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Research Article

CHANGING GROUNDWATER RESOURCES SCENARIO OF WESTERN RAJASTHAN

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Abstract: Groundwater assumes prime importance in arid areas like western Rajasthan where there is no other source of water. To meet the demand of ever-increasing population and economic development, groundwater has been indiscriminately exploited. An attempted has been made to assess the groundwater scenario of western Rajasthan over a long period of time, based on data collected from various sources. The number of wells (dug well /bore well /tube well) has increased four times with an annual growth rate of 9.91% (123051 in 1971 to 610992 in 2015) in last four decades.

The increasing number of wells has exacerbated the over drafting of groundwater, which has resulted in decline in groundwater table. The rate of decline in the groundwater table is the highest (> 0.50 m y^{-1}) in Jalore and Pali followed by Jodhpur, Jhunjhunu, Nagaur and Sikar (0.44-0.48 m y^{-1}) districts. The over exploitation of groundwater is also resulted in deterioration of water quality. Groundwater in >80% areas is having EC >2.0 d Sm^{-1} and is moderately good for irrigation, whereas 40% area have EC > 4.0 d Sm^{-1}, which is not very suitable for irrigation. A significant change has been observed in cropping pattern during last decade. With availability of tube-well and canal water, several high-water requiring crops like cotton, groundnut, sugarcane, rice, wheat, castor, *etc*., were introduced in area and severely impacted groundwater levels and quality. The severe and ongoing depletion of groundwater levels in western Rajasthan poses a growing threat to the food security. There is need for augmented/accelerated groundwater recharge, conjunctive use of poor-quality groundwater with rainwater, protected agriculture and rejuvenation of traditional water harvesting structures like village Pond, Tanka, Nadi, *Khadin etc*. to reduce the pressure on groundwater resources.

Keywords: *Groundwater, wells and tube wells, cropping area, Thar desert, western Rajasthan*

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Introduction

Rain is the primary source of water for all forms of water resources on the earth. Water resources are very scarce in western Rajasthan, comprising of 12 districts known as Thar Desert. There is no perennial river system in desert and rain is the sole source of water to meet all water requirement of the region. Groundwater is generally very deep and at many places' saline. Replenishment of groundwater is dependent on rain which ranges from 100-500 mm. Rainfall is very erratic (CV 35-60%) and not sufficient to replenish the levels of groundwater extracted during non-monsoonal times [1].

The study shows significant dependence on groundwater for various societal uses, and in future the dependence is going to increase only in view of expanding irrigation facilities, rapid urbanization, and impending climate change scenario [2]. Groundwater has played a significant role in increasing India's agricultural output. Groundwater supports 62% of India's total irrigated agricultural area and over 80% of rural and urban water supplies in 2009-2010. India uses the largest amount of groundwater *i.e.,* 24% of the global total [3]. India's rate of groundwater depletion increased by 23% between 2000 and 2010 [4]. Over exploitation of groundwater, particularly for irrigation, has resulted in substantial, widespread depletion of water tables and also increased the vulnerability of groundwater to pollution and increasing salinity and other forms of contamination [5]. The study shows per capita annual water availability has declined to 1,508 cubic meter in 2014 from 5,177 cubic meter in 1951. The per capita availability of water is estimated to decline further to 1,465 cubic meters by 2025 and 1,235 cubic meters by 2050 [6]. If it declines further to around 1,000-1,100 cubic meter, then India could be declared as water-stressed country. This paper attempts to assess long term changing groundwater resources scenario of western Rajasthan.

Study Area

The study has been conducted for arid western part of Rajasthan located between 22°30'-32°12' N latitude and 68°05'-75°45'E longitude covering total geographical area of 208176.34 km^2 [Fig-1]. Twelve western districts *i.e*. Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali, and Sikar are covered in the study area. Rainfall distribution is the region is highly uneven over space and time (CV 35-60%). The region receives low rainfall (<100 mm to 500 mm), has high evapotranspiration and high temperature regime. Groundwater is deep and often brackish. While the Rajasthan state overall average annual rainfall is 531 mm; it is 318 mm for the western parts of Rajasthan.

The western-central area is devoid of drainage system and surface water resources are meager. Due to low and erratic rainfall, replenishment of water resources is also very poor. The annual per capita availability of water in the state is 840 m^3 which is much below the threshold value of 1700 m^3 considered for water stress conditions. The per capita availability of water is further decreased to 680 m^3 for the western arid Rajasthan. Of the total water use about 85% of water is used for irrigation and remaining 15% is used for drinking, industrial and other purposes. With increasing demand for food and fodder to feed the ever-growing population, there will be more stress on the share of water available to the industries. While industrial growth is must for the overall development of economy, availability of water will be a serious challenge. Recent observation on climate change indicated likely alteration in the distribution and quality of natural resources particularly water.

Materials and Methods

In the present study, long term data on crops, irrigation, number of wells and tube wells, groundwater quality parameters were collected from various sources and detailed analysis have been done to assess changing scenario of groundwater status in western Rajasthan.

Fig-1 Western Rajasthan rainfall and drainage

Discussion

Wells and Tube wells

One of the root cause of groundwater depletion in western Rajasthan is availability of inexpensive motorized pumps and heavy subsidies for electricity and fuel. With flat rates for electricity, for example, the marginal cost of pumping additional water is effectively zero. As a result, farmers race to pump as much as they can before their neighbours get the last drop. In the study area, number of wells (dug well /bore well /tube well) has increased four times with an annual growth rate of 9.91% (123051 in 1971 to 610992 in 2015) in last four decades [Fig-2]. The wide spread increase in no. of wells and tube wells were supported by technological advancement in deep well drilling technology and availability of electricity in most parts of the arid zone of Rajasthan.

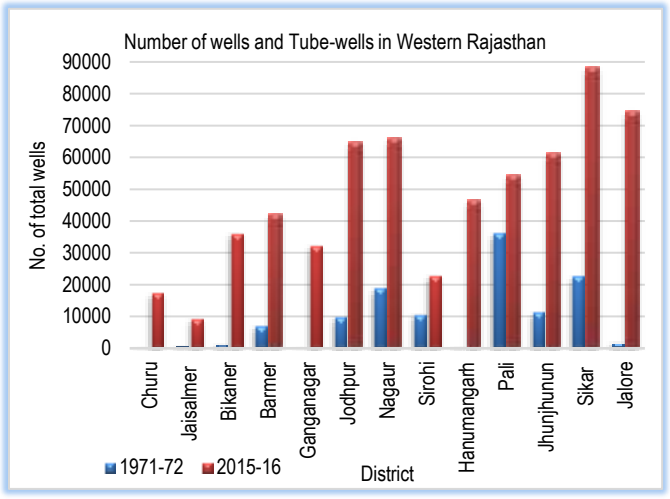

Fig-2 Districts-wise increase in no. of wells and tube wells.

Declining groundwater table

The increasing number of wells has exacerbated the over drafting of groundwater, which has resulted in decline in groundwater table prominently in nine districts namely Jodhpur, Jhunjhunu, Nagaur, Sikar, Bikaner, Churu, Jaisalmer, Jalore and Pali.

The rate of decline in the groundwater table is the highest (> 0.50 m y^{-1}) in Jalore and Pali followed by Jodhpur, Jhunjhunu, Nagaur and Sikar (0.44-0.48 m y^{-1}) districts. The rate of decline in the groundwater table is lowest (< 0.20 m y^{-1}) in Barmer, Churu and Jaisalmer districts owing to canal irrigation, and due to saline groundwater. Groundwater table is rising in Bikaner, Ganganagar and Hanumangarh districts due to canal (IGNP) irrigation [7].

Groundwater quality

One of the major aspects of groundwater use in western Rajasthan is its quality. Over-exploitation of the groundwater has not only depleted the reserve, but also has deteriorated quality. Groundwater extraction depends on quality of groundwater in different districts. [Fig-3] presents well/Tube wells density (No. per 1000 km^2) in ascending order for the western Rajasthan. The lowest well density is an indicator of poor quality of groundwater whereas highest well density indicate good quality water hence more groundwater extraction through increased wells. The canal command area of Bikaner, Ganganagar, and Hanumangarh are exception because of availability canal water for irrigation [8].

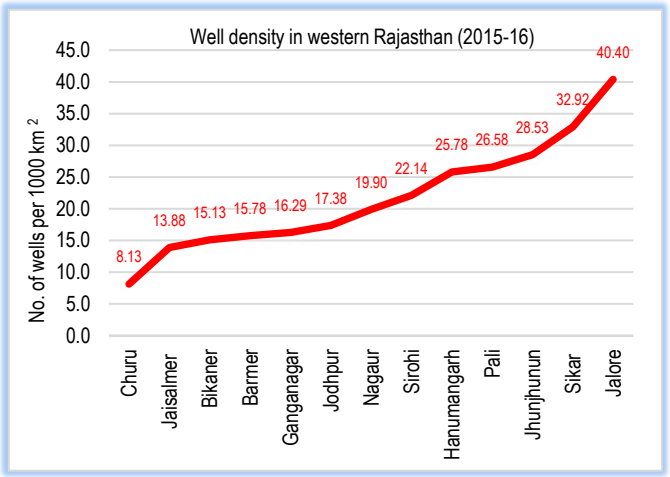

Fig-3 Well /Tube well density (No. per 1000 km^2 area) in western Rajasthan

The groundwater quality in western Rajasthan, in general, is poor as it contains high concentrations of fluoride, iron, arsenic, and nitrate in addition to water soluble salts. Groundwater in >80% areas is having EC >2.0 d Sm^{-1} and is moderately good for irrigation, whereas 40% area have EC > 4.0 d Sm^{-1}, which is not very suitable for irrigation. Some studies have indicated that about 95% areas in western Rajasthan contain fluoride in the groundwater beyond the permissible limit; and this fluoride is geogenic in nature [9].

Groundwater contamination

Quality of groundwater is also influenced by anthropogenic factors like excessive use of fertilizers and pesticides in agriculture, and improper disposal of municipal and industrial wastes. Agrochemicals carried along the runoff percolate down to the groundwater.

High concentration of nitrate (NO_3) in groundwater is caused due to excessive use of nitrogenous fertilizers, cattle wastes, wastewater disposal, pit latrines, *etc*. [10]. In western Rajasthan, particularly in the districts of Pali, Balotra and Jodhpur, textile mills are discharging untreated effluents to the tune of 22 million litres daily.

Cropping Area

Traditionally farmers in western Rajasthan grow rainfed crops like pearl millet, cluster bean, mung bean, moth bean, sesame since generations. However, with availability of tube-well and canal water, several new crops like cotton, groundnut, sugarcane, rice, wheat, castor, *etc*., were introduced without taking into consideration their high-water demand. During recent past decade (2007-08 to 2016-17) the area under irrigated crops like groundnut (191.2%), castor (14.6%), mustard (2.8) and wheat (26.4%) have increased at alarming rate in comparison to 2007-08 [Fig-4].

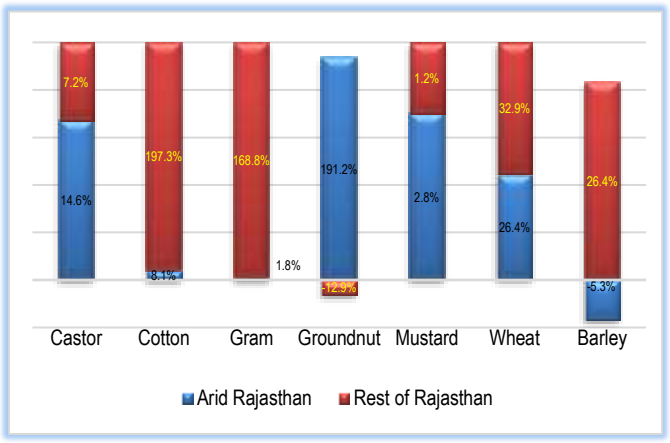

Fig-4 Percent change cropping in western vs. Rest of Rajasthan (2007-08 to 2016-17)

The rate is even higher in many crops in comparison to rest of Rajasthan [11]. Increase in irrigated area has severely impacted the groundwater level as well as quality.

Conclusion

The severe and ongoing depletion of groundwater levels in western Rajasthan poses a growing threat to the food security. Without serious efforts to stem the mining of groundwater, food production and other developmental activities will decline, unleashing painful social and economic consequences for this part of the state. Therefore, there is need for identification of potential hotspots for augmented/accelerated groundwater recharge at village level through remote sensing. Conjunctive use of poor-quality groundwater with rainwater to can greatly reduce draft on groundwater.

Application of research: Higher water use efficiency can be achieved by protected agriculture and rejuvenation of traditional water harvesting structures like village pond, tanka, nadi, *khadin etc.* can go in long way for reducing the pressure on groundwater resources.

Research Category: Groundwater Resources

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Study area / Sample Collection: Western Rajasthan

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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