

# GIS Approach for Groundwater Quality Study in Mewat District, Haryana, India

Rajvir Singh, Anup Kumar, S.K. Chakarvarti

**Abstract**—Water is prime requirement for living beings. The availability of good quality groundwater plays vital role in developmental planning as well as agricultural practices. The modern techniques like geographical information system (GIS) are employing for studying the spatial distribution of groundwater in a terrain. In the present study, secondary groundwater quality data have been used for groundwater quality study of Mewat district in Haryana. Ten groundwater quality parameters viz. pH, alkalinity, calcium, magnesium, hardness, total dissolved solids, iron, fluoride, chloride and nitrate have been used for inverse distance weighted interpolation technique in ArcGIS 9.3 software of 45 locations in the district. The result shows that pH in the study area ranges 6.5 to 8. The spatial distribution of pH shows that 1634.68 sq. km area (87.93%) falls under desirable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area. The alkalinity in the study area ranges 90 mg/l to 1400mg/l. The spatial distribution of alkalinity in the study area shows that 1525.77 sq. km area (82.07%) falls under desirable groundwater quality; 43.04 sq.km. area (2.32%) area falls under permissible groundwater quality and 65.87 sq.km area (3.54%) falls under non-potable groundwater quality. The calcium in the study area ranges 24 mg/l to 800 mg/l. The spatial distribution of calcium in the study area shows that 1153.33 sq. km area (62.04%) falls under desirable groundwater quality; 454.84 sq.km. area (24.47%) area falls under permissible groundwater quality and 26.51 sq.km area (1.43%) falls under non-potable groundwater quality. The magnesium in the study area ranges 10 mg/l to 300 mg/l. The spatial distribution of magnesium in the study area shows that 106.51 sq. km area (5.73%) falls under desirable groundwater quality; 1528.17 sq.km area (82.20%) area falls under permissible groundwater quality and 224.32 sq.km area (12.07%) falls under non-potable groundwater quality. The hardness in the study area ranges 190 mg/l to 1660 mg/l. The spatial distribution of hardness in the study area shows that 11.41sq. km area (0.61%) falls under desirable groundwater quality; 1574.22 sq.km. area (84.68%) area falls under permissible groundwater quality and 49.05 sq.km area (2.64%) falls under non-potable groundwater quality. The total dissolved solids (TDS) in the study area ranges 156 mg/l to 2500 mg/l. The spatial distribution of total dissolved solids (TDS) in the study area shows that 353.67 sq. km area (19.02%) falls under desirable groundwater quality; 1269.52 sq.km area (68.29%) area falls under permissible groundwater quality and 11.49 sq.km. area (0.62%) falls under non-potable groundwater quality. The chloride in the study area ranges 92 mg/l to 1600 mg/l. The spatial distribution of chloride in the study area shows that 571.3 sq. km area (30.74%) falls under desirable groundwater quality; 1055.54 sq.km. area (56.78%) area falls under permissible groundwater quality and 7.61 sq.km area (0.41%) falls under non-potable groundwater quality. The fluoride in the study area ranges 0.27 mg/l to 1.6 mg/l. The spatial distribution of fluoride in the study area shows that 1264.81 sq. km area (68.03%) falls under desirable groundwater quality; 365.66 sq.km area (19.67%) area falls under permissible groundwater quality and 4.21sq.km area (0.23%) falls under non-potable groundwater quality. The iron in the study area ranges 0.27 mg/l to 1.6 mg/l. The spatial distribution of iron in the study area shows that 1554.19 sq. km area (83.60%) falls under desirable groundwater quality; 80.49 sq.km area (4.33%) area falls under permissible groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area. The nitrate in the study area ranges 10 mg/l to 30 mg/l. The spatial distribution of nitrate in the study area shows that 1634.68 sq. km area (87.93%) falls under desirable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area. The study shows that pH and nitrate fall under desirable limit in the study area, iron falls under desirable and permissible limit while other parameters-alkalinity, calcium, magnesium, hardness, total dissolved solids, chloride and fluoride fall in desirable, permissible and non-potable limit of groundwater in the study area. The study is highly useful for planning and management of groundwater in the study area.

**Key words**—Geoinformatics, GIS, groundwater, IDW, interpolation, quality, Mewat, Haryana

## 1 INTRODUCTION

WATER is one of the most requirement for sustainability of life on Earth. Though, the availability of water is plenty on the planet earth, but the availability of fresh useable groundwater is very less. It is necessary to have information of water quality especially groundwater quality for development of agricultural practices and other developmental activities. The geographical information system (GIS) is the effective tool to represent data in spatial and non-spatial form which help in represent-

ing and understanding the scenario of particular parameters in an area. Many workers [1, 2, 3, 4, 5, 6, 9] have done good work on groundwater quality using geographical information system (GIS).

## 2 STUDY AREA

The study area, Mewat district is situated in the southern part of Haryana state. The geo-coordinates of the district are 27° 39'N to 28° 20' N latitudes and 76° 51' E to 77° 20' E longitudes and covering 1859 sq.km area (Fig.1). The district has undulating topography of hills, valleys, pediments, palaeochannels, obstacle sand dunes and plains. The climate of the district is semi-arid type and normal rainfall is 594 mm.

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Fig.1. Location map of the study area

TABLE 2  
DRINKING WATER PARAMETERS (IS 10500:2012)

Parameter	Desirable	Permissible	Non-potable
pH	6.5-8.5	-	-
Alkalinity (mg/l)	< 200	200-600	> 600
Calcium (mg/l)	< 75	75-200	> 200
Magnesium (mg/l)	< 30	-	> 30
Hardness (mg/l)	< 200	200-600	> 600
TDS (mg/l)	< 500	500-2000	> 2000
Chloride (mg/l)	< 250	250-1000	> 1000
Fluoride (mg/l)	< 1	1-1.5	> 1.5
Nitrate (mg/l)	< 45	-	> 45
Iron (mg/l)	< 0.3	-	> 0.3

**MATERIALS AND METHODOLOGY**

Secondary groundwater quality data of 45 locations of Mewat district for the years July 2014 and June 2015 have been downloaded from MDWSD website [7] (Table 1). Ten groundwater quality parameters include pH, alkalinity, calcium, magnesium, hardness, total dissolved solids, iron, fluoride, chloride and nitrate. The data have been put in ArcGIS 9.3 software and inverse distance weighted interpolation technique have been applied. The interpolated data have been classified in three classes as per IS 10500:2012 drinking water standards [8] (Table 2) and prepared the parameter wise groundwater quality maps of the study area. The area of each drinking water class for each parameter has been calculated in the ArcGIS software.

**3 RESULTS AND DISCUSSION**

**i. pH**

The pH in the study area ranges 6.5 to 8. The spatial distribution of pH in the study area shows that 1634.68 sq. km area (87.93%) falls under desirable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 2 and Table 3). As per IS 10500:2012 drinking water standards (Table 2) pH 6.5 to 8.5 falls under desirable groundwater quality and no relaxation below and above these limits.

TABLE 1  
GROUNDWATER QUALITY DATA (SOURCE: NRDWP, MDWS, GOVT.OF INDIA)

Location	Sample Date	pH	Alkalinity (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Hardness (mg/l)	TDS (mg/l)	Iron (mg/l)	Fluoride (mg/l)	Chloride (mg/l)	Nitrate (mg/l)
Taigra	28/12/2014	7.8	72	32	103	112	0.04	0.47	221	30	--
Taigra	18/12/2014	7.5	170	45	41	140	1376	0	1.7	132	--
Taigra	17/12/2014	7.8	170	58	13	183	417	0	1.1	142	--
Taigra	28/12/2014	7.2	170	80	29	140	428	0.08	0.63	270	--
Baoli	18/12/2014	7	1400	240	140	1300	1500	0.1	1.60	1048	--
Baoli	17/12/2014	7	1000	140	11	110	600	0.2	1.20	120	--
Phokri	28/12/2014	7.4	--	64	24	70	392	0.02	0.78	113	13
Phokri	18/12/2014	7.3	180	44	18	140	367	0	1	140	--
Phokri	28/12/2014	7.3	--	80	82	140	871	0.04	0.73	111	17
Phokri	28/12/2014	7.7	--	88	11	470	470	0.02	1.21	111	40
Phokri	17/12/2014	7.8	180	48	11	170	418	--	--	142	--
Phokri	18/12/2014	8.7	120	58	84	140	1274	--	1	700	--
Phokri	14/12/2014	8.7	1200	800	100	1800	1500	1.0	1.60	1400	--
Phokri	28/12/2014	7.4	--	40	40	100	400	0.08	1.08	142	10
Phokri	28/12/2014	7.8	--	44	10	130	452	0.11	1.41	134	10
Phokri	28/12/2014	7.8	--	78	13	180	888	0.21	0.71	142	12
Phokri	28/12/2014	7.3	120	84	14	140	88	0.04	1.04	110	--
Phokri	28/12/2014	7.4	12	14	14	180	111	0.08	1.04	411	13
Phokri	14/12/2014	7	180	64	18	170	180	--	1	142	--
Phokri	12/12/2014	7.7	170	24	48	240	411	--	--	178	--
Phokri	28/12/2014	7	--	120	41	180	1840	0.08	0.17	884	13
Phokri	11/12/2014	8.9	470	170	47	400	1100	0.3	1.4	170	--
Phokri	17/12/2014	8.3	1200	48	110	670	1500	0.25	1.60	1400	--
Phokri	28/12/2014	8.2	90	114	74	400	1270	0.08	1.11	140	--
Phokri	08/12/2014	7	400	180	45	170	600	0.22	1.00	100	--
Phokri	28/12/2014	7.4	120	40	41	200	707	0.09	0.84	270	--
Phokri	28/12/2014	8	--	48	17	180	378	0.02	0.78	148	15
Phokri	18/12/2014	8	120	12	17	400	1170	--	1	100	--
Phokri	17/12/2014	7.3	240	48	41	280	487	--	1	178	--
Phokri	28/12/2014	7.4	84	18	170	457	0.09	0.67	177	10	
Phokri	28/12/2014	7	100	100	10	240	470	--	1.08	104	--
Phokri	28/12/2014	7.8	--	34	41	180	154	0.1	1.17	133	17
Phokri	28/12/2014	8.8	--	64	47	180	478	0.08	0.27	108	20
Phokri	24/12/2014	7.7	--	38	48	180	470	0.04	0.67	270	17
Phokri	13/12/2014	7.3	--	44	49	140	471	0.10	0.47	69	10
Phokri	12/12/2014	7.2	--	38	18	240	400	0.11	0.98	82	17
Phokri	01/04/2014	6.7	680	60	111	600	1700	1.4	1.1	680	--
Phokri	21/12/2014	7.1	120	78	22	180	440	0.04	0.41	132	--
Phokri	11/12/2014	7.4	140	108	11	180	1170	0.02	--	487	10
Phokri	01/04/2014	7	200	140	13	140	300	0.28	1.20	300	--
Phokri	01/04/2014	--	--	--	--	--	--	0.02	--	--	10
Phokri	28/12/2014	7.2	120	80	18	130	160	--	1.12	104	10
Phokri	01/04/2014	7.2	170	134	87	180	1300	0.18	0.8	280	--
Phokri	01/04/2014	--	--	--	--	--	--	0.3	--	--	10
Phokri	01/04/2014	8.3	120	48	11	170	187	--	1	177	--

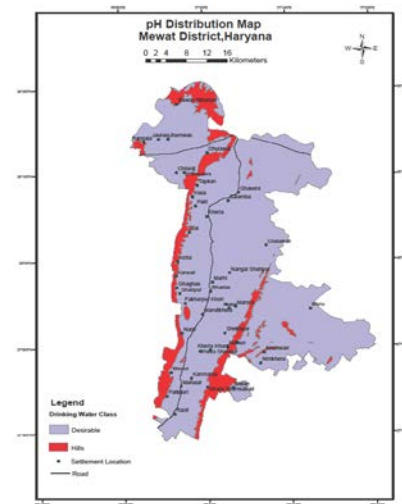


Fig.2.Spatial distribution of pH in Mewat District

**TABLE 3**  
AREA OF DIFFERENT DRINKING WATER CLASSES OF pH IN THE STUDY AREA

pH Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1634.68	87.93
Permissible	-	-
Non-potable	-	-
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**ii. Alkalinity**

The alkalinity the study area ranges 90 mg/l to 1400mg/l. The spatial distribution of alkalinity in the study area shows that 1525.77 sq. km area (82.07%) falls under desirable groundwater quality; 43.04 sq.km. area (2.32%) area falls under permissible groundwater quality and 65.87 sq.km area (3.54%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig.3 and Table 4). As per IS 10500:2012 drinking water standards (Table 2) alkalinity less than 200 mg/l desirable; 200-600 mg/l permissible and more than 600 mg/l non-potable groundwater quality.

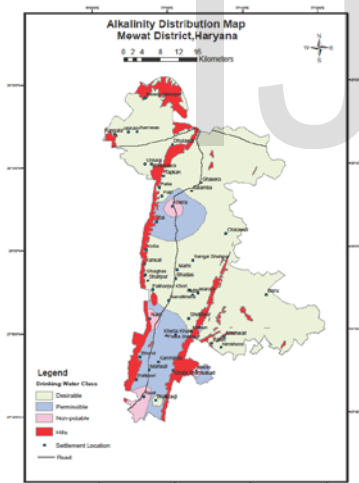


Fig.3. Spatial distribution of alkalinity in Mewat District

**TABLE 4**  
AREA OF DIFFERENT DRINKING WATER CLASSES OF ALKALINITY IN THE STUDY AREA

Alkalinity Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1525.77	82.07
Permissible	43.04	2.32
Non-potable	65.87	3.54
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**iii. Calcium**

The calcium in the study area ranges 24 mg/l to 800 mg/l. The spatial distribution of calcium in the study area shows that 1153.33 sq. km area (62.04%) falls under desirable groundwater quality; 454.84 sq.km. area (24.47%) area falls under permissible groundwater quality and 26.51 sq.km. area (1.43%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 4 and Table 5). As per IS 10500:2012 drinking water standards (Table 2) calcium less than 75 mg/l desirable; 75-200 mg/l permissible and more than 200 mg/l non-potable groundwater quality.

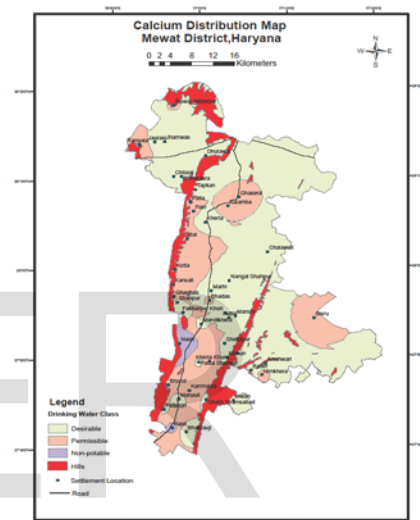


Fig.4. Spatial distribution of calcium in Mewat District

**TABLE 5**  
AREA OF DIFFERENT DRINKING WATER CLASSES OF CALCIUM IN THE STUDY AREA

Calcium (Ca) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1153.33	62.04
Permissible	454.84	24.47
Non-potable	26.51	1.43
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**iv. Magnesium**

The magnesium in the study area ranges 10 mg/l to 300 mg/l. The spatial distribution of magnesium in the study area shows that 106.51 sq. km area (5.73%) falls under desirable groundwater quality; 1528.17 sq.km. area (82.20%) area falls under permissible groundwater quality and 224.32 sq.km. area (12.07%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig.5 and Table 6). As per IS 10500:2012 drinking water standards (Table 2) magnesium less than 30 mg/l desirable and no relaxation for more than 30 mg/l.

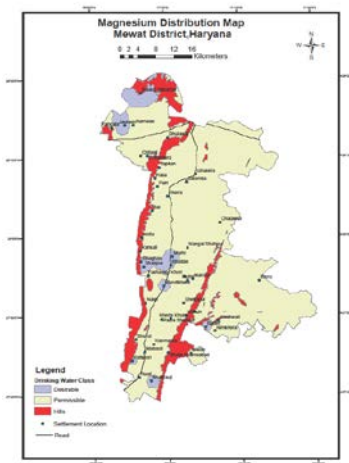


Fig.5. Spatial distribution of magnesium in Mewat District

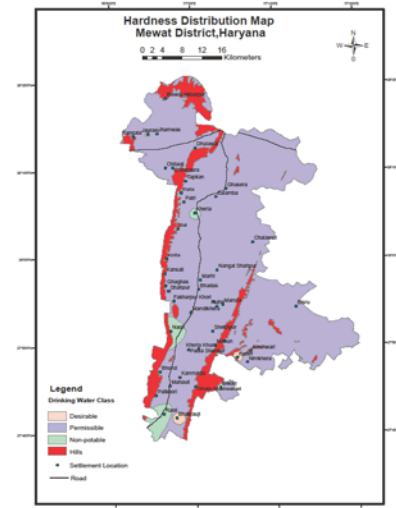


Fig.6: Spatial distribution of Hardness in Mewat District

TABLE 6  
AREA OF DIFFERENT DRINKING WATER CLASSES OF  
MAGNESIUM IN THE STUDY AREA

Magnesium (Mg) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	106.51	5.73
Permissible	1528.17	82.20
Non-potable	--	--
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**v. Hardness**

The hardness in the study area ranges 190 mg/l to 1660 mg/l. The spatial distribution of hardness in the study area shows that 11.41sq. km area (0.61%) falls under desirable groundwater quality; 1574.22 sq.km. area (84.68%) area falls under permissible groundwater quality and 49.05 sq.km. area (2.64%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 6 and Table 7). As per IS 10500:2012 drinking water standards (Table 2) hardness less than 200 mg/l desirable; 200-600 mg/l permissible and more than 600 mg/l non-potable groundwater quality.

TABLE 7  
AREA OF DIFFERENT DRINKING WATER CLASSES OF  
HARDNESS IN THE STUDY AREA

Hardness Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	11.41	0.61
Permissible	1574.22	84.68
Non-potable	49.05	2.64
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**vi. Total dissolved solids (TDS)**

The total dissolved solids (TDS) in the study area ranges 156 mg/l to 2500 mg/l. The spatial distribution of total dissolved solids (TDS) in the study area shows that 353.67 sq. km area (19.02%) falls under desirable groundwater quality; 1269.52 sq.km. area (68.29%) area falls under permissible groundwater quality and 11.49 sq.km. area (0.62%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 7 and Table 8). As per IS 10500:2012 drinking water standards (Table 2) total dissolved solids (TDS) less than 500 mg/l desirable; 500-2000 mg/l permissible and more than 2000 mg/l non-potable groundwater quality.



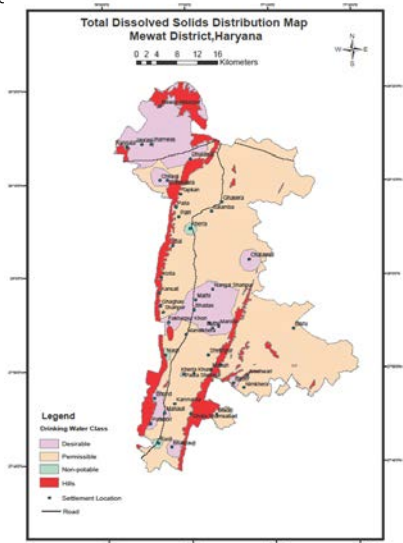


Fig.7: Spatial distribution of Total Dissolved Solids in Mewat District

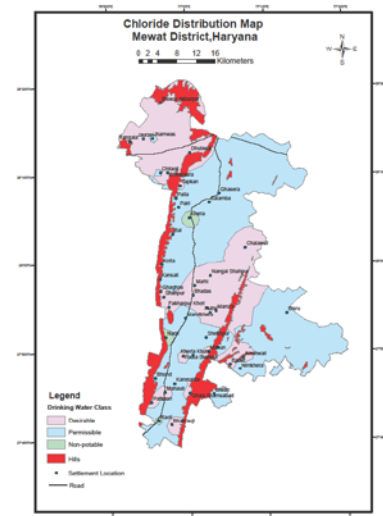


Fig.8. Spatial distribution of chloride in Mewat District

TABLE 8

AREA OF DIFFERENT DRINKING WATER CLASSES OF TOTAL DISSOLVED SOLIDS IN THE STUDY AREA

Total Dissolved Solids(TDS) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	353.67	19.02
Permissible	1269.52	68.29
Non-potable	11.49	0.62
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

TABLE 9

AREA OF DIFFERENT DRINKING WATER CLASSES OF CHLORIDE IN THE STUDY AREA

Chloride (Cl) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	571.53	30.74
Permissible	1055.54	56.78
Non-potable	7.61	0.41
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**vii. Chloride**

The chloride in the study area ranges 92 mg/l to 1600 mg/l. The spatial distribution of chloride in the study area shows that 571.3 sq. km area (30.74%) falls under desirable groundwater quality; 1055.54 sq.km. area (56.78%) area falls under permissible groundwater quality and 7.61 sq.km. area (0.41%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 8 and Table 9). As per IS 10500:2012 drinking water standards (Table 2) chloride less than 250 mg/l desirable; 250-1000 mg/l permissible and more than 1000 mg/l non-potable groundwater quality.

**viii. Fluoride**

The fluoride in the study area ranges 0.27 mg/l to 1.6 mg/l. The spatial distribution of fluoride in the study area shows that 1264.81 sq. km area (68.03%) falls under desirable groundwater quality; 365.66 sq.km area (19.67%) area falls under permissible groundwater quality and 4.21sq.km. area (0.23%) falls under non-potable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 9 and Table 10). As per IS 10500:2012 drinking water standards (Table 2) fluoride less than 1mg/l desirable; 1-1.5 mg/l permissible and more than 1.5 mg/l non-potable groundwater quality.

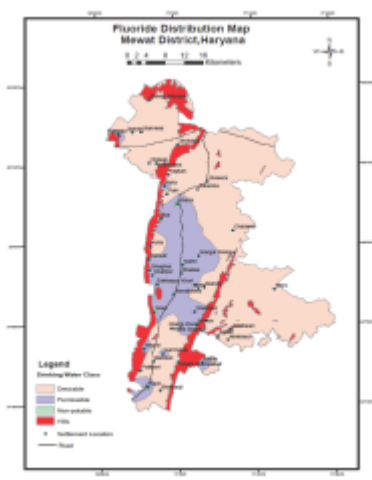


Fig.9. Spatial distribution of fluoride in Mewat District

TABLE 10  
AREA OF DIFFERENT DRINKING WATER  
CLASSES OF FLUORIDE IN THE STUDY AREA

Fluoride (F) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1264.81	68.03
Permissible	365.66	19.67
Non-potable	4.21	0.23
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**ix. Iron**

The iron in the study area ranges 0.27 mg/l to 1.6 mg/l. The spatial distribution of iron in the study area shows that 1554.19 sq. km area (83.60%) falls under desirable groundwater quality; 80.49 sq.km. area (4.33%) area falls under permissible groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig. 10 and Table 11). As per IS 10500:2012 drinking water standards (Table 2) fluoride less than 0,3mg/l desirable and more than 0.3mg/l non-potable groundwater quality.

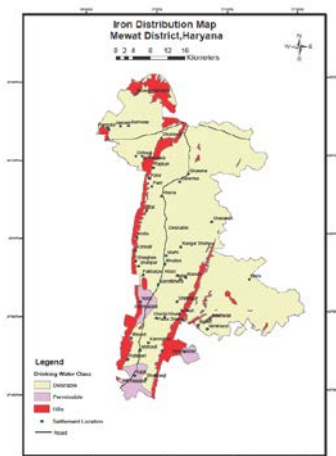


Fig.10. Spatial distribution of iron in Mewat District

TABLE 11  
AREA OF DIFFERENT DRINKING WATER  
CLASSES OF IRON IN THE STUDY AREA

Iron (Fe) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1554.19	83.60
Permissible	80.49	4.33
Non-potable	--	--
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

**x. Nitrate**

The nitrate in the study area ranges 10 mg/l to 30 mg/l. The spatial distribution of nitrate in the study area shows that 1634.68 sq. km area (87.93%) falls under desirable groundwater quality. Hills cover 224.32 sq. km area (12.07%) in the study area (Fig.11 and Table 12). As per IS 10500:2012 drinking water standards (Table 2) fluoride less than 45mg/l desirable and more than 45 mg/l non-potable groundwater quality.

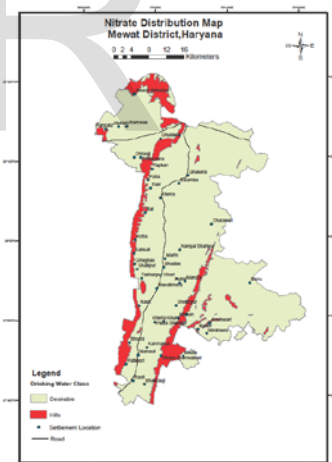


Fig.10. Spatial distribution of nitrate in Mewat District

TABLE 12  
AREA OF DIFFERENT DRINKING WATER CLASSES OF  
NITRATE IN THE STUDY AREA

Nitrate (NO <sub>3</sub> ) Drinking Water Class	Area (Sq. Km)	% of Total Area
Desirable	1634.68	87.93
Permissible	--	--
Non-potable	--	--
Hills	224.32	12.07
<b>Total</b>	<b>1859.00</b>	<b>100.00</b>

#### 4 CONCLUSIONS

In the study area, pH and nitrate fall under desirable limit; iron falls under desirable and permissible limits while alkalinity, calcium, magnesium, hardness, total dissolved solids, chloride and fluoride fall under desirable, permissible and non-potable limits of drinking water classes in the study area. The study is highly useful for planning and management of groundwater in the study area.

#### ACKNOWLEDGEMENTS

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