ASSESSMENT OF RATE AND MAGNITUDE OF GROUNWATER DEPLETION IN MAHENDERGARH DISTRICT, (HARYANA)

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Abstract: Mahendergarh district constitute South Western part of the Haryana state. Rainfall and canal network system are limited in this district. Therefore, groundwater is the only source to meet the demand for agriculture, domestic and industrial purposes. Proper knowledge of various parameters e.g. long-term changes in depth to watertable, magnitude and rate of depletion is necessary in order to make an efficient management plan to monitor groundwater resources. These essential parameters are evaluated in the present study. Mahendergarh district, in general, exhibit deeper watertable. The depth to watertable declined in all the blocks during the last decade (2004-2014) Ateli block exhibit maximum rate of decline (upto 2m/year) and Kanina block exhibited minimum rate of decline (0.385 m/year). It was observed that decline in depth to watertable have direct relationship with change in volume of groundwater storage and magnitude of depletion. Ateli block exhibited the maximum change in storage volume and magnitude of depletion as well. Kanina block found at the bottom of all five blocks with respect to changes in the above three parameters.

Keywords: Water table, Magnitude, Rate of Depletion, Storage

INTRODUCTION

Water has emerged as a resource of strategic importance because of its increasing demand in agriculture, domestic and industrial uses. Its adequate and continuous supply is essential to provide stability in food production and self-sufficiency to societies (GWC 2013). Increased demand for water has stimulated development of groundwater supply. Groundwater has emerged as one of the principal source of water for irrigation in areas where surface (canal) irrigation is either insufficient or prohibitively expensive. Groundwater is a replenishable finite source. It is common pool resource and termed as a heritage for all to manage (Aggarwal et. al 2009 a & b).

Intensive withdrawals of groundwater in excess of natural recharge over the years have affected the environment causing a continuous fluctuation in water table levels. More than half of the world's population is dependent on the groundwater for its survival (omvir and sharma 2010). Water storage is a serious problem in many parts of India including semi-arid region of Southern Haryana. The usable groundwater resource is essentially a dynamic resource which is recharged annually and periodically from rainfall, irrigation returns flow, canal seepage, influent seepage etc. (Chatterjee et. al. 2009).

Southern Haryana, being a semi-arid region with predominant agricultural economy facing a serious problem of water availability these days. In this region (including Mahendergarh district) rainfall is scanty and availability of surface water due to limited canal network is restricted. Water conservation practices are negligible under these situations. Annual net recharge of groundwater in this area has been much smaller than its discharge. Therefore, this region has been facing a challenge to maintain a delicate balance between replenishment and utilization.

In order to elucidate this natural process, first of all, a systematic study is required to understand the long-term change in magnitude and rate of depletion of its reserve before making management plan to maintain the balance. In this study, an attempt has been made to understand these long-term changes in Mahendergarh district of Southern Haryana.

1.STUDY AREA

Mahendergarh district (Figure 1) located on South Western part of Haryana state and lies between 27^0 47' and 28^0 28' north latitude and 75^0 53' and 76^0 22' east longitude. Narnaul town is administrative headquarter of this district. It is surrounded by Bhiwani and Jhajjar districts of Haryana in the north, by Rewari district of Haryana and Alwar, Jaipur and sikar district of Rajasthan in the South and by Sikar and Jhunjhunu districts of Rajasthan in the West. It has a geographical area of 1899 km^2.The district has five development blocks viz. Mahendergarh, Kanina, Atali, Narnaul and Nangal chaudhary (Figure.1). The elevations of the plains above mean-sea level range from 270.6 to 294.6 m in South 217.1 to 267.0 m in north and 252.9 to 294.6 m in west and from 218.6 to 270.6 m in the east. Mahendergarh district is a semi-arid with a long dry hot weather period. The average annual rainfall in the district is 407 mm. About 90 percent of the normal annual rainfall in the district is received during June to September. The occurrence, origin, quality and availability of groundwater in the district are related to the recent formations of the area and do not contain groundwater in substantial quantity.

2. MATERIALS AND METHODS

Adoption of sound analytical technique in any scientific investigation is necessary for proper interpretation. In the present study magnitude and rate of groundwater depletion are computed with secondary data obtained from groundwater cell (GWC) of Agriculture Department of Government of Haryana. The methodology approved by Groundwater Estimation Committee GEC-1997 has been followed. In order to compute the rate of groundwater depletion the water table fluctuation approach has been adopted. (GEC-1997)

2.1 Change in Groundwater Storage

In order to estimate the change in groundwater storage, water fluctuation data for the period June 2004 and June 2014 was used. The following equation was used to estimate the change in storage.

$$\Delta GWS = Aaq \times GWT \times Sy$$

Where,

Δ GWS = change in groundwater storage;
Aaq = involve area of aquifer;
GWT = fluctuation in groundwater table;
Sy = specific yield

Although, the specific yield values for different type of geological formation has been used by various researches and organizations differently. In this study, a uniform value of 12 per cent has been taken.

2.2 Magnitude of Depletion

Magnitude of depletion has been estimated by using the values of change in groundwater storage in each block.

Magnitude of depletion (m^3/day) =Total draft x 10000/365

1. RESULT AND DISCUSSION

In the present study status of water reserve in Mahendergarh district of Southern Haryana is assessed in order to facilitate the proper management plan for efficient use of this natural resource. Relevant data has been collected block wise and computation is carried out at block level.

3.1 Depth to Watertable

The secondary data on depth to watertable fluctuation has been calculated for all the five blocks of the district for the year 2004 and 2014 so as to observe the long-term change in water level in this semi-arid area of Mahendergarh district. The depth to watertable recorded in all the five blocks with the passage of a decade. In 2004 the shallow watertable (10.20 m) occurred in Nangal choudhary block while water levels were deepest (20.60 m) in the Mahendergarh block. During 2014, the shallowest (25.91 m) in Kanina block while the deepest (63.20 m) occurred in Ateli block. The depth to watertable was 53.16 m, 45.36 m and 55.60 m during 2014 in Mahendergarh, Nangal choudhary and Narnaul block respectively. Although, the depth to watertable declined in all the five blocks, however, the rate of decline was different in different blocks.

In the last one decade the depth to watertable declined maximum by about 22 m i.e. at a rate of more than 2m/year in Ateli block. The minimum decline in the depth of watertable occurred in Kanina block (3.85 m) i.e.at a rate of about one third of a meter/year. The depth to watertable declined at a rate of more than one meter/year in all the other three blocks (Mahendergarh, Nangal choudhary, Narnaul) during the last one decade (2004-2014).

These results (Table 1, Figure 2) suggest that excessive water has been withdrawn from all the five blocks during the last ten years.

Table: 1: Mahendergarh District: Average Depth to Water table during Last One Decades and its Fluctuation

Blocks	Depth to water table		Water level fluctuation		
	2004	2014	Total fluctuation during 10 year (2004-14)	Average fluctuation (2004-14)	2014-04
	(m)	(m)	(m)	(m)	(cm/year)
1	2	3	4	5	6
Ateli	41.23	63.2	-21.97	-2.917	-219.7
Kanina	22.06	25.91	-3.85	-0.385	-38.5
Mahendergarh	42.2	53.16	-10.96	-1.096	-109.6
Nagal Chaudhary	32.87	45.36	-12.49	-1.249	-124.9
Narnaul	42.7	55.6	-12.9	-1.29	-129

Source- For Col. No. 1, 2, and 3 Groundwater cell, Agriculture Department Government of Haryana For Col No. 4, 5, and 6 computed by author.

Although, groundwater is of poor quality in many parts of the district, however due to availability of inadequate canal water, the extraction from underground pool has been increasing day by day to meet the demand. If this situation is allowed to prevail for longer time without introducing sufficient recharge facilities, the problem of depletion may infest manifold that would ultimately increase the worry of farmers and planners.

3.2 Range of Depth to Watertable

Generally, the water levels are deeper in this district.

Table: 2 Mahendergarh District: Block wise Range of Depths to Water table in June 2014

Blocks	Rechargeable Area (ha)	0-1.5 (m)	1.5-3.0 (m)	3-10 (m)	10-20 (m)	20-30 (m)	30-40(m)	>40(m)
1	2	3	4	5	6	7	8	9
Ateli	30279	0 (0.0)	0 (0.0)	0 (0.0)	1920 (6.34)	1545 (5.10)	3667 (12.11)	23198 (76.61)
Kanina	37483	0 (0.0)	0 (0.0)	922 (2.45)	9137 (24.37)	5683 (15.16)	4688 (12.50)	16588 (44.25)
Mahendergarh	56593	0 (0.0)	0 (0.0)	0 (0.0)	1490 (2.63)	1490 (2.63)	11412 (20.16)	42026 (74.26)
Nagal Chaudhary	33446	0 (0.0)	0 (0.0)	436 (1.30)	3490 (10.43)	10179 (30.43)	8580 (25.65)	10716 (32.03)
Narnaul	26118	0 (0.0)	0 (0.0)	0 (0.0)	2857 (10.93)	2928 (11.21)	7570 (28.98)	12712 (48.67)

Source: For Col. No. 1, 2 and 3 Groundwater cell, Agriculture Department, Government of Haryana. For Col. 4, 5, and 6 computed by the author

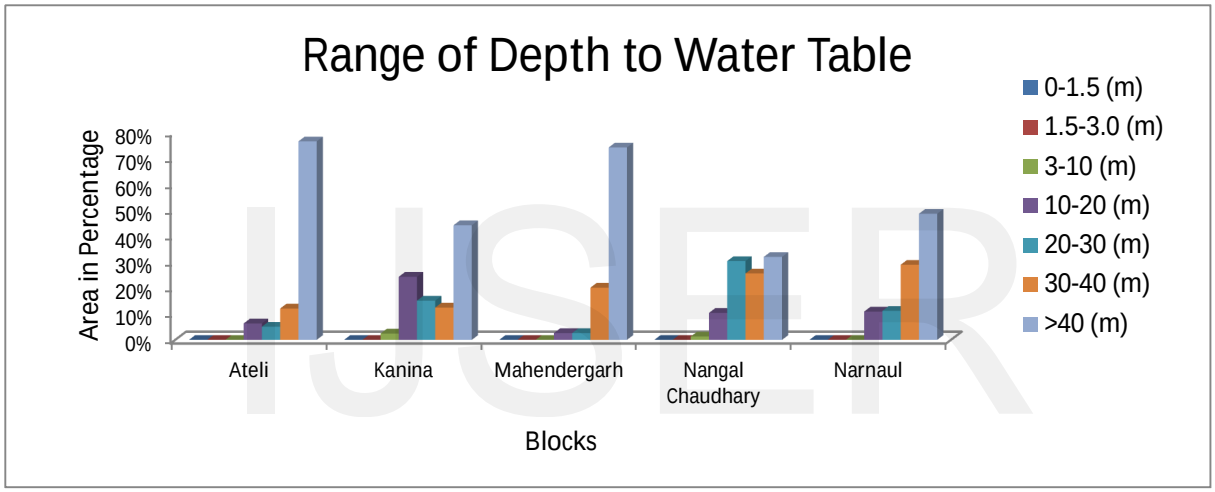

Figure 3

Figure 3 shows that no part of this district exhibited below 3.0 m the range of depth to watertable. In all the five blocks, appreciable area fall under the range more than 40 m depth. About 77, 44, 74, 34 and 49 per cent area fall the range above 40 m depth in Ateli, Kanina, Mahendergarh, Nangal choudhary and Narnaul blocks, respectively. This suggests that maximum area in all the five blocks falls in range of more than40 m depth to watertable. There was hardly any area in the district which falls in the range of less than 10 m depth. This clearly depict that water level is deeper in this district. Rainfall and other sources e.g. canal network is limited in this district groundwater is the main source of water for different uses. This may be the main reason of deepening water level in the area. The monitoring of groundwater level has assumed greater significance with the extensive development of groundwater resources. The watertable has rarely been stationary as it is continuously being affected because of input-output activities. The close observation regarding deepening of water level is important in areas, like Mahendergarh district, where water has already been in shortage and intensity of private tubewell has been increasing.

3.3 Change in Groundwater Storage

The secondary data about depth of watertable during 2004 and 2014 was used to compute the change in groundwater storage. The relationship as estimated in the previous section has been used to estimate the net change in storage between 2004 and2014 in all the blocks of Mahendergarh district.

$$\Delta \text{ GWS} = \text{Aaq} \times \text{GWT} \times \text{Sy}$$

In estimating the Δstorage in an unconfined aquifer, the specific yield values have a special significance.

The specific yield is termed as the value of water expressed as a percentage of the total volume of saturated aquifer that can be drained by gravity. Detailed test are required to estimate specific yield in the concerned area. Therefore, in the absence of detail studies values of 12 per cent has been taken for computation of storage change in all the blocks.

Fluctuations in watertable play an important role in affecting the groundwater storage. Table 3 col. 3, 4 and 5 indicates a negative change in storage.

Table No. 3: Mahendergarh District: BlockWise Assessment of changes in Storage and Magnitude of Ground Water Depletion

Blocks	Area (Km^2)	ΔStorage (ham)	Average ΔStorage (ham/year)	Magnitude of Depletion (m^3/day)
1	2	3	4	5
Ateli	318	-79827.6	-7982.8	-2187056.3
Kanina	379	-17317.1	-1731.7	-474442.4
M/garh	607	-74431.1	-7443.1	-2039208.6
Nagalchaudhary	349	-50128.9	-5012.9	-1373393.6
Narnaul	286	-40430.7	-4043.1	-1107689.4

Source: For Col. No. 1 and 2 Ground Water Cell Agriculture Dept., for Col. No. 3, 4,and 5 computed by the Author.

On an average, the change in volume in storage was -5242.7 ham/year in Mahendergarh district. The maximum change (-7982.8 ham/year) was in Ateli block followed by Mahendergarh block (-7443.1 ham/year). The minimum change was in Kanina block (-17317 ham/year). These results suggest that huge volume of groundwater has been withdrawn during the last decade. This large extraction, to meet the demand, may have happened due to increased numbers of tubewells by the farmers. (Figure 4)

3.4 Magnitude of Depletion

The tendency of groundwater depletion can be understood properly with the help of analysing its magnitude and rate within the specific time period. Magnitude of groundwater depletion is directly related to the change in the volume of groundwater storage. Table 3 col.5 indicate that the maximum magnitude of groundwater depletion was in Ateli block (-2187056.3 m^3/day) followed by Mahendergarh block (-2039208.6 m^3/day). The minimum magnitude of groundwater depletion observed in Kanina block (-474442.4 m^3/day). On an average, the magnitude of groundwater depletion in Mahendergarh district during last one decade was -1436357.6 m^3/day. The high magnitude of groundwater depletion in this district could have been due to high rate of extraction due to shortage of surface irrigation facilities.

CONCLUSION

The balanced development plan should meet the requirement to maintain equilibrium between withdrawal and replenishment in an area. In order to prepare an efficient development plan a proper evaluation of long-term changes in depth to watertable, magnitude and rate of depletion is essential. In this study, these parameters are evaluated at block level in Mahendergarh district for the period 2004-2014. The depth to watertable declined in all the five

blocks. The water level in Mahendergarh district dropped up to 22m during last one decade (2004-2014). Rainfall and canal network are limited in the district. Groundwater is the only major source of water to meet the demand. Water levels are generally deeper in the district. Decline in depth to watertable is directly related to the change in volume of groundwater storage and magnitude of depletion. All these parameters were maximum in Kanina block.

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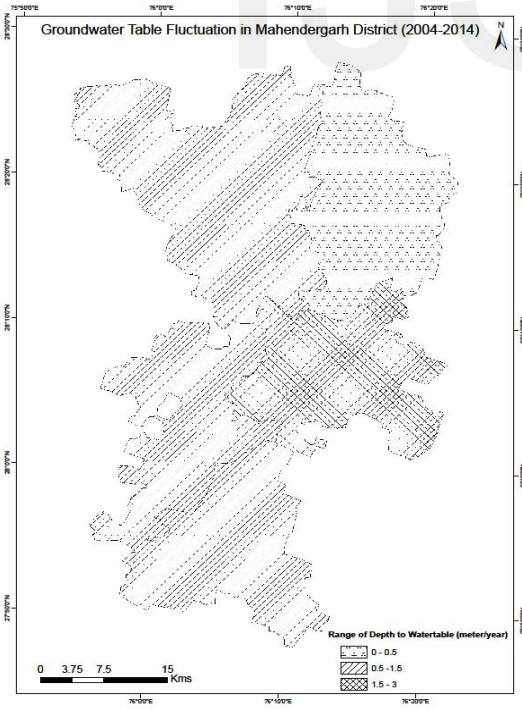

Figure:2

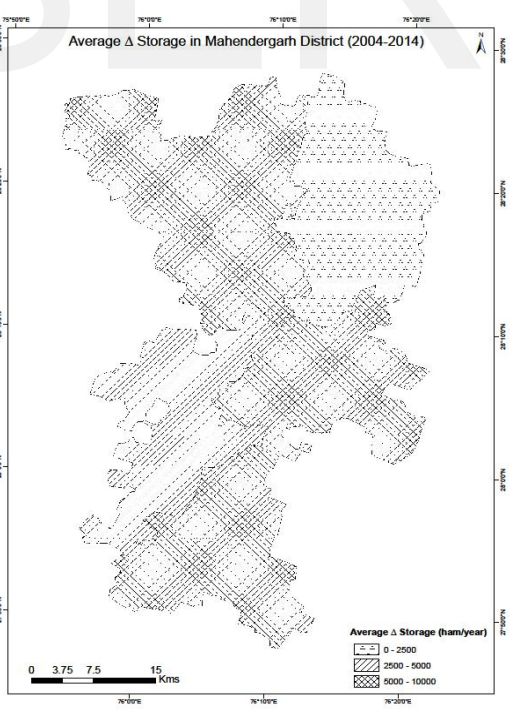

Figure: 4