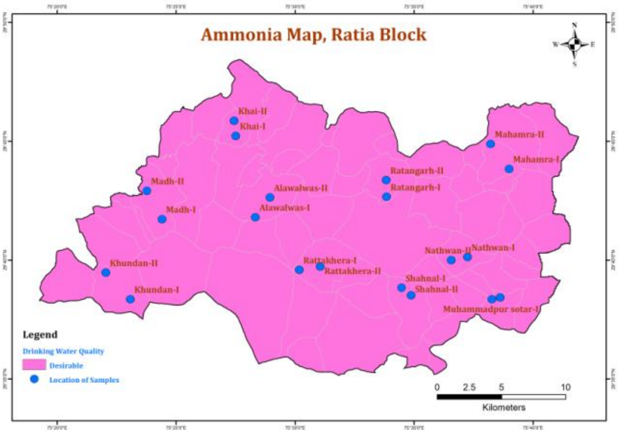

Figure 9: Spatial scenario of Ammonia map in Ratia Block

Table 10: Area of Ammonia under various drinking water categories

Drinking water Category (Ammonia)	Area (sq.km)	Percentage of Total Area
Desirable	535.38	100
Total	535.38	100

In the study area, **Nitrate** ranges between 45 mg/l to 100 mg/l which falls under desirable (45 mg/l) and non-potable (>45mg/l) drinking water class of IS 10500:2012. Desirable limit covers an area of 23.15 sq. km. (4.33%) and non-potable limit covers an area of 512.23 sq. km (95.67%) in the study area (Fig 10 and Table 11).

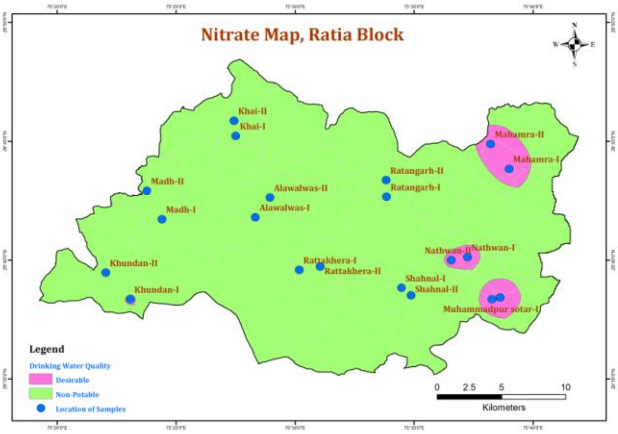

Figure 10: Spatial scenario of Nitrate map in Ratia Block

Table 11: Area of Nitrate under various drinking water categories

Drinking water Category (Nitrate)	Area (sq.km)	Percentage of Total Area
Desirable	23.15	4.33
Non-Potable	512.23	95.67
Total	535.38	100

6. Conclusions

The study shows that pH, iron and Ammonia falls under desirable limit; alkalinity, Hardness, chloride and TDS fall under desirable and permissible; fluoride falls under desirable, permissible and non-potable limit; nitrate falls under desirable and non-potable limit of drinking water class. The main goal of this study was to map and evaluate the groundwater quality of Ratia block. It is found that nitrate and fluoride is one of the main groundwater pollutants. High nitrate concentrations in water can cause public health risk and environmental pollution that have already become a common problem in many parts of the world. Nitrate threats depend on scales which can take on chronic and acute forms (Sausa et al., 2014). Nitrate contamination in groundwater systems is caused by various sources agricultural fertilizers application, overuse of chemical or manure fertilizers and long-term leaks in sewer lines (Viers et al., 2012). All these negative effects can be minimized by proper groundwater management and good governance to mitigate the risks for nitrate contamination. The study will be highly useful for planning and management of groundwater for drinking purpose in the study area. The groundwater quality map as a result of this research can be taken into account by Regional Water Company and other agencies as decision support system.

7. Conflict of Interest

None

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