International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 36, 2017, pp.-4546-4549.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

IMPACT OF GROUND WATER RECHARGE AND WITHDRAWAL ON WATER TABLE FLUCTUATIONS IN ALLUVIAL AREA

PATHAK RISHI, AWASTHI M.K., SHARMA S.K., HARDAHA M.K. AND NEMA R.K.

Department of Soil and Water Engineering, College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, 482004, Madhya Pradesh, India
*Corresponding Author: Email-rishipathakcae@gmail.com

Received: July 11, 2017; Revised: July 15, 2017; Accepted: July 16, 2017; Published: August 06, 2017

Abstract- In general, groundwater trends are declining throughout the world due to the continuous increase of ground water withdrawal to meet the daily needs of growing population. There is a general acceptance that the recharge of ground water in the alluvial region areas is more compared to other regions, however these concepts leads to an inaccurate estimation of ground water recharge in many alluvium regions. However, the recent investigations in the Patan block of Jabalpur district of M.P. India has indicated that, the pre-monsoon water level deepness prone to the higher recharge of ground water from the precipitation and other water resources like tanks and check dams. Similarly study also suggested that the pre-monsoon ground water level influenced higher recharge of ground water than the total annual amount of rainfall in study area. The study involved analysis of the ground water data for 16 years and mapped the changed in ground water levels between pre monsoon and post monsoon Further investigations made by analyzing the data of water level in the patan block. The ground water recharge estimation has been done by using water table fluctuation method and GIS application. The study concludes that nearly 22 percent of rainfall is either joining the ground water directly through infiltration or by different recharge attributed by various water conservation structures such as check dams, reservoirs, tanks etc. Also, the finding indicated that increase use of ground water for agriculture and the rise in agriculture area has leading ground water declination issue in study area.

Keywords- Ground water recharge, Water fluctuation method, GIS

Citation: Pathak Rishi, et al., (2017) Impact of Ground Water Recharge and Withdrawal on Water Table Fluctuations in Alluvial Area. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 36, pp.-4546-4549.

Academic Editor / Reviewer: Subhash Thakur, Sourabh Nema, Akhilesh Singh

Introduction

No one can deny the importance of groundwater in meeting crop water demands, especially in the arid to semi-arid regions of the world. The groundwater extraction in dry regions is used around 80% for agricultural purposes [6]. However, mismanagement of groundwater use in these regions is reported in many studies and this mismanagement is threatening the sustainability of this precious water resource [3 and 8]. Sustainable groundwater use depends on a comprehensive groundwater recharge policy [1]. The formulation of a groundwater recharge policy requires detailed information on groundwater recharge. Groundwater recharge is affected by many composite elements, which themselves are regulated by many other factors. For example, cropping pattern, cropping intensity, climatic parameters, hydraulic properties of the under lying soils, and irrigation practices [4] are some of the parameters which directly influence groundwater recharge. The study was conducted considering a critical importance of ground water level in alluvial region with a view of the declining trends of water levels in major parts of the country.

Materials and Methods

Study area

The study area is the Patan block of Jabalpur district covering an area of about 619 km2. The block area includes the 220 villages extending from 23°13'19.98"N to 23°25'6.66" N and 79°34'2.20"E to 79°50'11.02"E. The land use and elevation of the study area is given where the height varies from 318 to 569 m (above sea level). The predominant soils in the basin are clay loam and black soil. Ground water occurs unconfined to confined condition in Alluvium formation. The mean annual rainfall is 1357 mm and 90% of rainfall occurs during the monsoon period. The maximum and minimum temperature vary between 3.c to 43.c

In the present study Ground water levels in the patan block were observed during pre-monsoon and post-monsoon for the year 2000 to 2015. Similarly, 16 years data of the ground water level data had been received from the State data center, Bhopal for the Patan block, Jabalpur, M.P. India. Change in ground water levels between pre-monsoon and post-monsoon have been mapped for the past 16 years to see influence on ground water level during pre-& post monsoon session. Further investigations have been made by analyzing the hydrological data in the Patan block. The data records of ground water levels for every month from the year 2005 to 2015 have taken into consideration. The rainfall is also recorded near the ground water level. The combined plot of rainfall and water levels below ground level (bgl) is called Composite Hydrograph, which is used for analysis. By using the contour maps of Water fluctuations of the patan block during the year 2000, 2005 2010 and 2015 groundwater recharge estimation have been made.

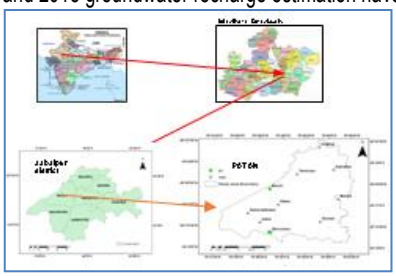


Fig-1 Location Map with Observation Wells and Peizometer Wells in the Patan Block

Results and Discussion

Discussion of contour Maps and analysis

The monthly water level data recorded by State Ground Water Department of Madhya Pradesh in 7 monitoring observation wells (for the past 20 years period between 1985-2004) and 2 piezometer wells (in which some Wells were established in 2005) in the study area have been considered for the analysis. The location of piezometer wells and observation wells are shown in [Fig-1]. The observed Water levels give depth in meters below ground level (bgl). Water table contour maps for pre-monsoon for 2000 and 2015 are shown in [Fig-2] and [Fig-3] respectively. From the contour maps of 2000, [Fig-2] and 2015, [Fig-3] it can also be observed that there is a progressive increase of area under the successive deeper ground water contours.

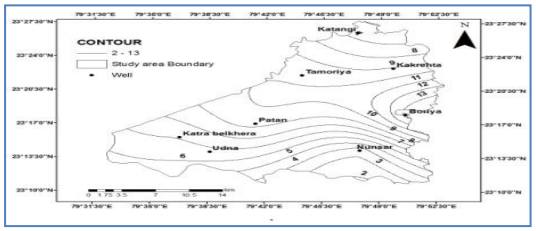


Fig-2 Water Table Contour Map for the Year 2000 pre Monsoon

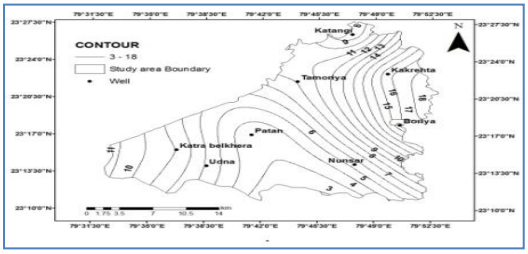


Fig-3 Water Table Contour Map for the Year 2015 pre Monsoon

Analysis of hydrograph

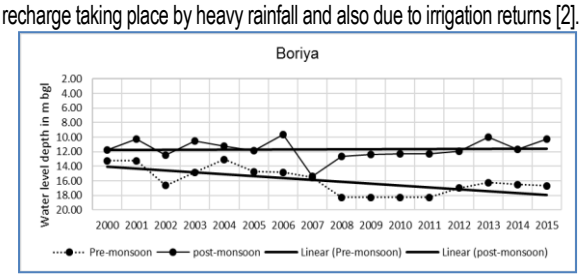
The upward and downward movement of water level caused due to rainfall as well as artificial recharge like check dams percolation dams, tanks, ponds etc. The respective observation wells hydrographs along with piezometer wells composite hydrographs are described in following figures

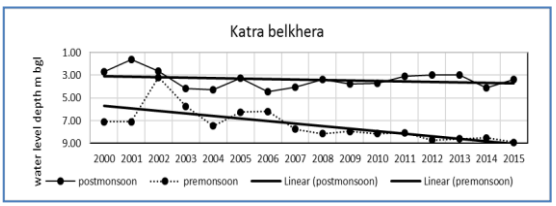
Discussion on Hydrograph observation wells

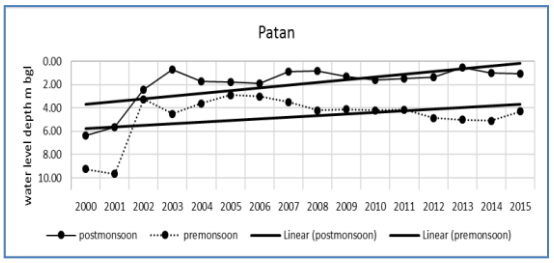
These hydrographs are observation wells for pre-monsoon and post-monsoon periods. Representation of hydrograph is shown in [Fig-4]. Out of 7 hydrographs 5 hydrographs show that water level trends are declining in Spite of normal trend of rainfall for most part of the past 16 years. This is due to (a) High ground water usage (b) Greater well density (c) specially increased agriculture area. Over all the ground water levels in the Patan block have been declining from the past 16 years [2].

Composite well hydrographs of piezometer wells

Composite well hydrographs with rainfall data plotted are shown in [Fig-5]. These hydrographs show that water levels are in general declining trend. Out of 2 hydrographs 1 hydrographs are showing declining trend of water levels. In general, the water levels in most of the cases return to its original position after a good rainfall. From the composite hydrographs, [Fig-5], it can be observed that it took two to three months' time to raise the ground water level after the rainfall occurrence. This phenomenon may be due to rapid recharge taking place by heavy rainfall and also due to irrigation returns [2].







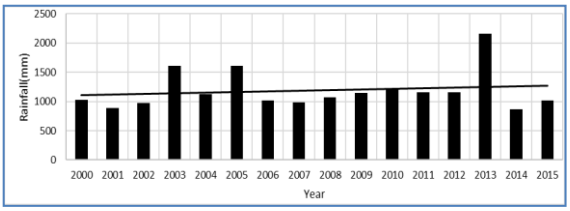
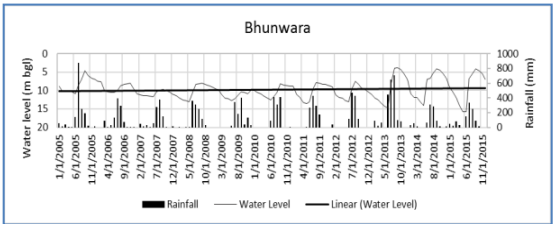


Fig-4 Ground Water Levels and Rainfall Trend in Bhuwara , Katra belcher and Patan



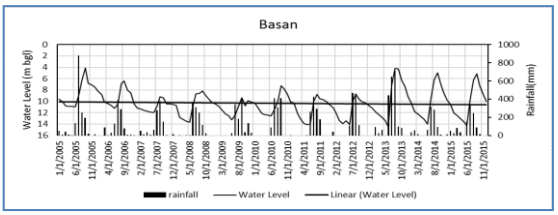


Fig-5 Composite Hydrograph of Basan and Bhunwara

Estimaton of Ground Water Recharge for the Patan Block

In the present study pre-monsoon and Post- monsoon ground water level are observed in the year 2000, 2005, 2010 and 2015 for the selected observation and pizeometric wells which are well distributed in study area.

These differences of pre-monsoon and post-monsoon levels are contours using Arc GIS Software. The water fluctuation contours for the years 2000, 2005, 2010 and 2015 has been prepared [Fig-6] where area between successive contours representing Ground water level fluctuations, is estimated by using the Arc GIS software and the specific yield (Sy) values of different formations are adopted from the recommended values of Ground Water Estimation Committee [5] based on local Geology By using the formula

The volume of water recharged was estimated as 122.93 MCM, 188.36 MCM, 165.64 MCM and 169.17 MCM against the volume of rainfall Water Of 615.47 MCM, 974.80 MCM, 760.56 MCM, 606 MCM forming a 19.9%, 19.3%, 21.7% and 27.9% of rainfall during the years 2000, 2005, 2010 and 2015 respectively. It has been observed that on an average 22.25% of rainfall is contributed to recharge the ground Water regime in the Patan block, through various ways such as direct infiltration, recharge from Tanks, Check dams etc.

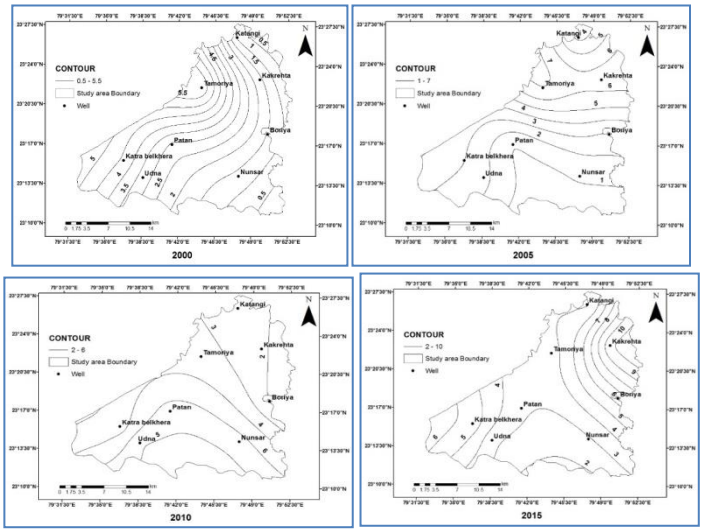


Fig-6 Contoure of the Ground water Fluction of the Patan Block during 2000, 2005, 2010, 2015

Rainfall and Recharge Relationships

The observed results suggested that the more the amount of rainfall more the recharge that occurs. In order to attain a relation between the rainfall and the recharge occurred, a graph is made by plotting the recharged against the total rainfall occurred, [Fig-7]. The best-fit line is obtained by least square method, which shows a linear correlation between rainfall and recharge.

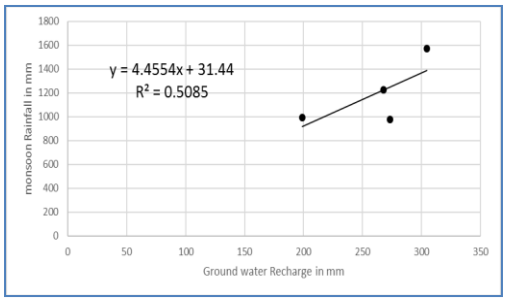


Fig-7 Relation between Rainfall Converted into Groundwater Recharge and Rainfall

Influence of pre- monsoon Ground Water Levels over the recharge of Rainfall to the groundwater

Influence of Pre-monsoon and post monsoon ground water levels were observed in the year 2000 to 2015 at 7 locations converting entire study area. A graphical relationship has been developed [Fig-8] between pre-monsoon water levels and the difference of pre-monsoon and post monsoon groundwater level, which have clearly demonstrated that a positive correlation exists. The [Fig-8] has been drawn between pre-monsoon ground water level and the raise in ground water levels (the difference between the pre-monsoon and post-monsoon levels) which indicated the deeper the pre-monsoon ground water more the recharge to the ground water from the rainfall and other sources

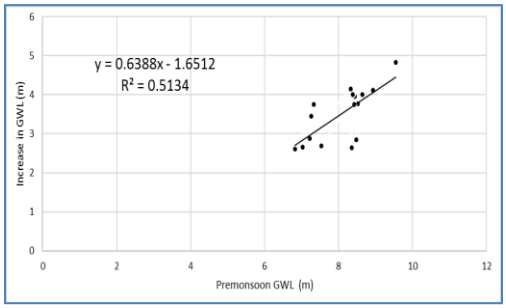


Fig-8 Relation between Pre-monsoon ground Water Level and Increase in Ground Water Level

The Effect of Large Scale Ground Water Withdrawal in patan block

In the present study focuses on the effect of large-scale ground water withdrawal in Patan block. The decreased in ground water level is due to increase in agricultural production in the patan block by tapping lot of surface water and ground water. This increased agricultural production is due to the continuous raising demand of food. The recent report of the World Bank has also indicated that the increased use of ground water in the India agriculture has led to decreased command area under the tanks [8]. To establish this fact further analysis has been carried out by using the crop data of the years 2001 to 2015 during rabi season which is collected from Madhya Pradesh Land Record. Analysis was done for observed data and the result found have been tabulated in the [Table-1]. It is evident that the total cropping area was increased by 7.21% from 2001 to 2015 respectively. The decrement the cropping area in 2005.Continuous raising demand of Jabalpur city lead to the change in the cropping pattern in the patan block.

Table-1 *Areas crop in the study area*

Crop	Total crop area of Rabi season			
	2001	2005	2010	2015
Wheat	18947	16258	21916	30089
Gram	16005	18919	18729	9057
Pea	8093	4521	3364	6784
Sugarcane	55	135	345	294
Vegetable	195	177	294	242
Total	**43295ha**	**40010ha**	**44648ha**	**46466ha**

Conclusion

It has been concluded from the current study that, nearly 22.25 % of annual rainfall is joining the ground water either by direct infiltration or by recharge through various structure such as tanks, ponds check dams etc. Study also suggested that the ground water deepness in pre-monsoon attract higher recharge to the ground water from the rainfall and other sources like ponds, tank and check dams. Study also revealed that pre-monsoon ground water level has higher influence in ground water recharge as compared to the total amount of rainfall for the selected study region. The study also suggested that there is an evidence of decline of ground water levels due to increase in Agriculture area by 7.21% which ultimately had an impact on water inflow thus less recharge happened and similarly increase in Ground water withdrawal in agriculture production as well as growing population demand in study area has also impacting the ground water declination in study area.

Acknowledgements

I would like to extend sincere thanks to my advisor, Dr. M.K. Awasthi, for the knowledge, guidance and freedom he provided throughout the course of this project.

Author Contributions: All author equally contributed

Abbreviations: WTF: water-table fluctuation

Conflict of Interest: None declared

References

[1] Awan U.K., Tischbein B. and Martius C. (2013) *Irrig. Sci.,* 31 (4), 793–806.
[2] Venkateswara Rao B., Varalakshmi V. and Vijayasarada S.T. (2009) *Journal of Applied Hydrology,* XXII(I), pp 102-117.
[3] Döll P. (2009) *Environ. Res. Lett.,* 4, 036006
[4] Freeze R.A. and Cherry J.A. (1979) *Remote Sens. Environ.,* 114 (1), 168–182.
[5] Gec. (1997) Report of the Groundwater Estimation Committee, Groundwater Methodology, ministry of water resources, Groundwatrer of India .pp 102.
[6] United Nations Educational, Scientific and Cultural Organization (UNESCO) 2003. Water for People, Water for Life, United Nations World Water Development Report, Part II: A Look at the World's Freshwater Resources. www.unesco.org
[7] Wada Y., van Beek L.P.H., van Kempen C.M., Reckman J.W.T.M., Vasak S. and Bierkens M.F.P. (2010) *Geophys. Res. Lett.,* 37,20402
[8] World Bank Report. (2005) India's Water Economy Bracing for Turbulent Future, NO.34750-IN pp.102.