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Changing Patterns of Ground Water Level in Fatehabad District of Haryana, India

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Abstract
Ground water is the world largest freshwater resource used in agriculture for irrigation. Ground water level in paddy cultivating region in Haryana is depleting very fast, threatening the future of agriculture productivity in one of the largest farming state in India. The aim of this study was to assess the trends in ground water level in the Fatehabad district of Haryana, India. Rapid increase in area under rice-cultivation, electric sets for pumping deep water and decrease in cultivation of less water requirement crops like pearl millet are the possible reasons behind rapid decline of ground water. In the present paper different factors like ground water level, area under rice cultivation, fertilizers consumption pattern and electric set were studied for the period between 2005 to 2013 in the Fatehabad district. The area under rice cultivation has increased from 31.67 to 40.36% with increased number of electric sets from 18542 to 31163 in 2005-06 to 2012-13, respectively. Area under pearl millet cultivation has also declined to 22.6 % in 2012-13 as compared to 2005-06. The district showed the second largest decline of 17.19 meters after district Mohindergarh since June 1999 to June, 2014 in Haryana. Sustainable use of water and cultivation of crops having less water requirements and drip/sprinkler irrigation are recommended to check the decline of ground water in the district.
Keywords: Ground Water Depletion, Rice Cultivation, Electric Set, Fatehabad, Haryana

1. Introduction

Ground water is considered as largest source of unfrozen freshwater present on the earth (Foster and Chilton 2003). It is an important source of drinking water as well as for irrigation worldwide. It is the only available source of irrigation and agriculture production in arid region of the world (Schwartz and Ibaraki 2015). Haryana state of India has a geographical area of 44.20 lacs hectares (Sharma *et al.* 2011) and has second position in the India's central pool of food grains (Satyawan *et al.* 2014). Being an agrarian state, about 85% of its total geographical area is under cultivation engaging 78% of population in agriculture. Wheat, rice, maize, pearl millet (*Bajra* in native Hindi language), cotton, mustard sugarcane, jute, sesame and groundnut are the major crops of the state. On an average 95-98% of the area under rice and wheat cultivation is irrigated. Ground water account for 60-65% to total irrigation requirement and rest of 35-40% is done through canal water. The total irrigated area by canal water is about 21.40 lacs hectares by various canals namely Western Yamuna canal, Gurgaon Canal, Jui canal, Bhakra canal and Jawaharlal Nehru canal.

Green revolution has changed the traditional rain-fed crop to wheat and rice as well as other commercial crops in Punjab, Haryana and western UP. Increased extraction of groundwater for irrigation has substantially contributed to 'green revolution' and enhanced food supply but it has led to depletion of ground water (Scanlon *et al.* 2007; Gun, 2012). These are more water intensive uses high amount of fertilizers that require protected irrigation (Pandey, 2014). Paddy being highly water intensive crop requires 24-28 irrigation in four month production period is most important reason for declining water table in central region and consume high fraction to total irrigation (Hira *et al.* 2004). The intensive exploitation of groundwater in many rice-wheat growing districts showed decline in water table (Singh, 2000). The continual rotation of wheat and paddy cropping pattern has also degraded water and soil in Punjab (Krishan *et al.* 2014) a neighboring state of Haryana. In Punjab during 1980 and mid 1990's sharp increase in area under paddy cultivation aggravate depletion of ground water and deepening of bore wells (Kaur and Vatta, 2015). In arid and semi-arid regions the annual rainfall is low and uncertain, water act as limiting factor in crop production and requirements are satisfied by supplementary irrigation Jalota and Arora, 2002; Li *et al.* 2004; Ji *et al.* 2007). The increased number of wells in semi-arid region leads to excessive extraction and without sufficient provision of recharge has led faster depletion of ground water (Roy and Shah, 2002; Reddy, 2005). In Haryana state the number of tube well have increased linearly since mid 1960 (Sharma *et al.* 2008). For a given land holding the increase in crop productivity on irrigated land leads to greater number and deeper tube wells which consequently decline water table (Foster and Rosenzweig, 2005).

2. Methods

Fatehabad is one of the smallest district of the state Haryana and covers 5.69% area of the state. The district is bounded by 28°48'15" to 29°17'40" North latitude and 76°28'4" to 77°12'45" East longitude covering an area of 2490 sq km. It has divided into five blocks namely Tohana, Ratia, Bhuna, Bhattu Kalan, and Fatehabad.

Fatehabad district can be classified into tropical desert and steppe, arid and hot which is mainly dry with hot humid summer and cold winter except during monsoon season. The hot weather season starts from mid march to last week of June followed by south west monsoon which lasts till September. The transition period from September to October forms the post monsoon season. The winter starts late in November and remains up to first week of March. The mean minimum and maximum temperature reaches to maximum up to 41.6^{0}C during May–June and 5.5^{0}C in January (Central Ground Water Board (CGWB), 2013).

The district is located in the indo-gangetic alluvial planes characterized by large and flat terrain interrupted by randomly located sand dunes along the Ghaggar river. The soils of the district are sandy-loam to loamy-sandy.

The normal annual rainfall in the district is 373 mm (CGWB, 2013). The south west monsoon sets in unevenly June and withdraw in end of September and contributes 80% of annual rainfall in a period of around 22 days. July and august are the wettest months and 20% of the rainfall is received during non-monsoon period in a wake of western disturbance and thunder storms. The area being flat terrain is conspicuous by absence of any well defined natural drainage system but the River Ghaggar drains the northern parts of the district. Heavy rainfall causes flooding as river course falling in the area is narrow. Fatehabad district has bestowed good irrigation facilities having Ghaggar river and Bhakra as a main canal. About 1400 square kilometer of the state is irrigated through canal network. It forms 70% of total irrigation area in the district and 30% of the area is irrigated by ground water through tube-wells.

Kahrif (summer or monsoon) and Rabi (winter) are two principal cropping season in a year in a season. Wheat is a major rabi crop followed by mustard and rapeseed whereas rice and cotton are two major kharif crops followed by other crops like cluster bean (*Gaur/Gwar* in native Hindi language), pearl millet and sugarcane. Rice is mainly concentrated near Ghaggar belt of the district whereas other crops like cluster bean, pearl millet and sugarcane are grown in southern part of the district. The cropping intensity estimate of the area is about 188%.

3. Results and Discussion

Water table in the district was 11.26 meters in 2005–06 which was changed to 22.76 meters in 2012–13 (Table 1). The decline is water table could be due to changing cropping pattern, increase in number of electric sets and fertilizers use in the study area. Based upon eight years data, the area under rice cultivation during the year 2005–06 was 68.4 thousand hectares which was 31.6% to the net shown area which and it increased to 89.6 thousand hectare in 2012–2013 which corresponds to 40.36% to net shown area. On the other hand, the area under pearl millet cultivation has decreased from 14.6 thousand hectare to 3.36 thousand hectare during the period. The land under pearl millet and cotton cultivation showed an overall decreasing trend while that of rice cultivation an increasing pattern was observed (Table 1). Total area under pearl millet and cotton cultivation has decreased 77.4 % and 10.0 %, respectively whereas for rice cultivation about 31 % increase was observed. This increase is due to large scale development of irrigation facilities, high yielding seeds varieties and chemical fertilizers (Neeraj, 2014). Pearl millet and cotton require comparatively less water than rice and more area under rice cultivation means more water demand. Around 4000 liter of water is required to grow I kilogram of rice while pearl millet require mere 30% of it (Sharma, 2007). Groundwater is more exploited during the study period as evident from the increase of electric sets in the district. The number of electric sets was 18542 in 2005–06 which increased to 31163 during 2012–13 (Table 1.). The electric sets become popular due to low cost, flat rate tariff and power subsidies (Mukherji *et al.* 2012). Further, free and unmetered power supply has weakened water harvesting and ground water and surface water management system (Shah, 2009). Fertilizers consumption in the study area was 75991 tonnes during 2005–06 which has increased to 104441 tonnes during 2012–13. With the increase in area under paddy cultivation fertilizer consumption increased which require more water. Similar studies were conducted in Hisar district, a neighboring district in study area, revealed that one hectare increase in irrigation increases the fertilizer consumption (Kaushik and Paharia, 2014). This increased use of fertilizers increases the demand of water for irrigation and also act as a factor behind declining water table.

4. Conclusion

In Fatehabad, shift in cropping pattern has changed from less water intensive crops i.e. pearl millet, and sorghum (*Jowar* in native Hindi language) to more water intensive crops like paddy. The area under paddy cultivation is increasing every year and to irrigate this area, the numbers of electric sets are increasing. Fertilizers consumption has also increased over the year to increase the yield. All the five blocks viz. Fatehabad, Tohana, Ratia, Jakhal and Bhuna are under over exploited categories (> 100%) (Department of Agriculture Haryana, 2015).

Diversification of agriculture to shift from paddy to sorghum, pearl millet and cotton during the kharif season is recommended. Direct seeded of rice (DSR) technique can be a good option than conventional flood irrigation to save water and other resources. Drip irrigation and sprinkler system of irrigation could be an option for crops in the study area except rice. Artificial recharge should be practiced in the areas with marked declination of underground water. On long term basis it is required to strengthen soil and ground water institutions, capacity building training and awareness in specific areas like artificial of ground water, watershed management and aquifer remediation.

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Competing Interests

The authors declare that they have no relevant competing interests.

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Table 1. Variation in ground water table, electric sets, cropping pattern, and fertilizer use in study area

Sr. No.	Year	Mean Water depth (meters)	Number of Electric Sets	Land under rice cultivation (000 hectares)	Land under pearl millet cultivation (000 hectares)	Land under cotton cultivation (000 hectares)	Fertilizer use (tonnes)
1	2005-06	11.26	18542	68.4	14.6	95	75991
2	2006-07	10.54	19580	70.1	11.7	90.9	81042
3	2007-08	10.59	21940	73.2	11.3	86	86119
4	2008-09	16.76	25008	77.8	10.3	83.4	97459
5	2009-10	18.36	27357	81.4	7.8	85.8	98509
6	2010-11	20.45	28821	87.6	7.8	85.8	103536
7	2011-12	21.79	29992	87.1	4.9	80.8	113378
8	2012-13	22.76	31163	89.6	3.3	85.5	104441

Source: Ground Water Cell, Haryana and Statistical Abstract, Haryana