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TEMPORAL ANALYSIS OF TRENDS IN GROUNDWATER LEVEL OF JIND DISTRICT, HARYANA

Sitender*

Reena**

Abstract

Dependence on groundwater has increased in past few decades due to changing climatic scenario, growth of human population, industrialization and urbanization to meet the resultant needs. Consequently, it has been mined in excess to that is available that has resulted in lowering of groundwater table. India being the world’s largest consumer of groundwater is affected badly by this problem, especially the parts of Indo-Gangetic plain like Haryana, Punjab, Rajasthan and Western part of Uttar Pradesh. Haryana being an agrarian state is in a critical position with respect to groundwater with 56cm per year depletion rate. Present research will focus on analyzing the trends of groundwater level of one of the

* Department of Geography, CRS University, Jind, Haryana

** Department of Grography, Govt. College, Jind, haryana

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agriculturally developed district of Haryana state i.e. Jind, from the year 1975 to 2015. The data for the study is taken from Groundwater Cell, Directorate of Agriculture, Panchkula, Haryana. The study reveals that the study area is in a critical condition with respect to the availability of groundwater with a stage of groundwater development at 99 percent. Groundwater table depth has increased from 11.25mbgl in 1975 to 13.76mbgl in 2015 with some ups and downs in between. Rainfall being the highest contributor of water to the aquifers has inverse relationship with groundwater level. In the year of good rainfall, groundwater level has improved and vice-versa. On the basis of the result of study, the authors are of the view that controlled groundwater use along with water conservation measures is required in the study area. Groundwater is the main source of water in 306 villages of the study area for domestic and irrigation purposes. Therefore, a cautious use of groundwater is required to avoid introduction of crisis related to water in future.

1. Introduction

Groundwater is one of the components of hydrological cycle. It is found stored beneath the earth’s surface in the void space between the grains of soil. The formation that contains water with the capability to yield it, if exerted pressure on it, is called aquifer. The potential of aquifers largely depend on the material, it is composed of. In general, aquifers that are formed in an area of alluvial deposits have better potential to serve in non-rainy days in arid and semi-arid climatic conditions. The omnipresent nature, less affected by climatic fluctuation and the best alternate of surface water in arid and semi-arid regions, are the few inherent characteristics of groundwater that makes it the most valuable resource of the planet earth (7). Dependence on groundwater has increased due to changing climatic scenario, growth of human population, industrialization and urbanization to meet the resultant needs, in past few decades (6). Consequently, this resource has been mined in excess to that is available which has resulted in lowering of groundwater table in most part of the world (2). India being the world’s largest consumer of groundwater is also affected badly by this problem, especially the Haryana, Punjab, Rajasthan and Western part of Uttar Pradesh of Indo-Gangetic plain (3). Haryana being an agrarian state is in a critical position with respect to groundwater with 56cm per year depletion rate. In the light of the above discussion, present research will focus on analyzing the trends of groundwater level of one of the agriculturally developed district of Haryana state i.e. Jind from the year 1975 to 2015.

2. Study Area

Jind district lies in the North of Haryana between 29.03’ and 29.51’ North latitude and 75.53’ and 76.47’ East longitude with a geographical area of 2702 sq. km. It has an average elevation of 227 meters from mean sea level. It consists of seven blocks namely Jind, Narwana, Safidon, Pillukhera, Uchana, Alewa and Julana.

The climate of the district can be classified as tropical steppe and semi-arid, with very hot summer and cold winter. The normal annual rainfall of the district is 515 mm which is unevenly distributed over the area for 26 days. The south-west monsoon, sets in from last week of June and withdraws in end of September, contribute about 84 percent of annual rainfall i.e. 433 mm. Rest 16 percent rainfall is received during non-monsoon period in the wake of western disturbances and thunder storms. The study area constitutes a part of Punjab-Haryana plain which is largely flat, featureless and monotonous alluvial upland plain and is formed of Pleistocene and sub recent alluvial deposits of the Indo-Gangetic system. It is dotted only sporadically with sand dunes and depression; yielding a local relief of not more than 6m. there is no perennial river in the district (4).

Major source of water availability are shallow tube wells and major & medium irrigation canals. Other sources of water availability include deep tube wells. It is served by Narwana and Barwala link canals of Bhakra canal system. The water supplied in these canals caters the 22 percent of water requirement of crops. Rest 78 percent water requirement is met with either shallow or deep tube wells. In the study area, average annual groundwater level was observed 11.25 mbgl in the year 1975 which has increased upto 13.76 mbgl in 2015. The rate of groundwater depletion over long term is about 6 cm per year.

3. Objectives

Present study aims at achieving the following objectives

- To analyze the present scenario of groundwater.
- To evaluate the change in the depth of groundwater level from 1975-2015.
- To assess the relationship between rainfall and groundwater level.

4. Database and Methodology

In order to achieve the objectives of the research, secondary source of data is used. It was collected from different govt. departments. Data regarding the groundwater availability and demand was assessed from the report of Central Groundwater Board published in 2013. The stage of groundwater development is calculated in percentage as a ratio of net annual groundwater draft to net annual groundwater availability. Block is taken as the assessment unit for the study. Data regarding the depth of groundwater level from 1975 to 2015 was collected from Groundwater Cell, Directorate of Agriculture, Krishi Bhawan, Panchkula. It was analyzed with the help of graphs. Annual average rainfall data was downloaded from Customized Rainfall Information System (CRIS) developed by Indian Meteorological Department, Ministry of Earth Science, New Delhi for the years 1975 to 2015. Relationship between the rainfall and groundwater level was established with the help of poly line graph.

5. Results and Analysis

5.1. Groundwater Scenario

It is evident from table 1 that the study area is not in a good position with regard to the status of groundwater availability. The stage of groundwater development which is a ratio of net annual draft of groundwater to net annual availability of groundwater is 99 percent placing it in a critical position. Out of the seven blocks of the district, not even a single block lies in the safe category. Three blocks, namely Alewa, Narwana and Safidon are over-exploited with a stage of groundwater development of 114, 124 and 109 percent, respectively. The annual draft of groundwater in these blocks is more than that is available through recharge from various sources. Jind blocks lies in critical position with a stage of groundwater development of 91 percent. Other three blocks, namely Julana, Uchana and Pillu Khera are in semi-critical category with a stage of groundwater development of 86, 83 and 81 percent, respectively. Blocks categorized as semi-critical are more prone to be converted into critical and over-exploited, thereafter. Therefore, cautious ground water development is required in these blocks. The blocks categorized as critical and over-exploited are left with no scope for further groundwater development in near future. Rather intensive monitoring and evaluation is required and future ground water development must be linked with water conservation measures in these blocks.

Table 1: Stage of Ground Water Development and Categorization of Assessment Units in Jind District: as on March 2011

Blocks	Net Annual Ground Water Available (ham)	Gross Annual Draft (ham)	Gap (ham)	Ground Water Development (%)	Category
Jind	18735	17067	1668	91	Critical

Alewa	6288	7175	-887	114	Over Exploited
Julana	8297	7131	1166	86	Semi-Critical
Narwana	14507	17971	-3464	124	Over Exploited
Uchana	10179	8470	1709	83	Semi-Critical
Safidon	13854	15072	-1218	109	Over Exploited
Pillu Khera	9854	7987	1867	81	Semi-Critical
District	81714	80873	841	99	Critical

Source: Central Groundwater Board Report, 2011.

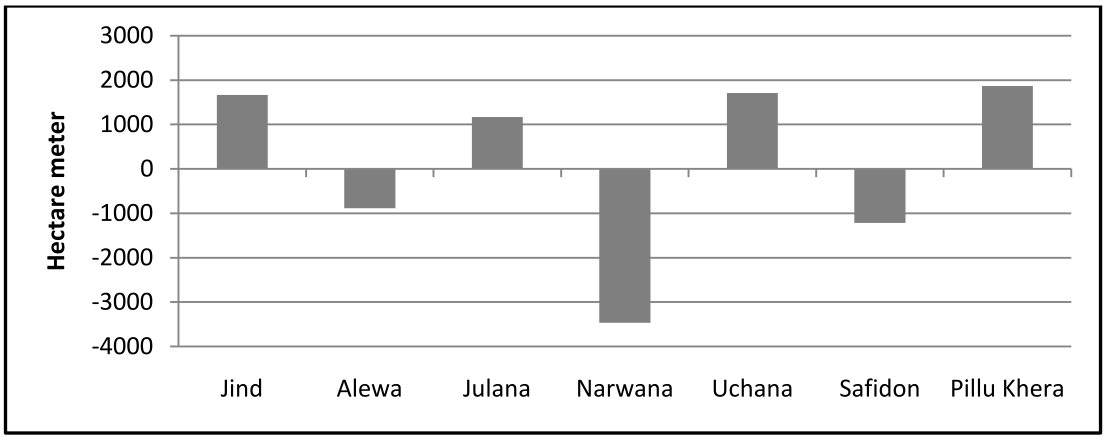

Figure 1: Gap between Recharge and Draft of Groundwater in Jind District: as on March 2011

Figure 1 reveals that three out of seven blocks in the study area have the draft of groundwater in excess to that is available through recharge in a groundwater year from different sources. This excessive mining of groundwater leads to the depletion of groundwater table. Narwana block has the highest gap between the draft and availability of groundwater while Pillu Khera block has the highest surplus availability of groundwater in the study area.

5.2 Temporal Analysis of Groundwater

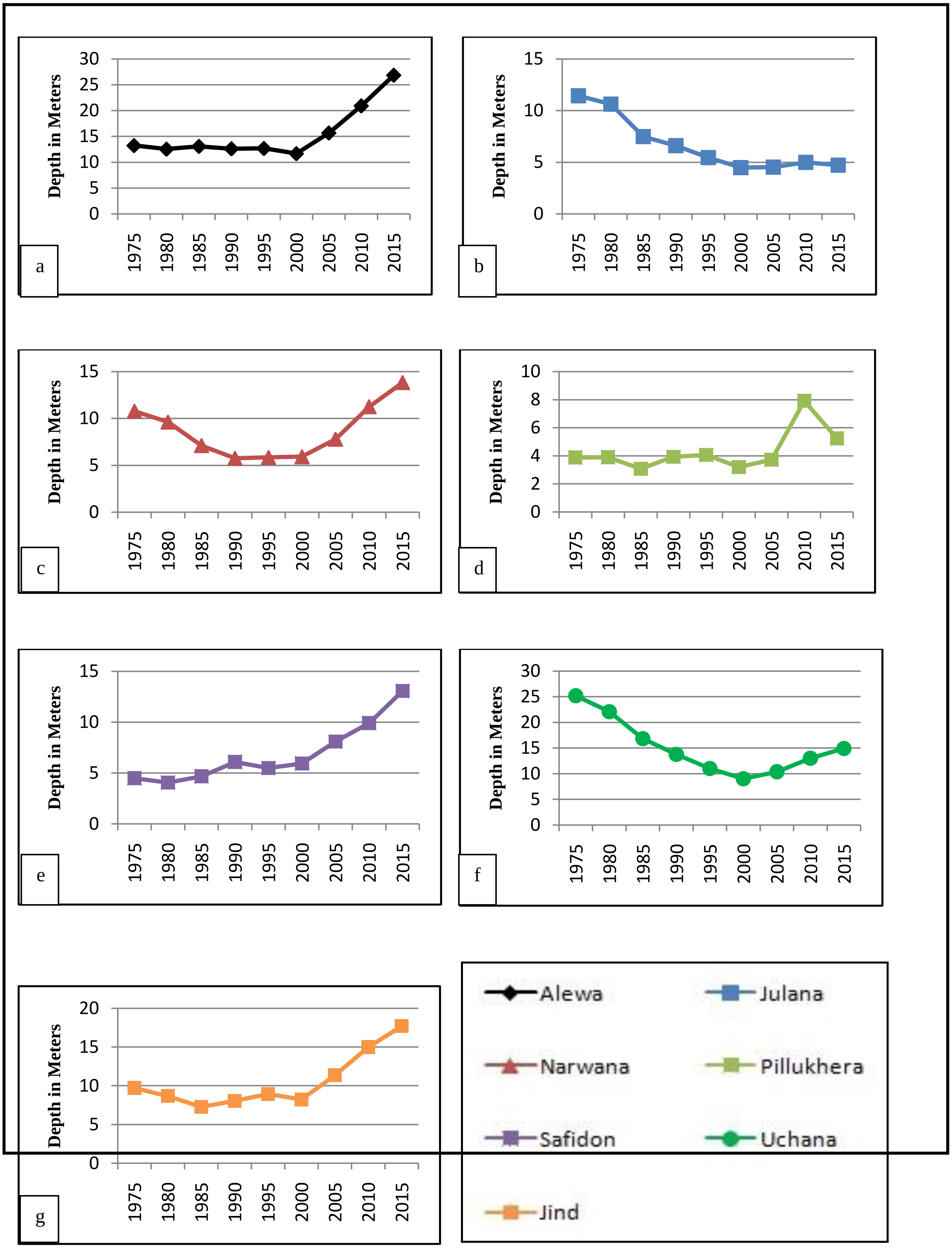

Figure 2: Blockwise Trends in Groundwater Level during 1975-2015

Figure 2 and Table 2 explain the block wise trends in groundwater level from 1975 to 2015. For the convenience in analysis, study period has been divided into eight parts with 5 year intervals i.e. 1975-80, 1980-85, 1985-90, 1990-95, 1995-2000, 2000-05, 2005-10 and 2010-15. Safidon and Jind blocks (fig. 2e & 2g) show continuous declining trend in term of groundwater level. Groundwater depth in Safidon block was 4.5mbgl in the year 1975 which has increased upto 13.06mbgl in the year 2015 while in case of Jind block it was 9.72mbgl in 1975 which has increased upto 17.69mbgl. The highest depth of groundwater level is observed in Alewa block (fig. 2a) in the year 2015 i.e. 26.83mbgl while it is observed to be lowest in Julana block i.e. 4.71mbgl. Julana and Uchana blocks of the study area show improvement in the level of groundwater. It has improved from 11.44 mbgl and 25.2mbgl in the year 1975 to 4.71mbgl and 14.93mbgl in the year 2015, respectively. All other five blocks except Pillu Khera shows depletion of groundwater table during the study period. In Pillu Khera block, level of groundwater does not show much change except 2005-2010 period where groundwater level has depleted upto 4mbgl. It is the highest fall of groundwater table in any block during the study period.

Table 2: Blockwise Trends of Groundwater Level during 1975-2015

Depth in meter below ground level

Year/Block	1975	1980	1985	1990	1995	2000	2005	2010	2015
Alewa	13.23	12.54	13.07	12.61	12.67	11.67	15.66	20.91	26.83
Julana	11.44	10.63	7.49	6.62	5.46	4.49	4.54	4.99	4.71
Narwana	10.78	9.62	7.12	5.76	5.85	5.93	7.8	11.26	13.83
Pillukhera	3.88	3.9	3.08	3.93	4.06	3.2	3.72	7.91	5.24
Safidon	4.5	4.07	4.69	6.09	5.49	5.94	8.09	9.91	13.06
Uchana	25.2	22.07	16.84	13.75	11	9.01	10.38	13.01	14.93
Jind	9.72	8.68	7.28	8.05	8.94	8.23	11.36	14.98	17.69

Table 3: Trend of Groundwater Level in Jind District during 1975-2015

Depth in meter below ground level

Season/Year	1975	1980	1985	1990	1995	2000	2005	2010	2015
June	11.8	11.97	9.03	8.31	9.11	7.02	9.24	12.67	13.44
Oct	10.69	8.89	7.99	7.92	6.17	6.83	8.34	11.03	14.07
Average	11.25	10.43	8.51	8.12	7.64	6.93	8.79	11.85	13.76

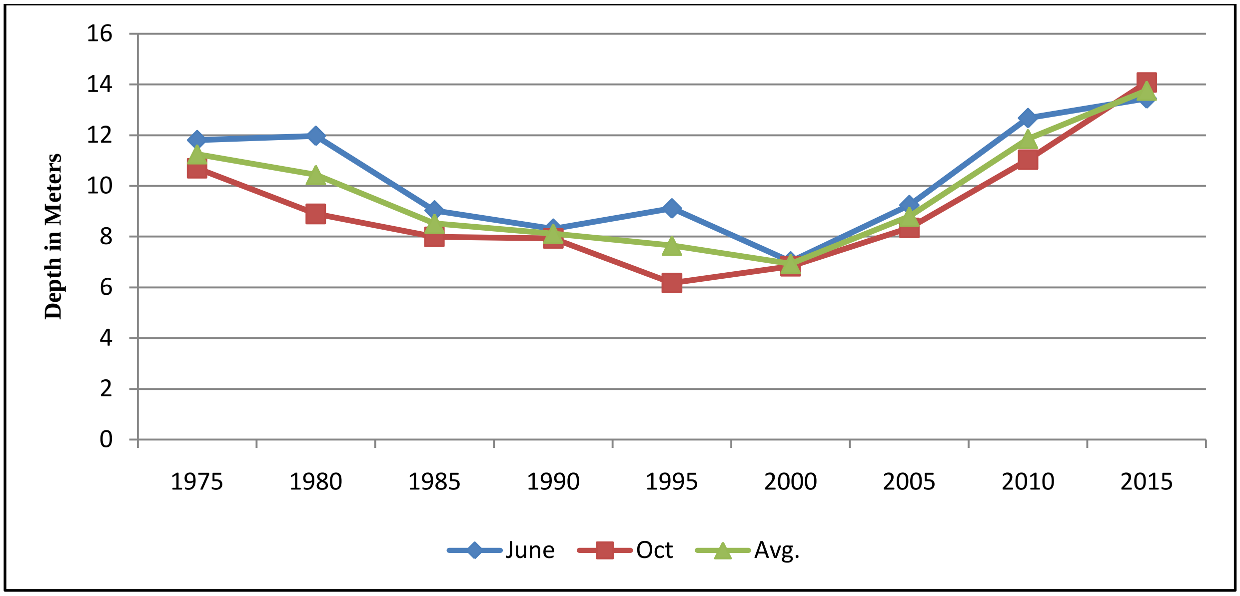

Figure 3: Trends of Groundwater level in Jind District during Pre-monsoon, Post-monsoon & Average Annual from 1975-2015

Table 3 exhibits that during the five out of eight study periods groundwater table of Jind district shows improving trends. Groundwater table was recorded in the year 1975 at the depth of 11.25mbgl. It shows improvement in the periods of 1975-80, 1980-85, 1985-90, 1990-95 and 1995-2000 and reaches upto 6.93mbgl. Afterwards depleting trend is observed and it has reached to 13.76mbgl. Groundwater table is lowered about 1.86mbgl deep from 2000-05, 3.06mbgl from 2005-10 and 1.91mbgl from 2010-15. Highest depletion in the groundwater table is observed in the period of 2005-10 i.e. 3.06mbgl while highest improvement in groundwater table is observed in the period of 1980-85 i.e. 1.92mbgl.

It is evident from figure 3 that after the year 2000, groundwater table is continuously declining in the study area. The gap between water level of pre-monsoon (june) and post-monsoon (October) is observed to be highest in the year 1995 when groundwater table has rises upto 3meters. It may attributed to the flood condition caused by the burst of monsoon in this year. On the other hand, failure of monsoon in the year 2000 has introduced no change in groundwater table between the two seasons. Contrary to all other study periods, groundwater table has shown depletion even in post monsoon season during the period 2010-15. It may be attributed to the increased use of groundwater and low rainfall, even below the average annual amount of rainfall.

5.3. Relationship between Depth of Groundwater Table and Rainfall

Groundwater level of an area is considered to be the result of sum of recharge from rainfall (Rrf), Irrigation Return Flow (Rirf), Canal seepage (Rc), Recharge from tanks and ponds (Rt) and recharge from Rainwater Harvesting Structures (Rrhs) (5). Out of these five components, rainfall has a direct bearing on groundwater level because it is the highest contributor of water to the aquifer. Response of groundwater levels to the incidence of rainfall depends on hydrodynamic properties of underlying rock formations. The occurrence of

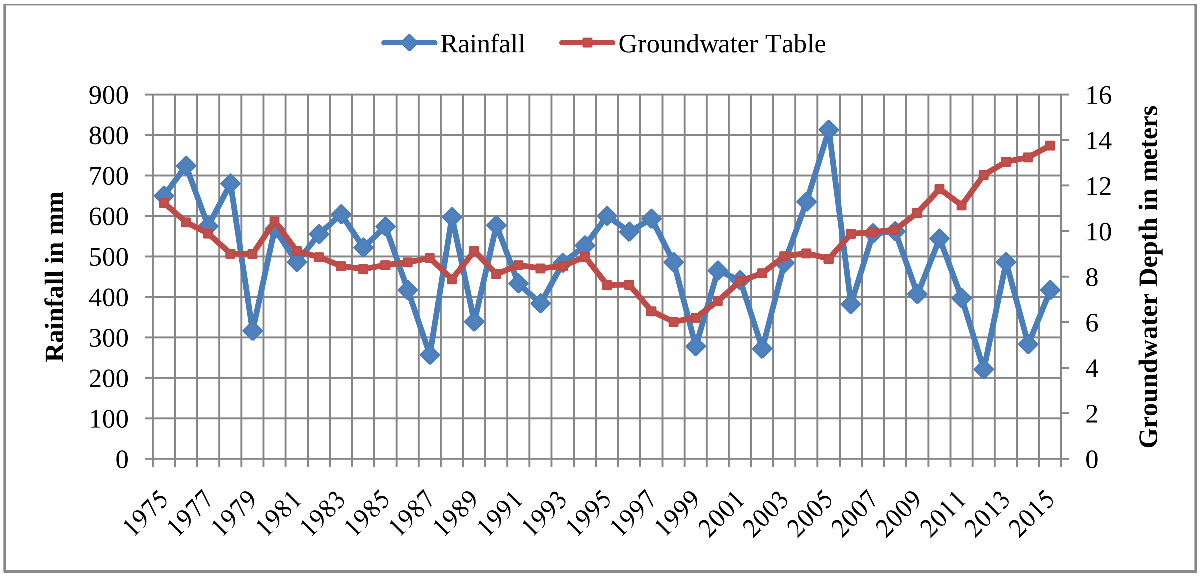

Figure 4: Relationship between Rainfall and Groundwater Level during 1975-2015

heavy rainfall results in flood and as well improvement in groundwater system (1). It is evident from figure 4 that good amount of rainfall has helped either in rising or stabilizing the groundwater table. Two extremes of low and high rainfall years i.e. 2012 and 2008, respectively are noticed from the figure and the groundwater level is found inversely related with these events. Highest rainfall in the study period is recorded in the year 2005 and subsequently improvement in groundwater level is noticed. Contrary to this, lowest rainfall of the study period in the year 2012 resulted in decreased percolation that has caused further depletion of groundwater level. It is clearly evident from the figure that substantial increase or decrease in the amount of rainfall has resulted in inverse change in the depth of groundwater table. With the increase in the amount of rainfall, depth of groundwater table has improved and vice-versa. From the year 1995 to 1999, an substantial improvement in the groundwater table is observed may be attributed to the heavy flood condition introduced in the year 1995 and improved amount of rainfall, afterward. Increased amount of rainfall lowers the crop water requirements that further reduce the amount of groundwater draft. Hence, improvement or stabilization in the level of groundwater table is observed. From the year 2008 to 2015 constant decrease in the amount of rainfall and constant increase in the depth of groundwater table verifies the above discussed facts.

6. Conclusion

The study reveals that the study area is not in a good position with regard to groundwater availability. The stage of groundwater development is 99 percent. Out of the seven blocks of the district, not even a single block lies in the safe category. Three blocks, namely Alewa, Narwana and Safidon are over-exploited , Jind blocks lies in critical category while remaining three blocks namely Julana, Uchana and Pillu Khera are in semi-critical category. The depth of groundwater table was recorded in the year 1975 at the depth of 11.25mbgl which has depleted to 13.76mbgl by the year 2015. The gap between water level of pre-monsoon (june) and post-monsoon (October) is observed to be highest in the year 1995 when groundwater table has rises upto 3meters. Rainfall has a direct bearing on groundwater level because it is the highest contributor of water to the aquifer. Highest rainfall in the study period is recorded in the year 2005 and subsequently improvement in groundwater level is noticed. Contrary to this, lowest rainfall of the study period in the year 2012 resulted in decreased percolation that has caused further depletion of groundwater level. From the year 2008 to 2015 constant decrease in the amount of rainfall and subsequent increase in the depth of groundwater table is observed.

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