Ground Water Assessment and its Utilization in Chitrakoot District, U.P.

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Abstract

The present paper attempts to study the ground water resources of Chitrakoot district (U.P.) and its uses in agricultural, domestic and industrial sectors. In the assessment of ground water the present study includes the condition of water table, recharge of ground water by rainfall, canal seepage and return seepage by irrigated fields, quality of ground water and its utilization in different sectors .This study reveals that the rate of recharge is higher than the rate of draft of ground water in the district as a whole at present. So it falls in the safe category for future development. It is also observed that the quality of ground water is suitable for both the domestic and irrigational purposes. Present study is based on the data collected from Central Ground Water Board (Lucknow), Office of Ex. Engineer, Irrigation Division ,Karwi (Chitrakoot), Office of Assistant Engineer Minor Irrigation Division(Banda) & chemical analysis of water samples from different observation wells of the Chitrakoot District personally collected in the last week of May 2008.

Introduction

Beneath the upper surface of the land lies a tremendous resource, which is the cause of our life is ground water. Ground water is found in pores and fissures of rocks. It is regulated by the quantum and speed of rains, extent of vaporization at the time of rain, slope of land, dryness of air, porosity & permeability of rocks, vegetative cover and water absorbing capacity of the soil.

This paper studies the ground water resources of Chitrakoot district .The study area lies between 24°53'N to 25°33'N latitude & 80°41'E to 81°34'E longitude and covers an area of 3205.95 km². Administratively the district comprises of two tahsils namely Karwi & Mau & five development blocks Pahari, Karwi, Manikpur,Ramnagar,Mau. Like other districts of Bundelkhand region Chitrakoot experiences extremities in climate conditions during summer & winter. The average annual rainfall for the District amounts to 800 to 950 mm. about 88% of the total annual is concentrated in the rainy season (from June to September).Average annual temperature is 33°C.

Ground Water Conditions in the District

(1) Water table & its fluctuation: Water monitoring in the study area is being done on a total of 34 observation wells at monthly intervals since 2002-07 by Central Ground Water Board, Lucknow U.P. The wells are mostly situated along the roads. The water table in the area exhibits marked seasonal fluctuations. For instance the average pre and post monsoon(2002-2007) depth of water table below ground for all of 34 well
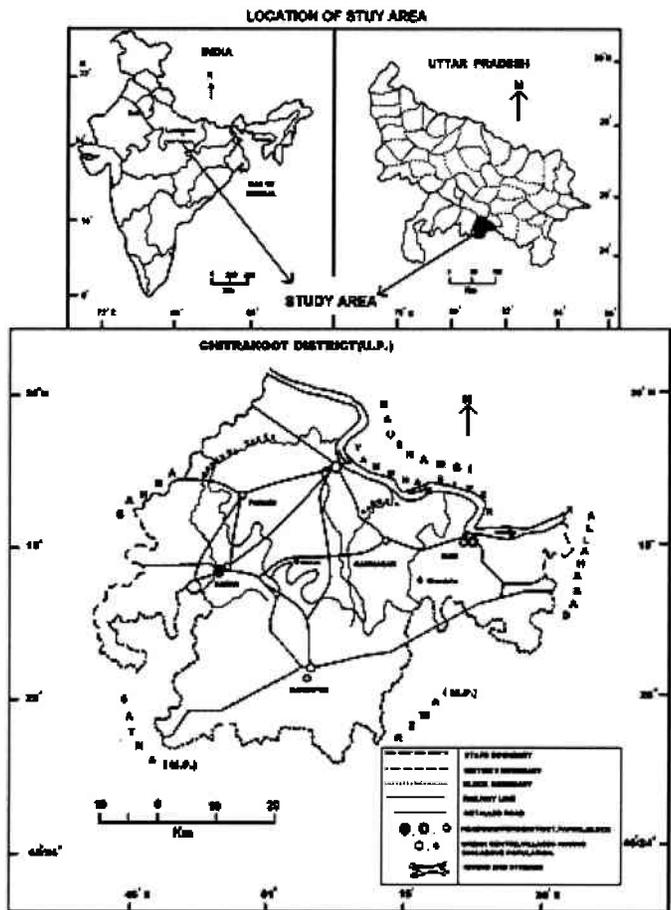
Fig-1

Table 1: Average depth of water table below ground surface in meters (2000-2007)

Block	Pre monsoon	Post monsoon	Average fluctuation (m.)
Karwi	9.98	7.53	2.45
Pahari	10.43	8.48	1.95
Manikpur	8.99	5.74	3.25
Ramnagar	7.34	5.10	2.25
Mau	7.90	4.61	3.29
Total District	8.93	6.29	2.64

Source: Computed from the data personally collected from the ground water department, Lucknow (U.P.)
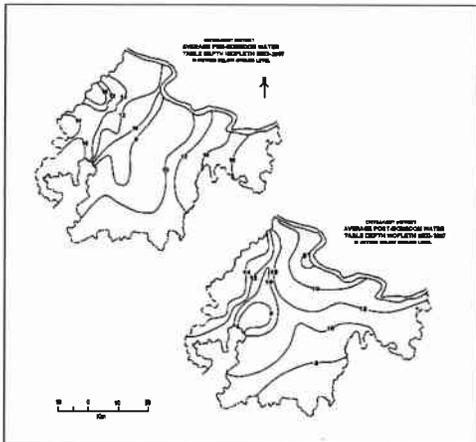
Fig-2

comes to 5 to 11 meters. The isopleth map of water table is shown in fig no-2.

A study of the trend of water table fluctuation during the period of record under consideration (2002-2007) reveals marked spatial variation. The average water table depth over the district as a whole is 7.61meter below the ground (fig-2).The corresponding averages for pre and post monsoon are 8.93 and 6.29 meter respectively (table-1).

For the study of water table fluctuation the study area has been divided into (i) area under tube-well irrigation,(ii) area under canal irrigation &(iii) area under tube-well & canal irrigation. Six hydrographs have been drawn and the corresponding rainfall amounts have also been plotted against the hydrographs to show the influence of rainfall on the fluctuations (fig-3).

The water table condition in the area is being influenced mainly by seasonal variation in ground water recharge from local rainfall and by pumping from tube wells. Thus water table maxima is attained in August-October and minima in April-May.

In 2007, a comparatively low rain fall year there was a general decline in water table throughout the year.

(2) Quality of Ground Water: As the resource the quality of ground water is as significant as its quantity. The quality of water is commonly assessed from a chemical analysis. Under the present study water samples from 18 observation wells were collected and analyzed. The result of the analysis is shown in table -2.

A diagram named as the U.S. salinity diagram classifying water quality for irrigation, has been suggested by the U.S. department of agriculture. It gives direct indication of the salinity and alkalinity hazards.

on the basis of SAR (Sodium Absorption Ratio) and EC(Electrical Conductivity), the diagram is divided into 20 water quality groups which represent good, medium and bad quality of irrigation waters. Water belonging to groups C_1 S_1 and C_2 S_2 are of good quality, those belonging to C_1 S_2, C_2 S_2, C_3 S_2 & C_3 S_1 of medium quality and the rest being of bad quality.

The result of the chemical analysis shows that total dissolved salts in the water are in permissible limits and pH value is less than 9.0. This indicates that the water is generally suitable for irrigation & domestic purposes in district. Further the electrical conductivity is medium in the entire district except Shivrampur in Karwi block(0.77 dSm²) Agriculture in these areas can flourish only in permeable soils and that too with moderate leaching.
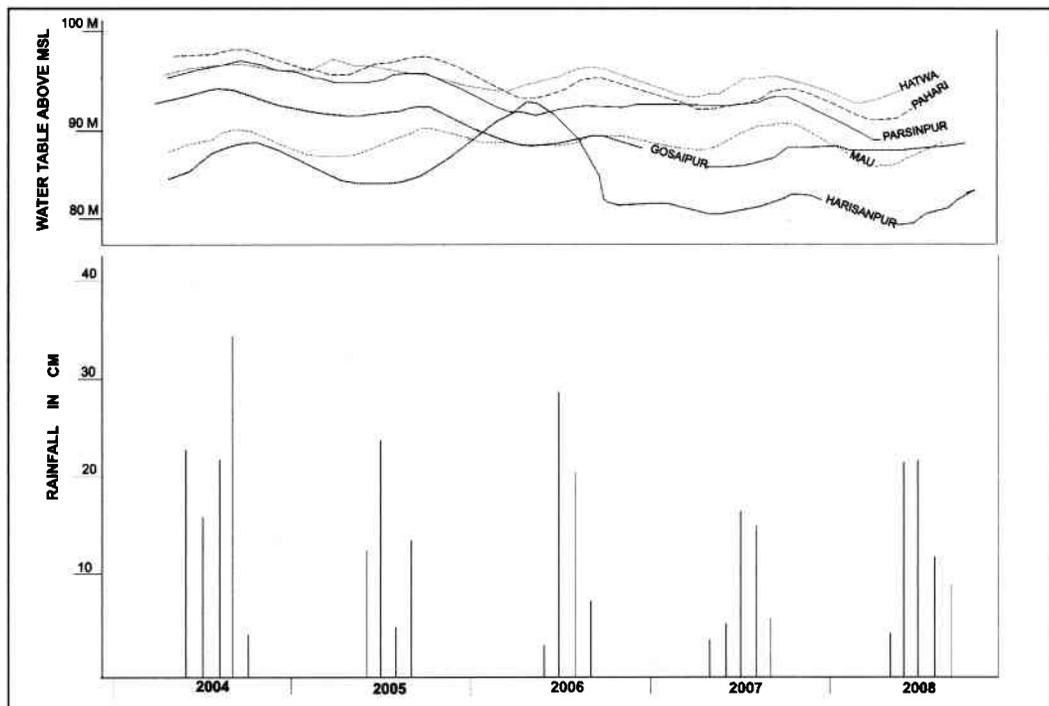
(3) Ground water recharge

Ground water recharge in the study area occurs from rainfall and seepage from canals & irrigated fields.

(A) Recharge by rainfall

Has been estimated by taking into account:

i) Average water rise due to rainfall.

ii) Specific yield of the underlying rocks (4%).

Thus recharge by rainfall in whole district amounts to 32532.49 ha.m(table-3).

(B) Recharge by canal seepage

This has been computed form :

i) Average wetted perimeter.

ii) Length of canal.

iii) Number of canal running days.

iv) Seepage factor.

Average wetted perimeter for main & minor canals has been computed from bed width & water depths obtained from their longitudinal sections & gauge values. Recharge from canal seepage is shown in table-4.

Thus the total annual ground water recharge from canal seepage for the whole district comes to **4500.13** ha.m.

(C) Recharge by seepage of irrigation water

Water from the fields has been calculated from 35% of volume of irrigation water released at canal out lets. This type of recharge is shown in table no.5.

Table 2: Quality of ground water in aquifers tapped by different wells in Chitrakoot district

S. No.	Location of observation wells	Hardness (ppm)	TDS (ppm)	Chemical Constituents(ppm)						
				Cl^-	CO_3^{--}	HCO_3^-	Ca^{++}	Mg^{++}	Na^+	K^+
1	2	3	4	5	6	7	8	9	10	11
01	RAJAPUR (RAMNAGAR)	52.7	340	600	15	300	12.7	40.0	1.67	19.4
02	KARUNDI (RAMNAGAR)	61.8	350	770	13	316	13.0	48.8	1.62	Absent
03	PARAKO (RAMNAGAR)	48.1	300	580	15	290	12.9	46.5	1.60	31.9
04	RAMNAGAR	57.60	310	620	14	330	12.0	56.0	1.59	64.7
05	PAHARI	64.24	200	Absent	16	460	27.5	62.5	1.74	42.6
06	PARSITPUR (PAHARI)	50.0	300	Absent	15	466	21.2	48.0	1.58	Absent
07	MAHUAGAON (PAHARI)	69.8	330	20	15	481	18.2	68.0	1.80	Absent
08	CHAKAUNDH (PAHARI)	51.69	310	40	15	420	20.7	50.0	1.69	25.2
09	MAU (MAU)	69.91	350	420	15	420	22.5	68.0	1.91	7.7
10	HATWA (MAU)	69.3	320	490	12	520	22.5	67.5	1.80	12.2
11	CHIBLAHA (MAU)	88.82	340	480	11	466	22.5	86.9	1.92	19.3
12	MURKA (MAU)	92.12	350	500	15	500	21.7	90.0	2.12	41.6
13	RANIPUR BHATT(KARWI)	72.2	290	1200	18	460	30.2	69.5	2.70	40.3
14	SHIVRAMPUR (KARWI)	70.5	290	350	13	560	21.2	68.0	2.50	36.3
15	BHARATKOOP (KARWI)	62.7	250	390	15	430	23.5	60.2	2.50	42.5
16	ENCHWARA (MANIKPUR)	51.01	290	160	15	460	27.5	50.5	0.51	20.1
17	BAGDARI (MANIKPUR)	55.0	270	100	15	480	23.3	55.0	0.30	6.4
18	BARAMAFI (MANIKPUR)	52.91	260	110	14	416	22.2	52.6	0.31	33.0

Recharge by return seepage from irrigated fields is **6051.674** ha.m.

Above table shows that the total ground water recharge for the district as a whole comes to **43084.29** ha. m.(table-6) by all sources.

Correlation of annual rainfall and total recharge

It is observed that correlation coefficient is very high in the district, it is 0.835. This magnitude of correlation coefficient(r) shows high interdependence between ground water recharge and rainfall.

Ground Water Utilization

The study under this head is confined to use of water in irrigation, domestic & industrial sectors.

(i) Use of ground water for irrigation- Normally ground water and surface water are used for irrigation and when water available in these sources is taken artificially for supplying water in required quantity to

Table-2 : Continued-

S.No	Location of Observation Wells	pH (ppm)	EC (dSm⁻¹)	SAR	KR	MR	SALINITY GROUP
		13	14	15	16	17	18
1	RAJAPUR (RAMNAGAR)	8.4	0.42	0.32	0.316	75.90	C_2S_1
2	KARUNDI (RAMNAGAR)	8.2	0.42	0.29	0.262	78.96	C_2S_1
3	PARAKO (RAMNAGAR)	8.6	0.40	0.29	0.0269	78.28	C_2S_1
4	RAMNAGAR	8.6	0.44	0.27	0.0233	82.35	C_2S_1
5	PAHARI	8.5	0.57	0.25	0.0193	69.44	C_2S_1
6	PARSITPUR (PAHARI)	8.5	0.60	0.27	0.0228	69.39	C_2S_1
7	MAHUAGAON (PAHARI)	8.2	0.55	0.27	0.0208	78.88	C_2S_1
8	CHAKAUNDH (PAHARI)	8.6	0.52	0.28	0.0239	70.72	C_2S_1
9	MAU (MAU)	8.4	0.61	0.30	0.0211	75.13	C_2S_1
10	HATWA (MAU)	8.2	0.67	0.40	0.02	75.0	C_2S_1
11	CHIBLAHA (MAU)	8.3	0.60	0.26	0.0175	79.43	C_2S_1
12	MURKA (MAU)	8.8	0.71	0.28	0.0189	80.57	C_2S_1
13	RANIPUR BHAT(KARWI)	8.4	0.67	0.29	0.0270	69.70	C_2S_1
14	SHIVRAMPUR (KARWI)	8.0	0.77	0.34	0.0280	76.23	C_3S_1
15	BHARATKOOP (KARWI)	8.2	0.73	0.37	0.0298	71.92	C_2S_1
16	ENCHWARA (MANIKPUR)	8.3	0.30	0.66	0.0065	64.74	C_2S_1
17	BAGDARI (MANIKPUR)	8.4	0.28	0.04	0.0038	70.24	C_2S_1
18	BARAMAFI (MANIKPUR)	8.2	0.32	0.03	0.0044	70.30	C_2S_1

crops, it is called irrigation. State tube wells, pumping sets, private tube wells & wells are the sources of withdrawal of ground water for irrigation in the study area.

It is clear from fig-6 that state tube wells exist only in Pahari block and estimated ground water withdrawal by state tube wells is only 0.366%.In the same block ground water withdrawal by private tube wells, wells and by pumping sets estimated as 82.16%, 7.00% and10.47% respectively. In Karwi block ground water withdrawal by state tube wells, private tube wells, wells and by pumping sets estimated as 0%, 51.49%, 34.47% and 14.04% respectively. In Manikpur block ground water withdrawal by state tube wells, private tube wells, wells and by pumping sets estimated as 0%, 59.08%,30.77% and 10.14% respectively.

In Ramnagar block ground water withdrawal by state tube wells, private tube wells, wells and by pumping sets estimated as 0%,68.93%,18.77% and 12.29%. In Mau block ground water withdrawal by state tube wells, private tube wells, wells and by pumping sets estimated as 0%, 61.68%,26.71% and 11.60%

Block wise withdrawal of ground water in the district by irrigational uses are shown in table7.

Thus annual estimated ground water draft for irrigation in the district is 17,963.676 ha.m.

(ii) Use of ground water for domestic and industrial uses

Domestic & industrial use of water includes water use for drinking, cooking, gardening, sanitation & industries.
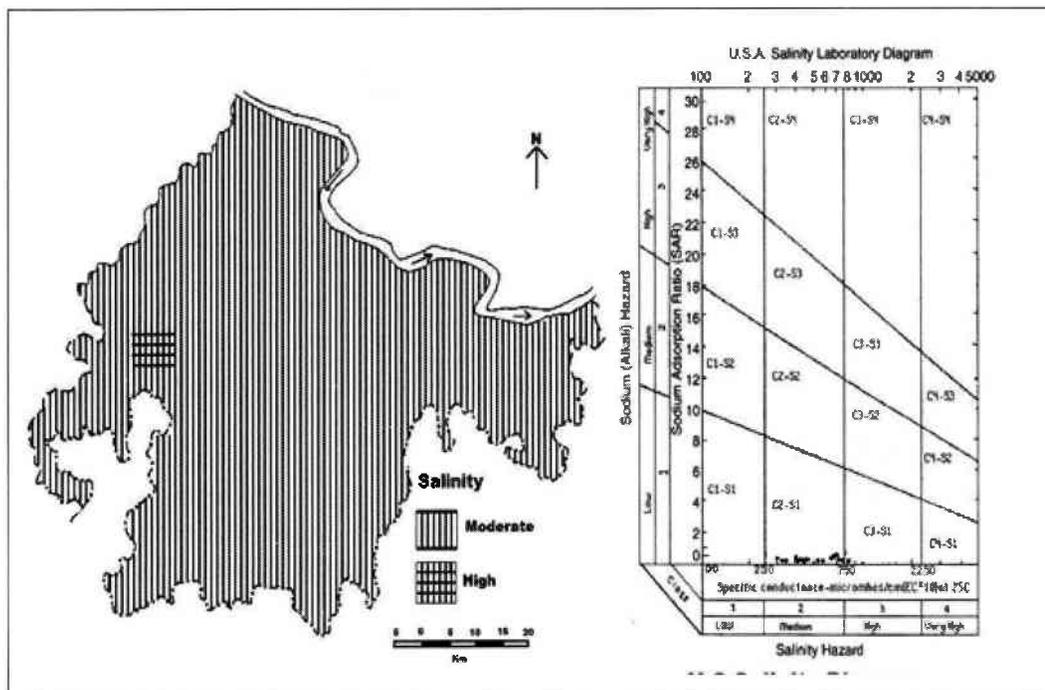
Table No-3: Ground water recharge from rainfall in Chitrakoot District (2008-2009).

Block (1)	Area (ha) (2)	water table rise (meters) (3)	Recharge(ha.m) (col.2×3×Specific yield)[10] (4)
Pahari	64939	1.41	3662.56
Karwi	80279	3.0	9633.48
Manikpur	105914	2.33	9871.18
Ramnager	42388	0.46	779.94
Mau	45377	4.73	8585.33
Total District	_	_	32532.49

Source:computed from the data personally collected from the Central Ground Water Board, Lucknow (U.P.)

There are wide variations in domestic water consumption pattern depending upon the season, belief, customs and habits of the consumers. Total availability of ground water in the study area is 42 MLD (million liters daily). The per capita rural water use is 70 lpcd (liter per capita daily) and this is for urban area is 120 lpcd. Urban water use is 1.182 ha.m/day and rural water use is 5.998 ha.m/day (including water used for cattle).

Table -6: Ground water recharge from all sources in Chitrkoot District (ha.m) -2008-09

Block	Recharge form Rainfall	Recharge form canal seepage	Recharge from irrigated field	Gross Recharge (ha. m.)
Pahari	3662.56	1299.69	3030.934	7993.18
Karwi	9633.48	1410.58	689.816	11733.88
Manikpur	9871.18	146.42	142.262	10159.86
Ramnager	779.94	529.87	705.621	2015.43
Mau	8585.33	1113.57	1483.041	11181.94
Total district	32532.49	4500.13	6051.674	43084.29

Source : Computed from the data personally collected from the office of Executive Engineer, Irrigation & Tubewell Division, Karwi, Chitrakoot.

Annual (2008-09) rural and urban water use for the district as a whole is 2189.197 ha.m and 431.43 ha.m respectively. Ground water withdrawal for domestic purposes amounted to 2547.74 ha.m in 2008-09.

From the industrial point of view the study area is very poor. Only small scale industries are established here like khadi, chemical, handicraft and silk etc and the consumption of water is very low in such type of industries. It amounted to 389.89 ha.m for the district as a whole in the year 2008-09.Total ground water withdrawal for domestic and industrial uses is estimated as 2937.63 ha.m.

Block wise withdrawal of ground water in the district by irrigational, domestic & industrial uses are shown in table-8.

The existing ground water withdrawal for the whole district is 20901.3 ha.m in the year 2008-09(table-8 & fig-6).

Conclusion

It may be concluded from the above discussion that water table fluctuation in the district occurs mainly due to variations in local rainfall & pumping by tube wells. Further the water table is not being significantly influenced by factors like influent seepage from or effluent seepage into surface water bodies. Rainfall is the main source of ground water recharge in Chitrakoot district . About 90% of the rainfall takes place between June to September and the remaining 10% is distributed in the rest of the period. Obviously, the monsoon rainfall is mainly responsible for groundwater recharge in comparison to other sources of recharge. This paper attempts to assess the ground water condition and its utilization in different sectors. The annual ground water recharge in the area for 2008-09 is estimated as **43084.29** ha.m. where as the utilization of ground water in the same year comes to **20901.3** ham. Thus the rate of total ground water recharge is higher than the rate of total ground water withdrawal in the district as a whole. So ground water is safe for future consumption. Quality of ground water in the study area fulfills its suitability for both the domestic & irrigational uses.
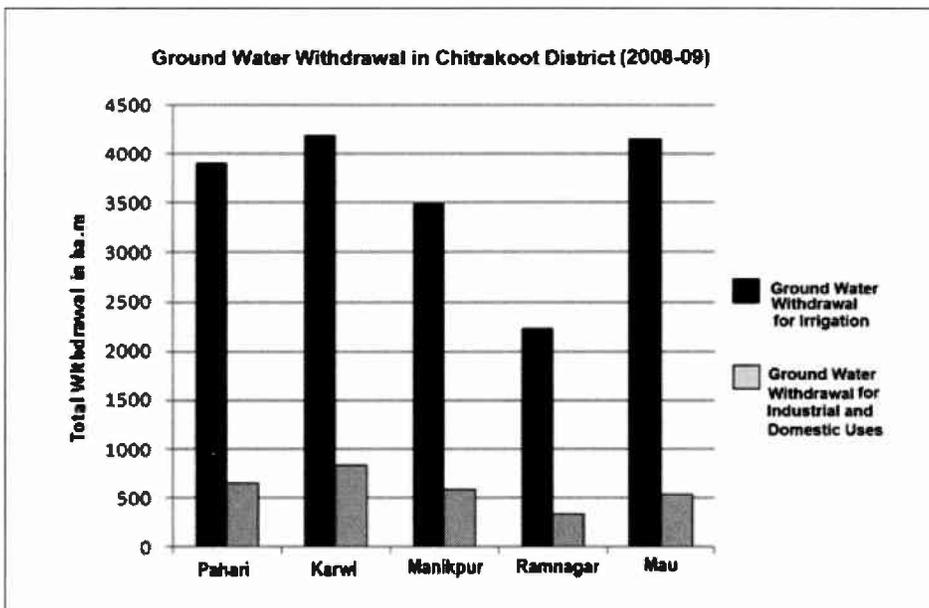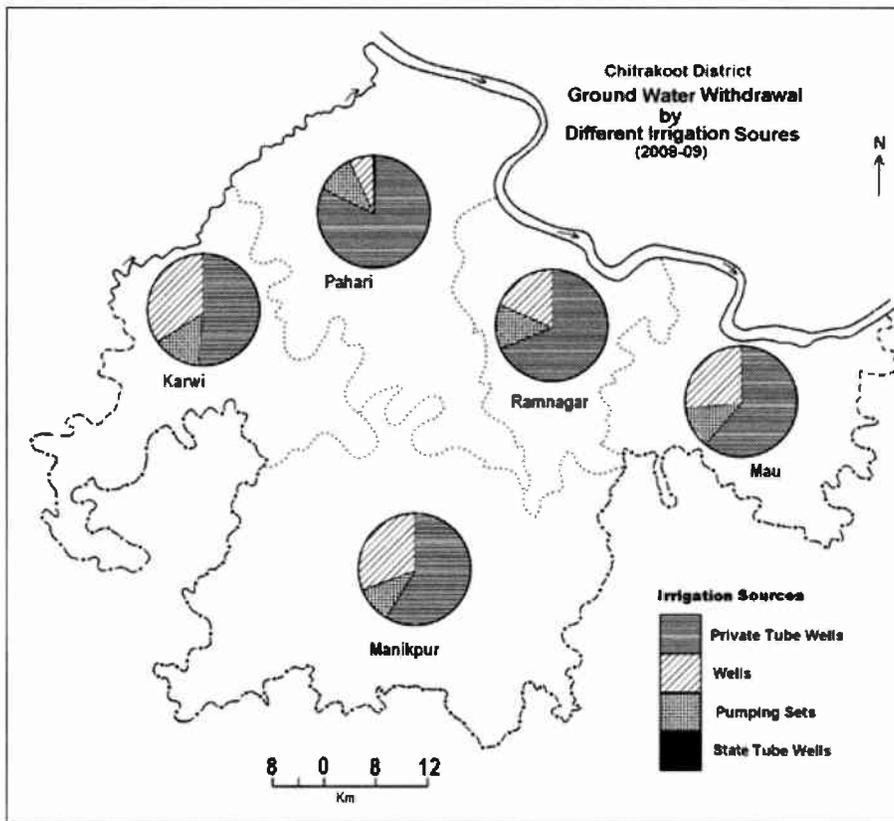
Chitrakoot District
Ground Water Withdrawal
by
Different Irrigation Soures
(2008-09)

N

Pahari

Karwi

Ramnagar

Mau

Manikpur

Irrigation Sources

Private Tube Wells

Wells

Pumping Sets

State Tube Wells

8   0   8   12
Km

Ground Water Withdrawal in Chitrakoot District (2008-09)

Total Withdrawal in ha.m

Ground Water
Withdrawal
for Irrigation

Ground Water
Withdrawal for
Industrial and
Domestic Uses

Pahari   Karwi   Manikpur   Ramnagar   Mau

Table-8: Withdrawal of ground water in Chitrkoot District (2008-09)

Block	Ground water withdrawal for irrigation (ha.m)	Ground water withdrawal for industrial & domestic uses (ha. m)	Existing gross ground water withdrawal for all uses (col. 2+col.)
Pahari	3912.714	645.24	4557.954
Karwi	4179.180	838.26	5017.44
Manikpur	3481.784	583.38	4065.164
Ramnager	2227.999	340.32	2568.319
Mau	4161.993	530.43	4692.423
Total district	**17963.67**	**2937.63**	**20901.3**

Source : Computed from the data personally collected from the office of Executive Engineer, Irrigation & TubeWell Division, Karwi, Chitrakoot.

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