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A Spatio-temporal Analysis of Groundwater Table in Semi-arid Region in Bhiwani district, Haryana

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Introduction:

In the recent age, looking at the increasing pressure of populating on the Earth has become very necessary of sustainable development of anything, because of that has done supply of requirement of the demand. This is the most commonly quoted and it aims to be more comprehensive than most; Sustainable development that meets of the present without compromising the needs of further generation to meet their own needs (Brundtland, .1987). From these demands, groundwater is the major source at present for the every human being live on the Earth.Groundwater is the most important source in the context of water using because of that some region of any area there is no alternate source of water, but the groundwater availability in this area met very easy. In thesemi and semi-arid region of the country and covered with the undulating sand dunes, there is lack of canal network and outreach of proper surface water because of that relief structure is not favorable in lay canal network. The present study area lies in north and north-east part covered with plain alluvial soil and left part of the study lies in semi-arid region and covered with undulating sanddunes. In this area the increasing of agriculture practices with technology development, the more quantity of water requirement for the irrigation and the groundwater extraction has been is more.

The groundwater level fluctuation is controlled by recharge and draft of groundwater and the diverse influences on groundwater levels include meteorology, tidal phenomena, urbanization, earthquakes and external loads stress and strain in water level due to groundwater recharge, discharge and intensity of rainfall are reflected in groundwater level fluctuation with time (Gopinath&Seralathan., 2008). The mean annual rainfall over India is about 105 cm and exceeds the global average rainfall of 70cm. Even then, 80% of the Indian territories fall under semi-arid conditions. This is because of spatial and temporal distribution of rainfall, overall variability's of monsoon, topographic variations, prevailing semi-arid to arid climatic conditions and varied nature of hydrogeology (S.N. Rai). The lowering of groundwater levels has resulted in reduction in individual well yield, growth in population, failure of bore wells, drying up dug wells and increase in power consumption (Imtiyas&Rao.,

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2008). Groundwater is often developed without proper understanding of its occurrence in time and space and is, therefore, threatened by over-exploitation and contamination. For that reason, groundwater management is the key to combat the emerging problem of water security. Knowledge of water table depth is a crucial element in many hydrological investigations, including agriculture salinity management, landfill characterization, chemical seepage movement, and water supply studies (Buchman &Triantafilis., 2009).Groundwater is the most precious natural resource of the earth and is of great importance in every facet of human life. Ground water is the largest source of fresh water and is most widely distributed resource on the earth.Due to the prevalent arid and semi-arid climatic conditions, tube wells have become the largest single source of irrigation, because livelihood of more than two-third of its population depends on agriculture. More than 90 percent of the rural population and nearly 30 percent of urban population also depend on ground water for meeting their drinking and domestic water requirements (Reddy et al., 1996).The excessive draft of groundwater and less recharge has depleted this natural resource. For fulfill the increasing demands of water. So, there is need to assess the potential groundwater areas. The excessive use of the groundwater purposes in some regions of the study area has affected the groundwater depth.

Objective:

(1) To analysis the Spatio-temporal pattern of Groundwater table in the study area.
(2) To correlate the Groundwater table with its impact factors such as Rainfall, Number of Tube wells and net Irrigated area from tube wells.

Methodology:

The study has been focused on the groundwater depth and its impact factor like, rainfall, number of tube wells, and irrigated area from tube wells. The study is based on secondary data extracted from the different department like Groundwater Cell, District Revenue department, and district statistical office of the Bhiwani District.

Block wise Data collected related to the study:

(1) Groundwater table data(1996 to 98 and 2013 to 15)
(2) Rainfall, Number of tube wells, Irrigated area from tube wells(1996 to 98 and 2013 to 15)

All data has been compiled in excel sheet for the analysis, and the triennium average value of three years were taken to present spatio-temporal distribution pattern of groundwater table

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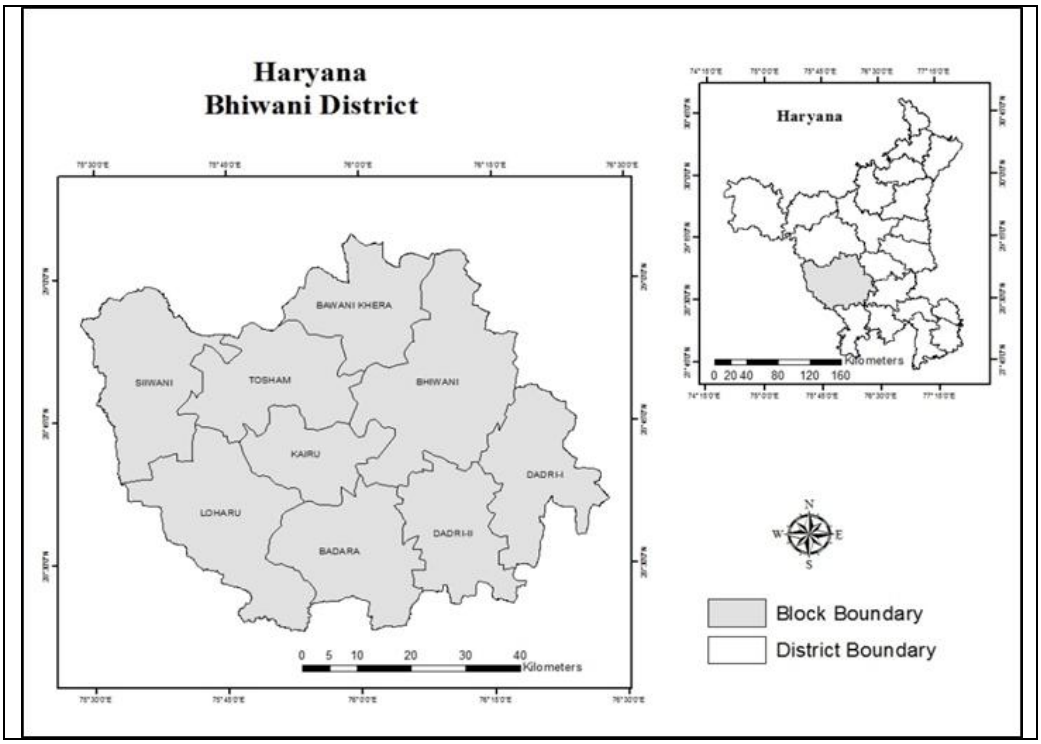
and its changes. The map has been prepared with the help of ArcGIS 10. Further, a table showing the correlation of groundwater table with its impact factors has drawn.

StudyArea:

Figure 1.1: Location of the Study Area



The district Bhiwani is the biggest district of the Haryana state lies in the south-western part of the state with a coordinates of 28° 20' N to 29° 25' N latitude and 75° 28' E to 76° 25' E longitude. The total geographical area of the district is 48, 70, 72 hect. With 9 administrative blocks i.e. Bhiwani ,Bawani Khera ,Siwani , Kairu , Dadri 1, Dadri 2 , Loharu , Badhra and Tosham. The study area lies in the semi-arid region and its physiographic ally condition is plain with an average altitude of 214.58 Meters above mean sea level. However, South-West part of district is marked by sand dunes covering Badhra, Loharu, and Tosham blocks.The soil varies from sand to sandy loam in Dadri 1, Bhiwani, and Tosham blocks. The blocks Badhra, Loharu, Siwani, are covered by sandy soil. Clayey loam to clay and loamy soil is found at many places in Bawani Khera, Dadri 1, and Bhiwani blocks. The area adjacent to Rajasthan is covered by sandy soil.

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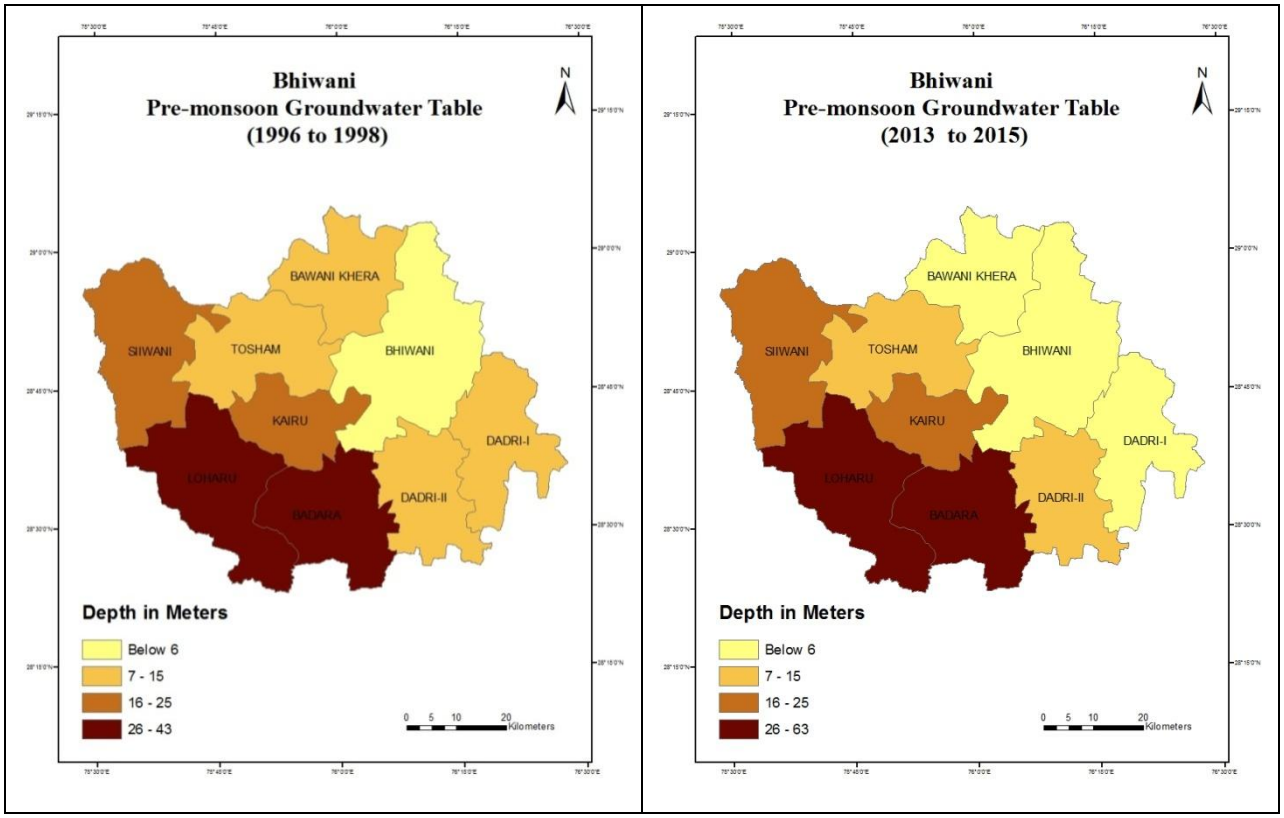
Figure 1.2: Average Annual Depth of Groundwater during Pre-Monsoon (1996 to 98-2013 to 2015).



These maps shows that the groundwater table fluctuation that above mention the time periodin during pre-monsoon season of the study area. The map of during the time of 1996-1998 shows the lowest depth of the groundwater table in the south, south-west and central part of the study area with the highest depth in Loharu block (43 mt.) and the nearest in Bhiwani block below (6 mt.), while in the time of 2013 – 15 the depth of groundwater found in same the time period of 1996 – 98 with (63 mt.) in Badhra block. But in the north and north-east part of the study area the water table have coming nearest to the surface with below (6mt.). There is happened in the study area because of that in the north - east part irrigated by canal water resources while other area extracted of groundwater for the irrigation purpose(Figure 1.2:).

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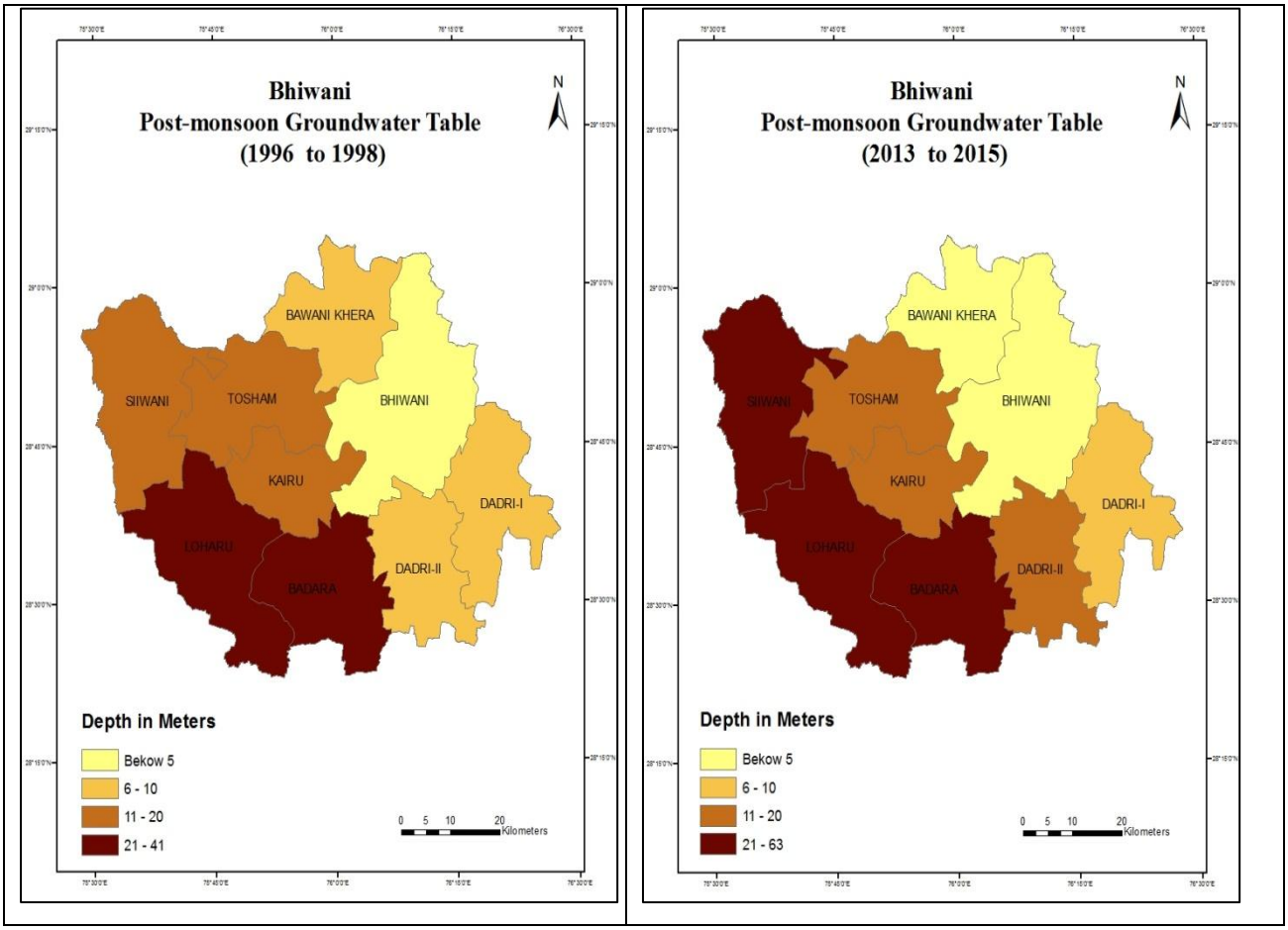
These maps show that the groundwater depth in the study area after post monsoon so that the rainfall is the major factor to affected the groundwater table. According the distribution pattern of groundwater table, in the west and south-west part of the study area has found highest declining depth of groundwater table as compare to the north and north - part with (21 to 63 mt.). Only one block Bawani Khera has risen the groundwater table after post monsoon (Figure 1.3 :).

Figure 1.4:

Annual average change in groundwater table in the study area

(1996 to 98 -and 2013 to 15).



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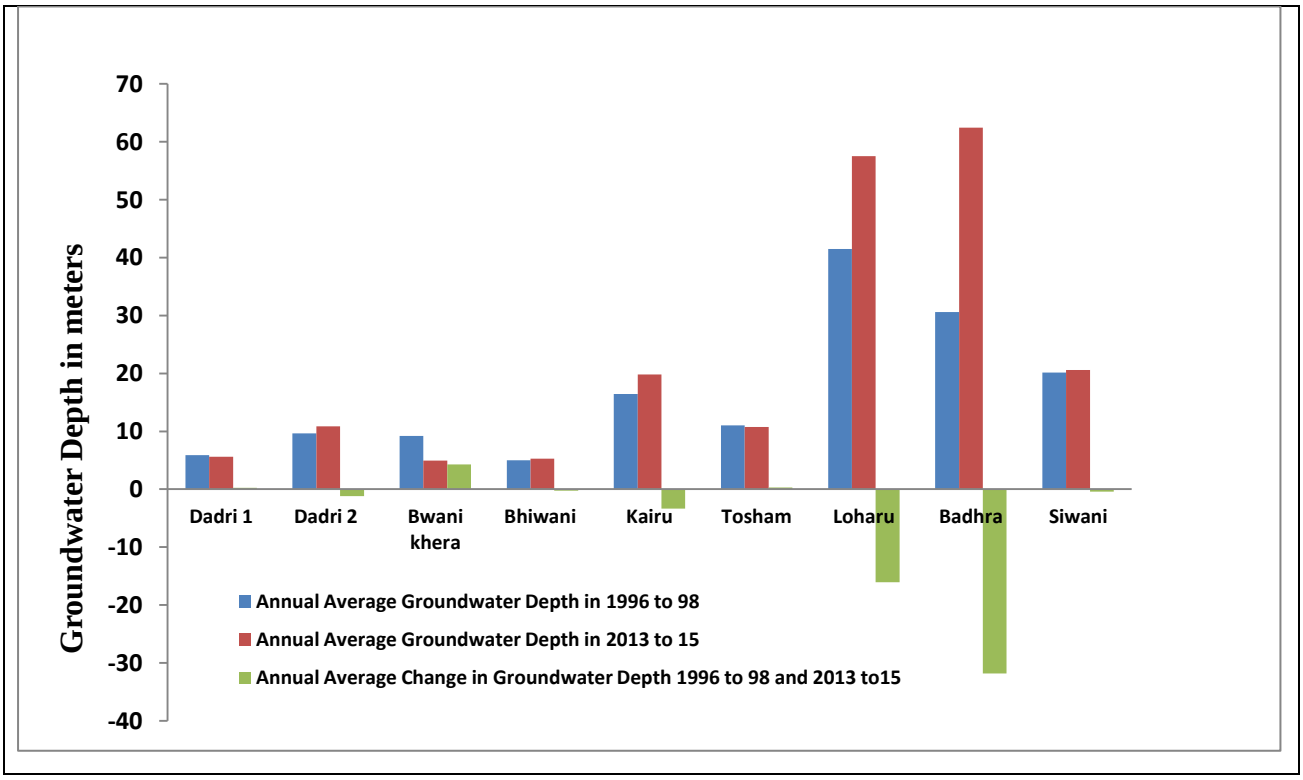
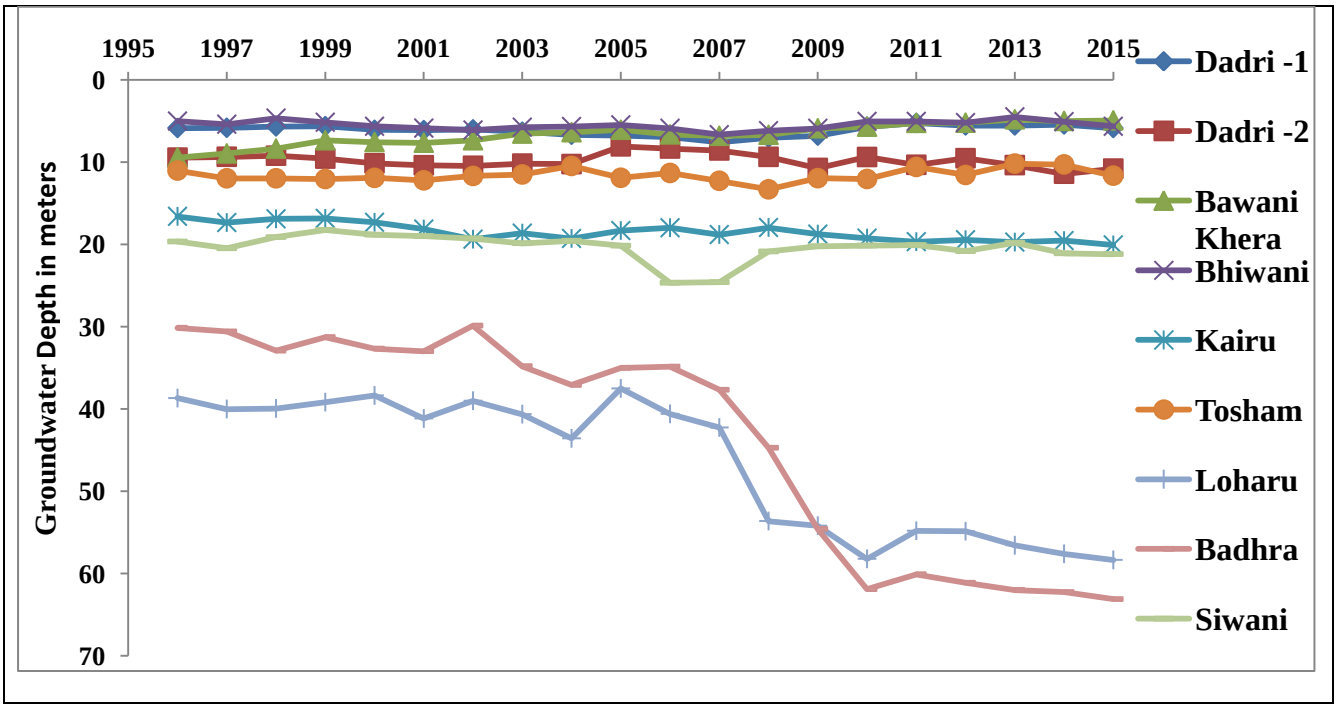


Figure 1.5: Block wise historical Annual water table trend in (1996 to 2015).



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In this graph shows that the groundwater table rise and decline in the study area in the time period of 1996 to 2015. The highest declining rate of groundwater table has found three blocks namely Badhra, Loharu and Kairu with their Dadri-2 and Siwani and highest rigging groundwater table blocks Bawani Khera, Dadri-1 and Tosham. In Bhiwani block has found slightly rigging change in groundwater table in this time period (Figure 1.4 and 1.5).

Table 1.1: Correlation of groundwater table with impact factors (1996 to 98).

	Annual Average Groundwater table in mt.	Irrigated area per 1000 hec.	Number of Diesal Tubewells per 1000 hec.	Number of Electric Tubewells per 1000 hec.	Rainfall in mm
Annual Average Groundwater table in mt.	1				
Irrigated area per 1000 hec.	-0.41	1			
Number of Diesal Tubewells per 1000 hec.	-0.21	0.87	1		
Number of Electric Tubewells per 1000 hec.	-0.32	0.90	0.95	1	
Rainfall in mm	0.15	0.37	0.39	0.35	1

Table 1.2: Correlation of groundwater table with impact factors (2013 to 15).

	Annual Average Groundwater table in mt.	Irrigated area per 1000 hec.	Number of Diesal Tubewells per 1000 hec.	Number of Electric Tubewells per 1000 hec.	Rainfall in mm
Annual Average Groundwater table in mt.	1.00				
Irrigated area per 1000 hec.	-0.24	1.00			
Number of Diesal Tubewells per 1000 hec.	-0.89	0.43	1.00		
Number of Electric Tubewells per 1000 hec.	0.89	-0.01	-0.87	1.00	
Rainfall in mm	0.71	0.47	-0.41	0.70	1.00

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The table 1.1 and 1.2 shows that the factor affecting to the ground water depth like irrigated area from tub wells (Diesel and Electric) and rainfall. In 1996 to 98 has found is very low negative relation between groundwater table and tub wells (Diesel and Electric) while in the 2013 to 15 has been found very high negative relation with electric tub wells and very high positive relation with diesel tub wells with the groundwater depth. So we can say after increasing of electric tub wells groundwater depth has been much declined. And find out that strong relation between with rainfall found in 2013 to 15.

Conclusion:

The study reveals that the overall depth of the groundwater has been declining except the north-east part of the study area during the period of 1996 to 2015. It has been declined north-east to south-western part. After 2006 the graph shows very high rate depletion of water table in the south and south central part of the study area (Loharu & Badhra block) because of the high intensity of electric tube well for irrigation purpose which eventually leads towards more quantity of water drafting through this practices. That is why the net ground water recharge is low as compared to total usage.

However, in the depth north-eastern part of the study area (Tosham ,Bawani Khera and Dadri-1) there is a slight positive change in groundwater table due to less number of electric tube wells and also because the canal water use for irrigation purpose. The highest change in groundwater depth during (1996 to 2015) is found in Badhra ,Loharu , Kairu , Dadri-2 and Bawani Khera block , -31.85 , -16.05 , -3.35 , -1.22 and 4.25 meters.

The overall average value of the groundwater depth was about 16.60 meters of the study area in 1996 to 98. The Loharu block showed the lowest groundwater table near about 41.48 meters which lies in south-western part of the study area and the nearest groundwater table was in Bhiwani block with 4.99 meters. But in 2013 to 2015 the depth of groundwater has increased with the 21.98 meters in the study area. The lowest groundwater depth has been found in the Badhra block with 62.47 meters and the nearest depth of the groundwater has been found in the Bawani Khera block with 4.93 meters.

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