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IMPACT OF PRECIPITATION, TEMPERATURE AND HUMIDITY ON GROUNDWATER FLUCTUATION IN SHALMALA RIVER SUB-BASIN DHARWAD DISTRICT, KARNATAKA, INDIA

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***Abstract*— A study has been carried to determine the fluctuations of groundwater in Shalmala river sub-basin. To achieve this goal, two years data of rainfall, temperature, humidity and depth of groundwater (2017, 2018) have been collected from Shalmala river sub-basin and recorded manually for pre-monsoon season as well as post-monsoon season. The average rainfall of the area is 664.9mm, temperature and humidity are 25.81^{0}C, 65.36% respectively. The highest groundwater fluctuation is recorded at Tabkadhonalli village whereas least is recorded at Hubballi in the year 2017. Hence the study concludes that there is need for watershed development program in the area of Hubballi and Devaragudihal village taking into consideration of the site factors.**

***Keywords*— Below ground level (bgl), Shalmala sub-basin, Hubballi, Karnataka**

1. INTRODUCTION

Groundwater is one of the most important renewable resources which play a vital role into livelihood and is primary source of fresh water in the many parts of the world. Decline in ground water levels were reported in many parts of the world [1],[2],[3]. Compared to other countries, India is the largest user of ground water for irrigated agriculture [4]. The farmers are mainly depending on ground water for irrigation in non-monsoon period. Hence, it is important to know how much precipitation is required to recharge the groundwater table [5],[6]. Groundwater recharge mainly occurs through the infiltration of rainwater and surface water. On the other hand, groundwater can also play an important role in sustaining the stream flow [7]. Groundwater fluctuation level mainly depends on the drainage, topography of the area, soil, vegetation and specific yield of the particular area [8]. However, human is also a main reason for depletion of groundwater by over exploitation and excessive groundwater pumping [9]. It is described that the water table fluctuation (WTF) method is based on the rise or fall in groundwater levels due to the recharge and discharge of groundwater [10],[11],[12]. Rainfall Infiltration Factor (RIF) is also the indirect method for estimating the groundwater recharge [13],[14]. The soil-moisture balance study indicated that the groundwater recharge is more dependent on the continuous rainfall of the total annual volume of rainfall [15].

2. METHODOLOGY

2.1. STUDY AREA

The Shalmala river sub-basin, Dharwad district, Karnataka is located between latitudes 15º 06' 21.6" to 15º 24' 50.4"; longitudes 75º 00' 3.6" to 75º 11' 49.2" and fall in parts of Survey of India toposheet numbers 48M/3 and 48M/4 (1:50,000 Scale). The sub-basin covers an area of 363.39Km² (Fig. 1). The elevation ranges from 498m to 772m above mean sea level (MSL) and receives 772mm of average annual rainfall and annual average temperature is around 24.3ºC.

Geologically, the study area is covered by Sedimentary rocks such as greywacke, argillites and banded ferruginous quartzite. The study area comprises metamorphic formation like Quartz mica-schist of Chitradurga group of Archean age. At some places, dolerite dyke cuts across the bedding planes.

2.2. DATA COLLECTION AND ANALYSIS

07 locations within Shalmala river sub-basin have been selected, measured and estimated the fluctuation level of groundwater. Out of 07 stations, 06 are belonging to hand pump borewells

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(HPBW) and 01 is dug well (DW). The depth of the groundwater level has been recorded manually in the year of 2017 as well as 2018 of both the seasons respectively. Hydrometeorology data such as rainfall, temperature and humidity has been collected from the statistical department of Dharwad district. The location map of all 07 sample stations of Shalmala river sub-basin are shown in figure1.

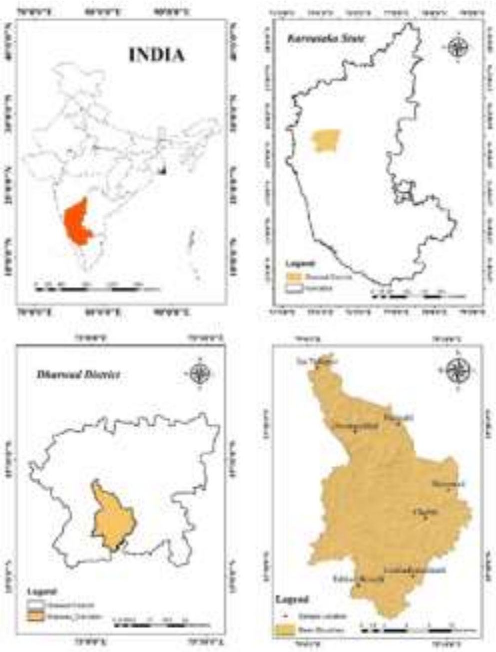

Fig. 1 Location map of the Shalmala river sub-basin

3. RESULTS AND DISCUSSIONS

3.1. PRECIPITATION

Precipitation is one of the major components of the water cycle and is liable for depositing the water on the earth. Precipitation is defined as the releasing of water from the clouds in the sort of drizzle, rain, snow, sleet, hail etc. The table 1 shows that, the lowest rainfall is observed in the month of February (0.02 mm) and highest is observed in the month of September (181.5 mm) with an average 50.77 mm in the year 2017. Subsequently, in the year 2018, minimum precipitation is recorded in the month of January (0.04 mm) and maximum is recorded in the month of May (190.3 mm) with an average of 60.05 mm. According to average monthly rainfall of the year 2017 and 2018 (Figure 2), suggests that the maximum rainfall is occurred in the month of May (139.045 mm).

Table I. Average rainfall (mm) of the Dharwad District from 2017-2018.

Year / Month	2017	2018	Average (mm)
January	0.03	0.04	0.035
February	0.02	0.47	0.245
March	4.87	37.57	21.22
April	12.56	46.74	29.65
May	87.79	190.3	139.045
June	58.12	131.8	94.96
July	87.31	104.1	95.705
August	54.43	89.22	71.825
September	181.5	63.35	122.425
October	117.7	37.85	77.775
November	4.26	12.79	8.525
December	0.59	6.39	3.49
Total	609.18	720.62	
Average	50.77	60.05	

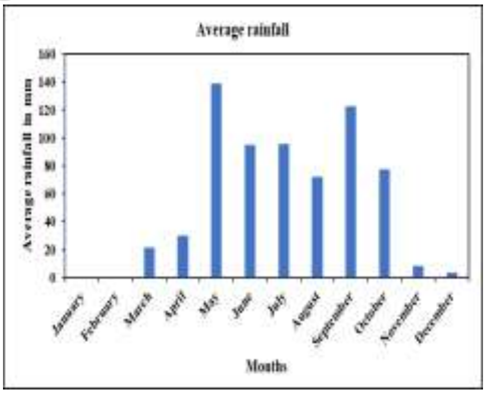

Fig. 2 Average rainfall (mm) from 2017 to 2018.

3.2. TEMPERATURE

Temperature is the amount of heat content in the atmosphere. The quantity of heat in the air determines the speed of the molecules within the atmosphere. More the heat faster will be the movement of molecules which raises in temperature. The heat within the atmosphere comes from the sun and varies at different levels within the atmosphere. At any place, the typical temperature of the air depends mainly on latitude, longitude and altitude of the area, it's basically controlled by radiation. Usually, the temperature is measured by using a thermometer in degrees Fahrenheit or Celsius.

As mentioned in Table 2, in 2017 within the present study, the least temperature is observed in the month of December (21.91°C) and highest is observed in the month of May (29.68°C) with an average 26.06°C. In 2018, the minimum temperature is recorded in the month of December (21.6°C) and maximum is recorded in the month of April (29.83°C) with an average 25.56°C. From the figure 3, it is concluded that the highest monthly average temperature of 2017 and 2018 is recorded in the month of April (30.065°C).

Table II. Average temperature (°C) data of the Dharwad District from 2017-2018.

Year / Month	2017	2018	Average (°C)
January	22.33	22.51	22.42
February	25.7	24.16	24.93
March	27.29	27.72	27.505
April	30.3	29.83	30.065
May	29.68	28.92	29.3
June	26.86	26.07	26.465
July	25.84	24.51	25.175
August	26.29	24.2	25.245
September	26.35	25.82	26.085
October	26.2	26.62	26.41
November	24.02	24.78	24.4
December	21.91	21.6	21.755
Average	26.06	25.56	

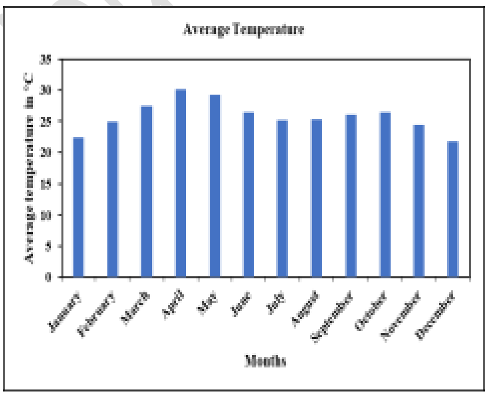

Fig. 3 Average temperature (°C) from 2017 to 2018.

3.3. HUMIDITY

The humidity refers to the amount of water vapor in the air whereas water vapor is a gas in the atmosphere that helps to make clouds, rain or snow. Humidity is usually expressed as relative humidity or the percentage of the maximum amount of water air can hold at a given temperature. Cool air holds less water than warm air. At a relative humidity of 100%, air is said to be saturated, which means the air cannot hold any amount of water vapor. Excess water vapor will fall as precipitation. Clouds and precipitation occur when air cools below its saturation point. This usually happens when warm, humid air cools as it rises.

In the study area, it is observed that, in 2017, the least humidity is recorded in the month of February (53.99%) and highest is recorded in the month of 78.43% with an average 67.11%. further, in 2018, the lowest humidity is recorded in the month of February (45.81%) and highest is recorded in the month of August 80.38% with an average 63.61%. The highest monthly average humidity is observed in the month of July (79.21%) as shown in the figure 4.

Table III. Average humidity (%) data of the Dharwad District of 2017 and 2018

Year / Month	2017	2018	Average (%)
January	55.33	58.56	56.945
February	53.99	45.81	49.9
March	56.27	52.66	54.465
April	57.16	56.39	56.775
May	63.34	62.68	63.01
June	75.94	75.76	75.85
July	78.43	79.99	79.21
August	77.05	80.38	78.715
September	78.26	69.16	73.71
October	75.83	62.86	69.345
November	67.68	60.98	64.33
December	66.08	58.09	62.085
Average	67.11	63.61	

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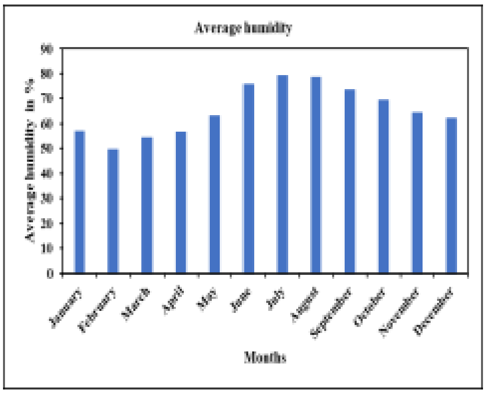

Fig. 4 Average humidity (%) from 2017 to 2018.

3.4. GROUNDWATER FLUCTUATIONS

The fluctuation of groundwater for the year 2017 and 2018 within the present study has been monitored and evaluated in the table 4 and 5.

Table IV. Details of key wells in the year 2017 monitored in Shalmala river sub-basin.

Location	Stations	Pre-monsoon water level depth	Post-monsoon water level depth	Fluctuation	Fluctuation Rise/ Fall
Joa Yellapur	HPBW	39.61	42.42	2.81	Fall
Sherewad	DBW	19.7	16.15	3.55	Rise
Chabbi	HPBW	29.81	21.37	8.44	Rise
Hubballi	HPBW	9.9	8.59	1.31	Rise
Devaragudihal	HPBW	33.91	37.72	3.81	Fall
Guddadha hulikatti	HPBW	32.70	25.5	7.2	Rise
Tabkad honnalli	HPBW	48.0	24.46	23.54	Rise

Table V. Details of key wells in the year 2018 monitored in Shalmala river sub-basin.

Location	Stations	Pre-monsoon water level depth	Post-monsoon water level depth	Fluctuation	Fluctuation Rise/Fall
Joa Yellapur	HPBW	46.63	41.31	5.32	Rise
Sherewad	DBW	18.58	17.25	1.33	Rise
Chabbi	HPBW	30.96	19.82	11.14	Rise
Hubballi	HPBW	9.63	8.31	1.32	Rise
Devaragudihal	HPBW	45.15	35.08	10.07	Rise
Guddadha hulikatti	HPBW	26.47	22.99	3.48	Rise
Tabkad honnalli	HPBW	45.78	30.03	15.75	Rise

3.5. DEPTH OF GROUNDWATER LEVEL DURING PRE-MONSOON SEASON

The depth of groundwater level in the year 2017, varies from 9.9 mbgl to 48 mbgl with an average 30.51 mbgl during pre-monsoon (Table 4) whereas in the year of 2018, the depth of groundwater level varies between 9.63 mbgl to 46.63 mbgl with an average value 31.88 mbgl. The lowest depth of the groundwater level in the year 2017 is recorded at Hubballi region whereas highest is recorded at Tabkadhonnalli village (Table 4). Simultaneously, in the year 2018, the minimum depth of groundwater level is recorded at Hubballi region and maximum is recorded at JoaYellapur village (Table 5). Classification of wells of both the years (2017 and 2018) based on the depth for pre-monsoon season are shown in table 4 and 5 respectively. The water level map for pre-monsoon season of both the years (2017 and 2018) are shown in figure 5 and 7.

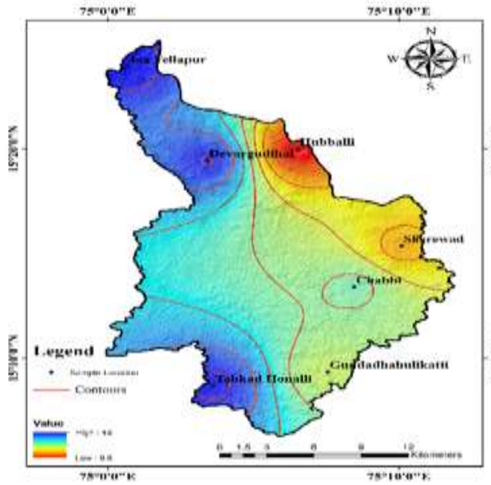

Fig. 5 Map showing depth of water level of pre-monsoon season 2017.

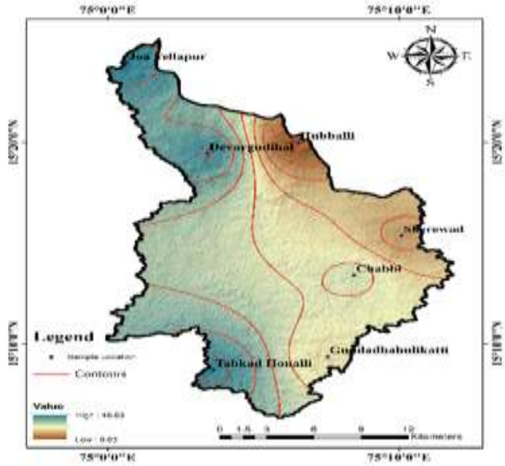

Fig. 7 Map showing depth of water level of pre-monsoon season 2018.

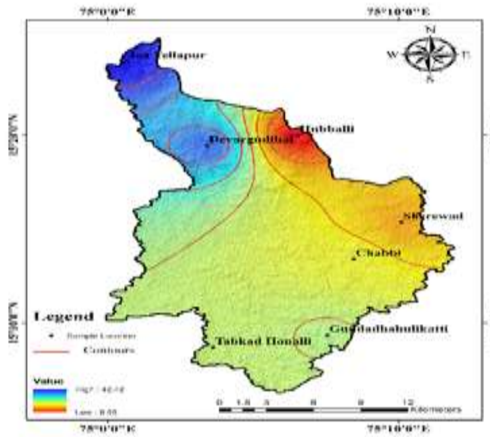

Fig. 6 Map showing depth of water level of post-monsoon season 2017.

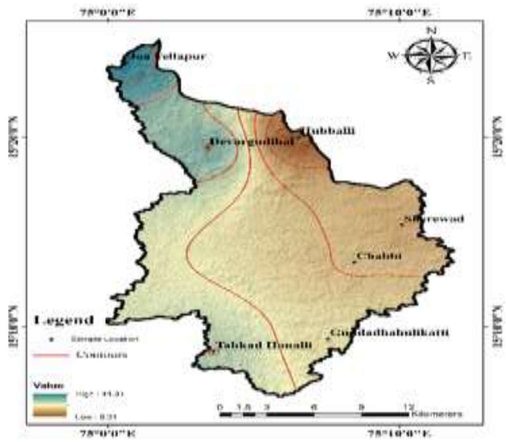

Fig. 8 Map showing depth of water level of post-monsoon season 2018.

3.6. DEPTH OF GROUNDWATER LEVEL DURING POST-MONSOON SEASON.

In the year 2017, the depth of groundwater level from the Shalmala river sub-basin is ranges from 8.59 mbgl to 42.42 mbgl and average is 25.17 mbgl as shown in table 1. While, in the year 2018, the depth of groundwater level varies between 8.31 mbgl to 41.31 mbgl with a mean 24.97 mbgl. Minimum depth of water level of both the years (2017 and 2018) are recorded at Hubballi region and maximum at Joayellapur village (Table 4 and 5). Classification of wells of both the years (2017 and 2018) based on the depth for post-monsoon season are shown in table 4 and 5. The water level map for post-monsoon season of both the years (2017 and 2018) are shown in figure 6 and 8.

4. FLUCTUATION OF WATER TABLE

The groundwater fluctuation has been evaluated by comparing the data of groundwater level of pre-monsoon and post monsoon seasons of both the years (2017 and 2018) respectively (table 4 and 5). In the year 2017, the groundwater fluctuation varied as fall of3.81 m at Devaragudihal village to rise of 23.57 m at Tabkadhonalli village (Table 4). It seems to be over-exploitation of groundwater at Devaragudihal village. Hence, it shows fall in the groundwater level, rural development around the area might be the reason. Simultaneously, in the year of 2018, the fluctuation of groundwater ranges from the rise of 1.32 m at Hubballi region to rise of 15.75 m at Tabkadhonalli village as shown in table 5. The fluctuation map of both the years (2017 and 2018) are shown in figure 9 and 10.

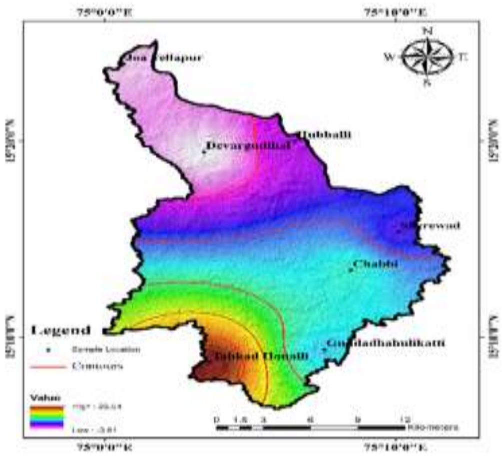

Fig. 9 Fluctuation map of the study area 2017.

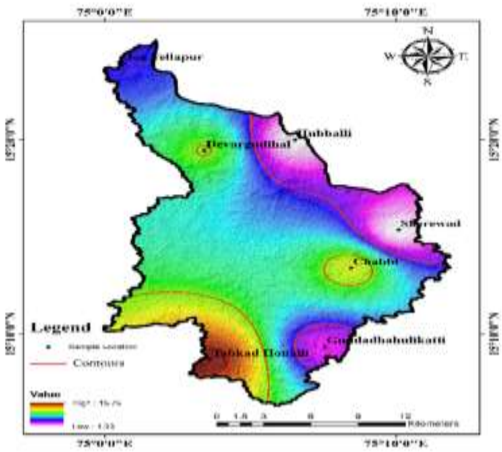

Fig. 10 Fluctuation map of the study area 2018.

5. CONCLUSION

In this study, it is observed that the fluctuation in groundwater level varies from fall of3.81m to rise of25.57 m in 2017 and further in 2018,fluctuation ranges as the rise of 1.32m to rise of15.75m.In Hubballi area, the fluctuation values are found to be very less (rise) compared to other noted stations, therefore artificial recharge structures are recommended to increase the level of groundwater. Taking into consideration of all other parameters, the average rainfall increased from 2017 to 2018, also Humidity and average temperature shows favorable conditions for more recharge. However, it is concluded that all 07 locations within the study area have sufficient infiltration capacity, but in the year 2017stations namely JoaYellapur and Devargudihal village showed fall in groundwater level even in the post monsoon season might be due to the invidious atmospheric conditions. Thus, it suggests to increase the recharge activity in the area by avoiding over exploitation of groundwater. Hence, to sustain the groundwater for the betterment of tomorrow.

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