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Pattern of Groundwater Utilization and Exploration for Agriculture in Charkhi Dadri District Haryana: A Geospatial Analysis

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Abstract

One of the most crucial natural resources for maintaining life on Earth is groundwater. Due to a lack of available surface water or the high cost of importing water, groundwater is the only source of potable water in many regions of India. The symbiotic relationship between agriculture and groundwater underscores the importance of understanding the intricate patterns that govern their interaction. Groundwater, a hidden resource beneath our feet, plays a pivotal role in ensuring crop yield stability and mitigating the effects of erratic precipitation patterns. Charkhi Dadri district has been selected for present study. Integrated approach has been used to explore the spatial dimension of ground water level and water table dynamics. The groundwater table in Charkhi Dadri has declined significantly over the past 20 years. The most severely depleted areas are in the southwestern and northeastern parts of the district. These areas are also the most densely populated and agriculturally productive areas in the district. there is a clear gradient in groundwater utilization for agriculture from west to east. The western part of the district has a higher density of electric wells and a higher level of groundwater utilization for agriculture than the eastern part of the district. The density of canals is highest in the western part of the district, where the density of electric wells is also highest. This suggests that the canals are playing an important role in supplying water for groundwater extraction in this area.

Introduction:

One of the most crucial natural resources for maintaining life on Earth is groundwater. Due to a lack of available surface water or the high cost of importing water, groundwater is the only source of potable water in many regions of India (Pradhan et al., 2016). In many parts of the country, groundwater resources are getting worse because they are being overused and there aren't any thorough management plans in place. Any management choice needs to be based on a deep understanding of the long-term changes in groundwater potential and its regional pattern (Raghunath et al. 2005). Agriculture, as the cornerstone of global sustenance, faces unprecedented challenges in the 21st century. With a burgeoning world population and the unpredictable impacts of climate change, the need for sustainable agricultural practices is more critical than ever (Smith et al., 2016). Central to this endeavour is the judicious utilization of water resources, particularly groundwater, which serves as a lifeblood for irrigation in agricultural landscapes (Johnson & Williams, 2016). The symbiotic relationship between agriculture and groundwater underscores the importance of understanding the intricate patterns that govern their interaction. Groundwater, a hidden resource beneath our feet, plays a pivotal role in ensuring crop yield stability and mitigating the effects of erratic precipitation patterns. As we navigate an era of heightened environmental consciousness, unravelling the geospatial nuances of groundwater utilization in agriculture becomes paramount for fostering resilience and optimizing resource allocation.

Statement of Problem:

Managing irrigation water is one of the most important problems in this unexpected global water crisis. Since irrigation is a big part of Indian agriculture, farmers have taken a lot of groundwater from private tube wells to use in their crops since electricity costs are subsidised. The World Bank reported in 2010 that the area that was watered by groundwater had grown by 500% since 1960, and the number of wells in India had grown to 20 million (Roy & Shah, 2002). In the long run, this situation could make it harder to get to groundwater supplies, which will make pumping more expensive and allow saltwater to get into coastal aquifers.

Study Area:

Charkhi Dadri is 22nd district of Haryana of the Indian state of Haryana. It is located at a latitude of 28.5667° N and longitude of 76.3167° E. The city has an average elevation of 235 meters (771 feet). Charkhi Dadri is located in the central part of Haryana and is bordered by the districts of Bhiwani, Rohtak, Jhajjar, and Rewari (Figure -1). The physical attributes of Charkhi Dadri are characterized by its flat terrain and semi-arid climate. The climate of study area is hot and dry in the summer and cold and dry in the winter. The physic of the district has been developed by combined work of alluvial and aeolian processes. There is no perennial river passing through the district Area experiences have dendritic to semi dendritic drainage patter in rainy seasons. There is a vast area drained by canals irrigation network. It is feed by Loharu feeder, Jui feeder and Indira Gandhi Canal, which is the branch of western Yamuna canal network. These are supplemented for ground water levels and quality of drained area. Southwestern Haryana is less developed than rest of Haryana from agricultural point of view. There are various factors behind such a difference in the agricultural development of this region and irrigation is one of the most important one. In the Southwestern Haryana development of canals and, tubewells is different from rest of Haryana. In this background, the present study aims to examine the development of irrigation in Southwestern Haryana from spatial and temporal prospectives using secondary sources of data.

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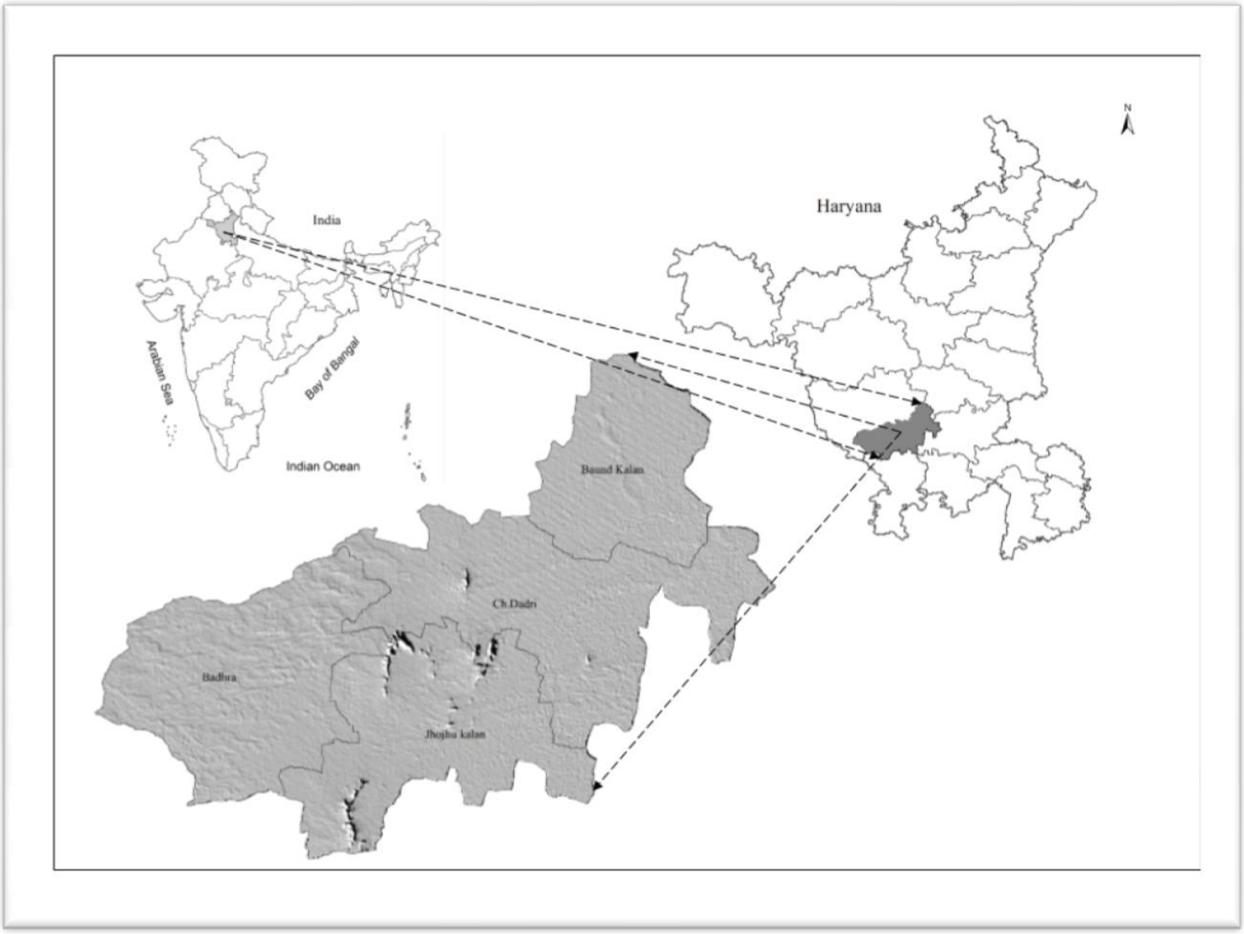

Figure - 1. Study Area

Data Base and Methodology

Integrated approach has been used to explore the spatial dimension of ground water level and water table dynamics. All the attribute data has been integrated with spatial data in GIS software. For this study, multi-types data has been used. That are as under;

a) Spatial Data:
   - ✔ Open Series Survey of India Topographical Maps
   - ✔ Google Earth Satellite Image

b) Attribute Data:
   - ✔ Ground Water Data
   - ✔ Tubewell Data
   - ✔ Other published/unpublished supporting data.

GIS software was used to explore spatial patterns and trend of ground water level over the study. The spatial interpolation analysis tool of GIS software was used to deduct the spatial distribution pattern and trend the ground water dynamics variability. Specifically, an inverse distance weighted (IDW) interpolation method was applied to process discrete rainfall data, which is expressed in Eq. (Lam, 1983):

$$F(x,y)=\left[\sum_{i=1}^{n}W(L_i)Z_i\right]\Big/\left[\sum_{i=1}^{n}W(L_i)\right],$$

Where *W* (*Li*) is the weighting function, which reduces with distance extending; *Li* is the distance between point *i* and point (*x*, *y*); *Zi* is the measured value at point I; *F*(*x*, *y*) is the interpolated value at the point (*x*, *y*). All thematic layers were analyzed with the help of integrated approach of remote sensing and GIS

Result and Discussion

The figure – 2 shows that the rainfall in Charkhi Dadri is generally highest in the southwestern part of the district and lowest in the northeastern part of the district. The southwestern part of the district receives an average of 376 to 400 mm of rain per year, while the northeastern part of the district receives an average of 251 to 275 mm of rain per year.

The figure- 3 shows that the groundwater table in Charkhi Dadri has declined significantly over the past 20 years. The most severely depleted areas are in the southwestern and northeastern parts of the district. These areas are also the most densely populated and agriculturally productive areas in the district.

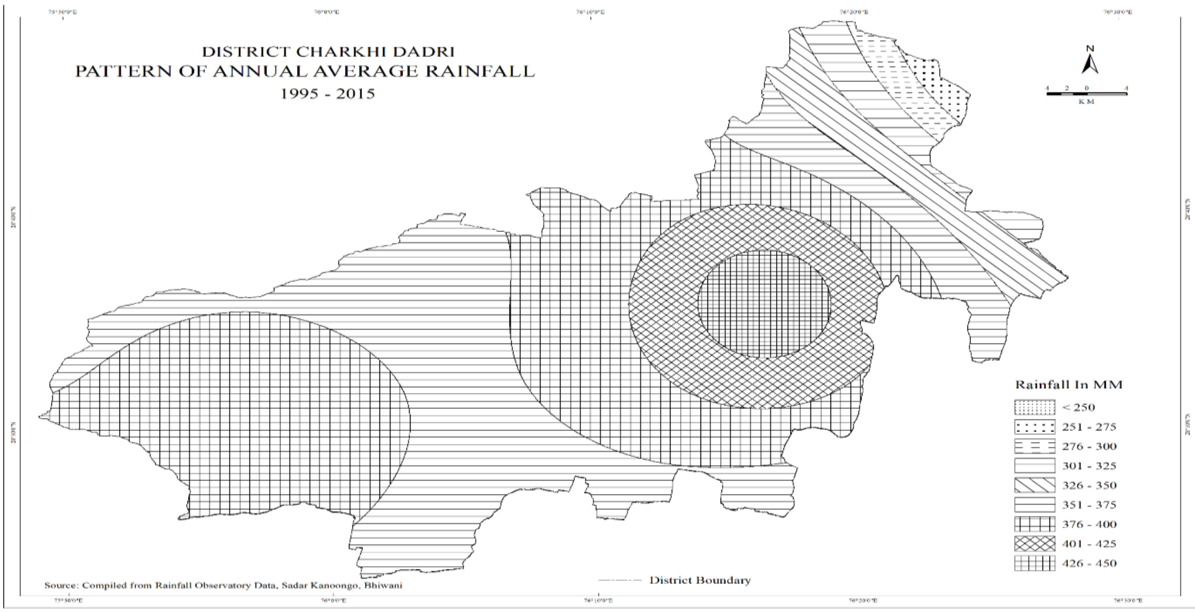

Figure - 2

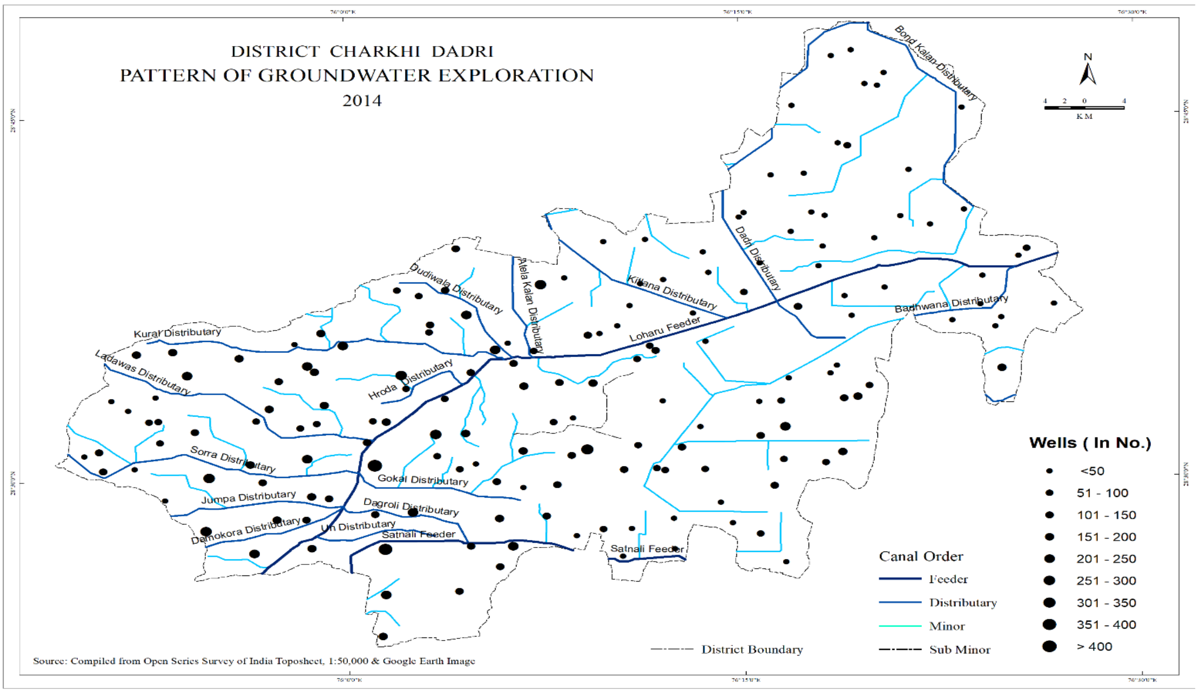

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Figure - 3

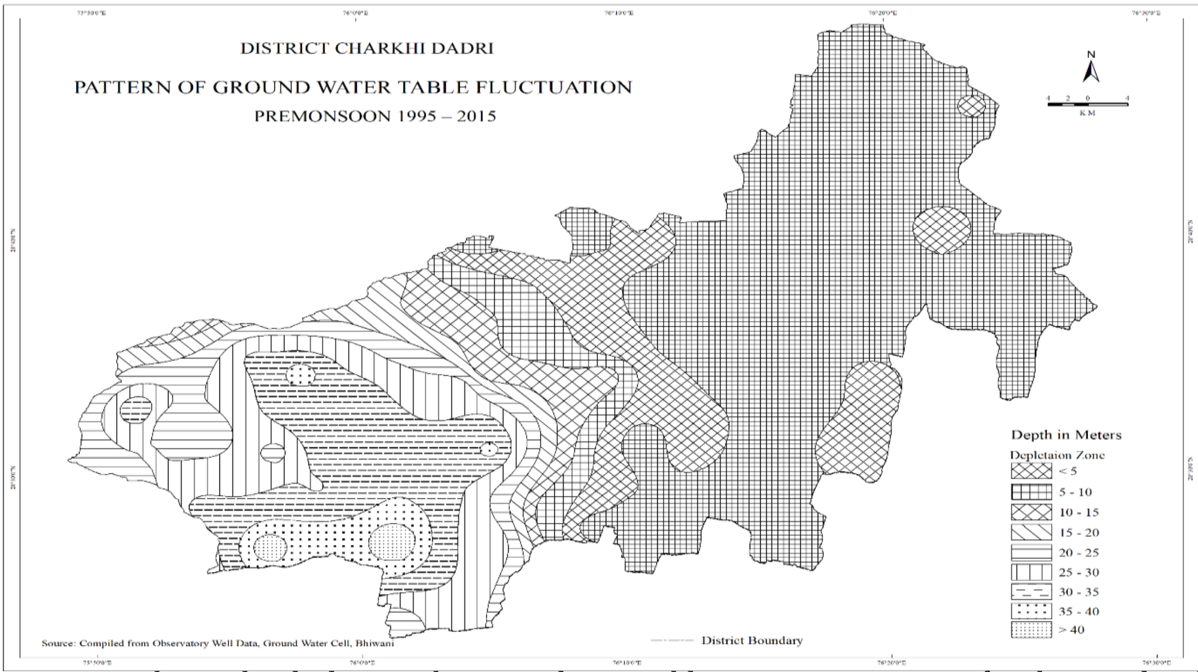

Figure- 4: shows the decline in the groundwater table is a major concern for the people of Charkhi Dadri. It is affecting agricultural productivity, drinking water supplies, and the environment. The government of India is taking steps to address the problem, but more needs to be done to conserve groundwater and manage it sustainably.

Table No. 1 Changing Dimension of Ground Water Level from Year 2003 -14

Sr. No.	Year	*G. W. D. (in meter)	**Tubewell/Borewell. Density	***C D
1	2003	29	10.38	0.47
2	2004	34.08	10.92	0.47
3	2005	37.11	11.43	0.47
4	2006	31.78	11.82	0.47
5	2007	39.15	12.05	0.47
6	2008	46.6	12.6	0.47
7	2009	54.8	13.15	0.47
8	2010	61.22	13.91	0.47
9	2011	59.8	14.67	0.47
10	2012	60.67	15.58	0.47
11	2013	62.41	16.8	0.47
12	2014	65.19	18.03	0.47

Source: Ground Water Cell, District Bhiwani & Dakishan Haryana Bijli Vatern Nigam, Op/ Circle Bhiwani

*Ground Water Depth (In Metre) **Tubewell/Borewell Density (per/Sq. Km. Area)

*** Canal Density (Canal Length per/ Sq. Km. Area).

Conclusion:

The geospatial analysis also shows that there is a clear gradient in groundwater utilization for agriculture from west to east. The western part of the district has a higher density of electric wells and a higher level of groundwater utilization for agriculture than the eastern part of the district. This is likely due to the fact that the western part of the district has more fertile soil and a longer growing season than the eastern part of the district.

The canals are used to transport water from surface water sources to agricultural fields. The density of canals is highest in the western part of the district, where the density of electric wells is also highest. This suggests that the canals are playing an important role in supplying water for groundwater extraction in this area.

Electric wells are located in close proximity to canal distributaries in Charkhi Dadri district.

Overall, the geospatial analysis shows that groundwater utilization for agriculture is highest in the western part of Charkhi Dadri district, where the density of electric wells is also highest. This suggests that farmers in this area are more reliant on groundwater for irrigation than farmers in other parts of the district.

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