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Water Draft Exceeds the Quantity of Groundwater Recharge: A Case of Yarehalli Micro-Watershed, Davanagere District, Karnataka

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ABSTRACT

The groundwater is a dynamic and replenishable natural resource but in hard rock terrains its availability is of limited extent and essentially confined to the fractured and weathered horizons, which points toward efficient management of groundwater in these areas. The behaviour of groundwater in the Indian sub-continent is highly complicated due to the occurrence of diversified geological formations. Hence, the groundwater extraction and corresponding recharge studies were conducted at Yarehalli micro-watershed during the year 2016-2017. The results indicated that the groundwater fluctuation and discharge was more in the year 2017 as compared to 2016. The total draft of groundwater was found to be 27, 09, 619 m^3, against the total recharge of 1, 80, 462 m^3 with the groundwater extractions being 15 times more than the recharge.

Key Words: Groundwater draft, Groundwater fluctuation, Groundwater recharge, Micro-watershed, Natural resource.

INTRODUCTION

In India, the water resource potential in terms of natural runoff is about 1,869 billion Cubic Meter (BCM)/yr, while, the usable water resources of the country have been estimated as 1,123 BCM/yr. This is mainly due to constraints of topography and uneven distribution of the resource in various river basins, which makes difficult to extract the full potential of the natural runoff. Further, the share of surface and groundwater resources extracted from the natural flow was accounted to 690 BCM/yr and 433 BCM/yr, respectively. Therefore, the net annual groundwater availability for the entire country is only 398 BCM, excluding 35 BCM as natural discharge. The overall contribution of rainfall to the country's annual groundwater resource is 68 per cent and the share of other resources, such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures accounted for 32 per cent. Meanwhile, the ever increasing population of the country has resulted to 15 per cent reduction in the national per capita annual availability of water *i.e.,* from 1,816 m^3 in 2001 to 1,544 m^3 in 2011.

Groundwater is the purest form of water on the earth and found to be unlimited natural resources to mankind at the cheapest cost. It always flows through the fractures of rock and pore spaces over a long distance in the aquifers and to be available to the vast number of people at their firm. The configuration (shape or form of the surface) of the water table is a function of the geometry of the land surface, rate and location of ground-water recharge and discharge, aquifer properties, and extent, thickness, and shape of the aquifer and adjacent confining units (Haitjema and Bruker, 2005). The water table rises due to increased ground-water storage when the rate of recharge exceeds the rate of discharge and declines when these conditions are reversed (Veeger and Johnston, 1996). Fluctuations

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can be the result of any influence that can change the amount or location of recharge or discharge. These days the groundwater is being exploited, day by day the number of bore wells and the boring depth also increasing as the depth to water table going down every year.

Groundwater is dynamic natural resources that can be recharge most during the rainy season by rainwater for the rest of the year. Over withdrawal of groundwater causes decline in the water table due to the stress and distorting the aquifer and may also lead adverse surface and subsurface environmental effect. Groundwater recharge is usually influenced by climate variability and human intervention such as groundwater abstraction excessive or unsustainable withdrawal and the rest (Abdullahi and Garba, 2015). Use of groundwater for irrigation is a global inventory via a range of pumping technologies and the studies from India and Bangladesh reported that the groundwater level (0.1 - 0.5 m/yr) is drastically declined indicating reduction in aquifer storage for unsustainable groundwater abstraction for both irrigation and urban water supplies (Siebert *et al*, 2010). Hence, the study was conducted to assess the impact of rainfall on the yield and depth of water table at Yarehalli micro-watershed, Chennapura sub-watershed in Channagiri taluk, Davanagere district under the Karnataka Watershed Development Project (KWDP-II), Sujala-III by University of Agricultural Sciences, Bengaluru.

MATERIALS AND METHODS

Location of the study area

The study was conducted in Yarehalli micro-watershed (Code–4D4C4W1c) is a part of Chennapura sub-watershed, Channagiri taluk, Davanagere district covering an area of 761 ha is located at North latitude 13^0 58' 59.959" and 14^0 1' 3.722" and East longitude 75^0 51' 37.585" and 75^0 53' 29.93" and spread across Dongraghatta, Sunageri, Haronahalli and Yarehalli villages. The predominant soils found in the region are red sandy soil and red loamy soils with the average annual rainfall of 612-1054 mm (Fig. 1). The main cropping season is *Kharif* and the major crops grown in the study area are paddy, ragi, jowar, maize, groundnut and sunflower. The bore well density was around 11 bore wells per sq. km and they are depending on groundwater for irrigation and also for domestic purpose (Fig. 2).

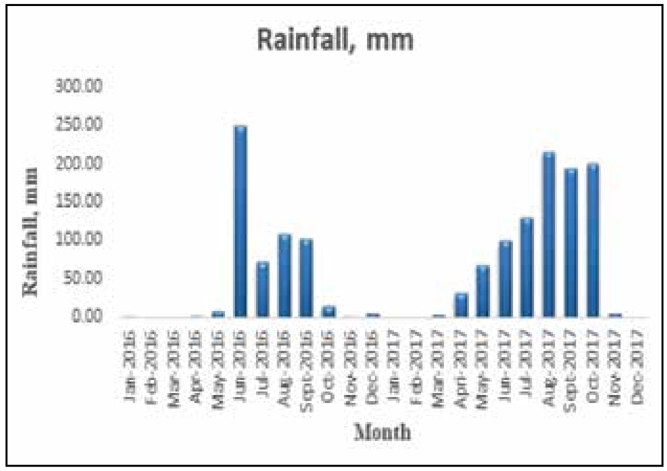

Fig 1. Rainfall pattern of Yarehalli micro-watershed

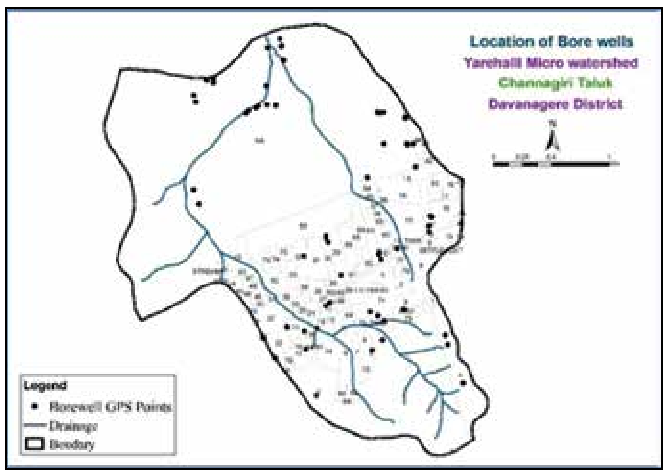

Fig 2. Location of selected borewells in Yarehalli micro-watershed

NATURE AND SOURCES OF DATA

For the survey, 65 bore wells were randomly selected and the water yield (litre/minute) was recorded seasonally through volumetric basis by the expertise field staff. Further, the depth of the groundwater table (meters) was monitored in all the selected bore wells of the micro-watershed at monthly intervals for the academic year 2016 and

2017. Care was taken to obtain the groundwater levels by bore well accessories. Primary data regarding number of bore wells, farm ponds, check dams, irrigated lands *etc* within the watershed boundary was recorded personally by the field staff through face to face interaction with the sample households. The other necessary information like number of households in the village, area under dry land, irrigated land were collected from the records maintained at the Gram Panchayath.

Well Recharge and Draft

The groundwater assessment is accomplished by evaluation of change in annual depth to Groundwater level (m), fluctuations (m), well yield/ discharge (lpm), draft (m^3) throughout the cropping season and recharge (m^3).

Groundwater fluctuation (m)

The average annual groundwater fluctuation (m) was calculated by taking into the difference between pre monsoon and post monsoon groundwater level. The groundwater level data was used with recurrence interval of one month throughout the year in the study area.

Well discharge or well pumping rate (lpm)

Water table fluctuation (WTF) method is most common method used to estimate the recharge of water in shallow unconfined aquifers where groundwater levels respond to precipitation. In the present study, the WTF method was used because it is not restricted by the mechanisms by which water flows through the unsaturated zone (Lutz *et al*, 2015). Finally, season-wise draft was calculated by taking into consider the season-wise average discharge values from the bore wells.

Draft (m^3)

It is the water quantity being pumped from the aquifer system throughout the Cropping season.

Draft (m^3) = (Season-wise average discharge (lpm) **x** No. of pumping wells **x** No. of pumping hours/day **x** No. of pumping days in the season **x** 60)/1000

Total Draft = Well draft for all seasons + draft for domestic purpose

Domestic Draft = Per capita water requirement/day **x** 365 **x** Population

Recharge (m^3)

It is volume of water expressed in m^3 that gets into the aquifer by artificial/natural method.

Recharge = Monsoon Recharge + Non-monsoon Recharge

Monsoon Recharge = (R) = Sy x (Dh) x A + P

Non-monsoon Recharge* = Non-monsoon rainfall (m) x RIF x A

* Non-monsoon recharge is estimated only when non monsoon rainfall is more than 10 per cent of annual recharge.

Where,

Sy = Specific yield (as per Groundwater Estimation Committee (GEC-97) recommendations)

Dh = Rise in groundwater table due to rainy season (m)

P = Groundwater draft during the monsoon period (m^3)

A= (Geographical area of watershed) – (area of watershed having > 20 per cent slope) in m^2

RIF= Rainfall Infiltration Factor

Specific Yield for Bore Well Zone

Specific yield values for fractured formation have not been recommended by GEC-97 methodology. However, as per field experience and discussions with the scientists of Central Ground Water Board, it emerged that specific yield is dependent on lineament and fracture intensity of the aquifer material. If water level is within top 100 m in the bore well, a maximum specific yield value of 0.1 % (0.001 as fraction) can be taken. If the water level is beyond 100 m this value has to be further reduced.

Table 1. Specific yield values as per GEC-97 recommendation.

Formations	GEC-97 Recommendation (%)	As Fraction
Alluvium	4-8	0.04-0.08
Laterite	2-3	0.02-0.03
Basalt	1-3	0.01-0.03
Lime stone	1-3	0.01-0.03
Granites/ Schists/ Gneisses	1-2	0.01-0.02

Source**:** Report of the ground water resource estimation committee, ministry of water resources government of India, New Delhi, 2009.

Table 2. Rainfall Infiltration Factor (RIF) as per GEC-97 Recommendations.

Formation	RIF (%)
Alluvium	10-12
Laterite	6-8
Basalt	6-8
Limestone	5-7
Granites/Schists/Gneisses	5-9

RESULTS AND DISCUSSION

The results showed that the depth to groundwater level was recorded to 22.10 m during pre-monsoon and 32.80 m for post monsoon with the water table fluctuation of about 10.60 m during 2016 as shown in figure 3 and 4. Further, the discharge variations were also observed in *kharif*, *rabi* and summer seasons and the values were 2.52, 2.35 and 1.68 l/sec, respectively (figure 5). Similarly, the average fluctuation of groundwater level in the year 2017 was 22.4 m and the average fluctuation of discharge during *kharif*, *rabi* and summer were 2.36, 2.44 and 2.28 l/sec, respectively.

It was observed that the fluctuation in recharge were more in the year 2017. The annual draft of groundwater for irrigation was found to be 26, 57, 150 m^3 in which 50 per cent of the draft was observed during *rabi* season followed by summer

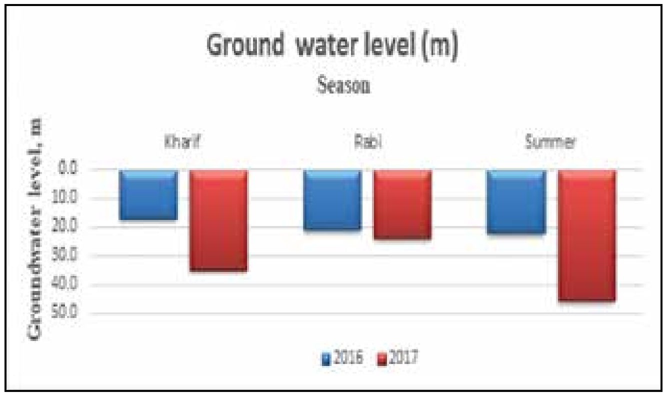

Fig 3. Groundwater level in different season

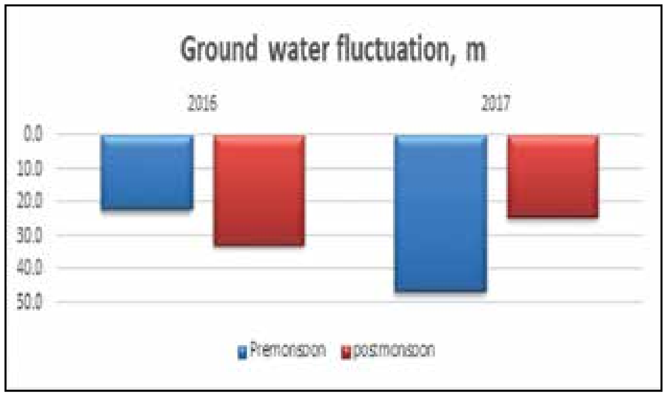

Fig 4. Groundwater fluctuations during 2016-2017

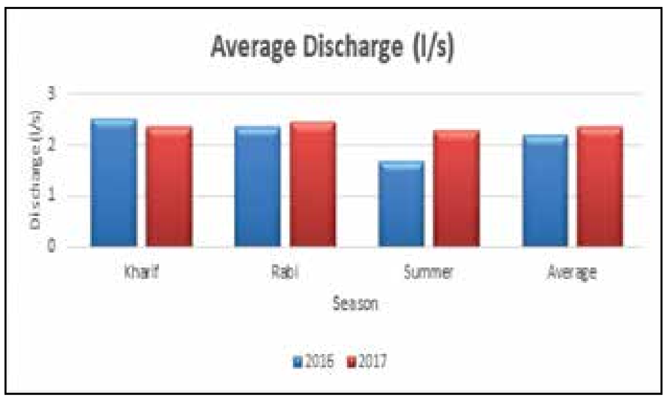

Fig 5. Discharge variations during 2016-2017

(46.77 %) and *kharif* (3.19 %). The annual water draft for domestic purpose (52, 468 m^3) was calculated by taking into consider the per capita water requirement for domestic purpose (l/day) of the total household members present in the micro watershed. Therefore, the total annual draft was arrived at 27, 09, 619 m^3 by considering both annual draft for irrigation and domestic purpose. On the other hand, the annual recharge of groundwater

Table 3. Annual draft of Groundwater in Yarehalli micro watershed

Particulars / Water Draft		No. of functioning wells	Average discharge (l/hr)	Water pumped (No. of hours /d)	Daily draft (m^3)	No. of pumping days in a season	Total draft (m^3)
Annual draft for Irrigation	Kharif	374	9078.22	1	3395.30	25	84881.40
	Rabi	374	8463.72	4	12661.70	105	1329482
	Summer	372	6052.21	6	13509	92	1242787
	Total						2657150
Annual draft for domestic purpose*							52468.75
Total Annual Draft (m^3)							2709619

Note: *- Calculated by considering total population in the micro watershed multiplied with the per capita water requirement for domestic purpose (lit/day).

was calculated in both mansoon and non-mansoon season. During mansoon period, the net availability of water recharge was highest (1,36,314 m^3) when compared to the non-mansoon period (44147 m^3). Finally, the total availability of groundwater recharge was found to be 1, 80, 462 m^3 by taking into consider five per cent sub surface discharge at monsoon and 10 per cent sub surface discharge at non-monsoon periods. By considering both the annual draft and recharge of groundwater in the micro watershed, it was shocking to note that the groundwater extraction being 15 times more than that of the annual recharge in the micro watershed. The present study was in line with the study conducted by Moran *et al* (2015) that the overdraft is occurring in an increasing number of groundwater basins throughout the California and is impacting the State in many ways.

POLICY IMPLICATIONS

Groundwater overdraft occurs when the water draft exceeds the amount of water recharge into an aquifer leading to decline in the groundwater level which puts extra burden for the farmers to drill deeper bore wells and failure of bore wells. Hence, the study indicated the vast scope and opportunity of artificial groundwater recharge structures which help in sustainable way of managing water resources

Table 4. Annual recharge of Groundwater in Yarehalli micro watershed

Particulars / *Water Recharge*	Watershed area suitable for recharge (ha)**	Rainfall (mm)	Water draft for corresponding period of water level rise (m^3)	Water recharge (m^3)	Sub surface discharge*	Water Recharge available for use (m^3)
Monsoon	761.94	419.72	89467	143488.55	7174.42*	136314.10
Non-monsoon ##	761.94	189.35	-	49052.93	4905.29#	44147.64
Annual recharge (m^3)						192541.50
Annual Subsurface discharge (m^3)						12079.72
Total annual Recharge available for use (m^3)						180461.80

* Sub surface discharge at 5 per cent of monsoon and 10 per cent of non-monsoon recharge

in the micro watershed. Further, it is necessary to create awareness among farm households regarding the judicious use of groundwater by appropriate choice of low water intensive and high value crops through micro irrigation for the better future.

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REFERENCES

Abdullahi M G and Garba I (2015). Effect of rainfall on groundwater level fluctuation in Terengganu, Malaysia, *J Remote Sensing & GIS*, **4**(2): 142.

Haitjema and Mitchell Bruker (2005). Are water tables a subdued replica of the topography?, *Ground Water* **43**(6): 781-786.

Siebert S, Burke J, Faure J M, Frenken K and Hoogeveen J (2010). Groundwater uses for irrigation- A global inventory, *Hydrology and Earth System Sci* 14: 1863-1880.

Tara Moran, Janny Choy and Carolina Sanchez (2015). The Hidden Costs of Groundwater Overdraft - Understanding California's Groundwater, *Water in the West Series*.

Veeger A I and Johnston H (1996). *Hydrogeology and water resources of Block Island*, Rhode Island, U.S. Geological Survey Water-Resources Investigations Report.

Lutz A, Minyila S, Saga B, Diarra S, Apambire B and Thomas J (2015). Fluctuation of Groundwater Levels and Recharge Patterns in Northern Ghana, *Climate* **3**: 1-15.

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