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STATUS OF GROUND WATER RESOURCES IN HARYANA & ITS DYNAMICS AND SPATIAL PATTERN

Dr. P.K Sharma

Department of Geography, Himalayan University, Ita Nagar (Arunachal Pradesh)

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ABSTRACT:

Groundwater has emerged as a key resource input in India's agriculture and food security in recent years. Over the past three decades it has become the main factor of growth in irrigated areas. At present tube wells accounts for over 60 percent irrigated area in the country. Currently, in Haryana about 85 percent of total cultivated area is irrigated. The rapid expansion of groundwater use has been a major factor contributing to the increase in net irrigated area. The present study covers various aspects of groundwater irrigation in Haryana ranging from availability to accessibility of groundwater. It shall examine the dynamics of groundwater availability and utilization as well as the twin problems, waterlogging and groundwater depletion. The study also examines of groundwater quality for agricultural usages in different regimes of groundwater availability. Further the study provides insight about inequality in groundwater access across the regime as well as land holding size of farmers. Lastly the study evaluates the structure and role of groundwater markets in accessibility of groundwater resources in different groundwater availability regimes.

1. INTRODUCTION:

Groundwater extraction has increased dramatically in India since independence. Available statistics and projection indicate that there is a rapid growth in the area irrigated by groundwater, the number of wells, and number of energized pump sets. Depletion in groundwater resources on account of its reckless exploitation has been reported in several agriculturally developed regions of the country. According an assessment made in a NASA study, during 2002 to 2008 three agriculturally developed states (Punjab, Haryana and Rajasthan) together lost about 109 cubic km of water leading to a decline in water table to the extent of 0.33 m per annum.

Haryana is one of the agriculturally developed states in India. A large part of the state except the Shiwalik piedmont plain in north-eastern region has semi-arid climatic conditions. There are no perennial river running through the state. Moreover about two-thirds of the area is underlain by the aquifer having brackish water. Large parts of the state are underlain by alluvium except the southern and north-eastern regions which have consolidated hilly formations. Historically, the state of Haryana has been chronically deficit in water resources. Drought conditions are common in south and western parts in Mahendergarah, Rewari, Bhiwani, Hisar, and Sirsa districts. A large part of state has experienced rise in water table apart from challenge posed by waterlogging due to inadequate natural drainage in central region. The state has varied hydrogeological characteristics leading to regional difference in groundwater potential. Canal was dominant source of irrigation in the state in 1965-68 accounting for about 78 percent of irrigated area. But its relative contribution in irrigation declined with expansion of tubewell irrigation. The proportion of canal irrigated area in the state declined to 41 percent in 2012-15. On the other hand groundwater irrigation hasexpanded very fast in the state during last three decades. In 1965-68 the share of groundwater irrigation in total irrigated area was only 19 percent which increased to 59 percent in 2012-15. This shows the growing dependency of agriculture sector in Haryana on groundwater to meet the increasing demand of water for irrigation. The rapid expansion in tube-well irrigation has led to groundwater mining in many part of state. The present chapter portrays the dynamics of groundwater and its harnessing in the state and their link with groundwater depletion.

2. STUDY AREA:

The state of Haryana in India is located between 27º39' to 30º56'N latitude and 74º 27' to 77°36'E longitudes, covering an area of 44,212 sq. km. It occupies about 1.40 percent of the total area of the country (Fig. 1.1). At present, the state is divided into four commissionaires and 22 districts. The state has natural geographical boundaries of the Shiwalik hills in the north, the Yamuna River in the east and the Ghaggar River in the north. In the south Aravalli hills define the natural boundary which runs through southern Delhi and Gurgaon district. In the west of the state lies the Thar Desert of Rajasthan. The state is bounded by Uttar Pradesh and Delhi in the east, Punjab in the north, Himachal Pradesh in the northeast and Rajasthan in the south and west.

Haryana being located in the interior of Indian sub-continent is mostly warm and semi-arid climatic conditions. It is southwesterly monsoon winds that bring here over 75 percent of total annual rainfall from month of July to September. From October to the end of June next the weather remains almost dry excepting for few showers received from western disturbances. The average rainfall of the state is 560 mm which varies from less than 300 mm in south-western parts to over 1000 mm in the hilly tracks of northeast. The state is chronically deficit in water resources. Thus Haryana has subtropical continental monsoon climate having seasonal rhythm and great annual range of temperature. The distribution of soils in Haryana reflects complexity. A major part of the state is covered by loamy soils. These soils are also known as bangar soils and covers the northern and central part of the state. Silty loam soils (khaddar soil) are found along the course of Yamuna River. Clayey silts are known as bet, found along the courses of Ghaggar and Markanda seasonal streams. The extreme western part of the state is mostly covered by sandy to loamy sand soils. The sandy loam soils belt covers the western and southern districts. (Pandey et al. 2004)

3. AVAILABILITY OF GROUNDWATER RESOURCES IN HARYANA:

The groundwater availability in a region is largely determined by geophysical conditions like underlain geological layers, surface configurations and rainfall regime. Table 3.2 reveals that in 1995 in Haryana net availability of groundwater was 724.84 thousand ha-m which increased to 1029.67 thousand ha-m in 2013, recording an increase of about 42 percent. This may be largely due to change in rainfall regime and increasing intensity of canal irrigation. There is a significant variation in groundwateravailability across the state of Haryana. It is evident that very high growth in groundwater availability is recorded in Jind and Faridabad districts (more than 100 percent). On the other hand it has declined slightly in Karnal and Panipat districts. In 1995 least groundwater availability (13.94 thousand ha-m) was in Mahendergarh district and highest, 123.59 thousands ha-m, in Hisar district. In 2013 too Hisar district had highest availability of groundwater (133 thousand ha-m) and Mahendergarh (25.63 thousand ha-m) had least availability. The availability of groundwater was high in eastern and northeastern regions of the state comprising Kaithal, Yamunanagar and Karnal, Panipat, Sonipat and Ambala districts. Except two districts in southwestern Haryana, Mahendergarh and Rewari, all other districts have more than 30 thousand ha- m groundwater availability. In 2013 also similar pattern of spatial variation in absolute availability of groundwater resources was observed in the state.

Table 3.2 Haryana: District-wise Ground water Availability, Draft, Balance and Level of Development

Districts	Groundwater Availability ('000 ha m)		Growth in Groundwater Availability (Percent)	Annual Draft ('000 ha m)		Growth in Groundwater Draft (Percent)	Groundwater Balance ('000 ha m)		Level of Groundwater Development (percent)	
	1995	2013	1995-2013	1995	2013	1995-2013	1995	2013	1995	2013
Ambala	47	70.86	50.76	33.24	69.12	107.94	13.76	1.74	69	98
Bhiwani	40.74	62.12	52.48	14.76	105.14	612.32	25.98	-43.02	36	169
Faridabad	30.88	63.27	104.88	22.47	64.10	185.28	8.41	-0.84	73	101
Gurgaon	40.01	45.64	14.07	37.3	47.95	28.54	2.71	-2.31	93	105
Hissar	123.59	133.41	7.94	39.1	194.42	397.25	84.49	-61.02	32	146
Jind	34	102.18	200.52	26.05	115.14	341.98	7.95	-12.96	77	113
Kaithal	46.34	53.51	15.47	64.48	120.69	87.17	-18.14	-67.18	139	226
Karnal	74.89	71.95	-3.93	114.18	87.16	-23.66	-39.29	-15.22	152	121
Kurukshetra	26.49	51.70	95.17	53.84	145.12	169.53	-27.35	-93.42	203	281
Mahendergarh	13.94	25.63	83.86	23.31	22.16	-4.94	-9.37	3.47	167	86
Panipat	34.07	33.28	-2.32	49.57	54.24	9.42	-15.50	-20.96	145	163
Rewari	16.38	30.96	89.02	21.83	28.34	29.82	-5.45	2.62	133	92
Rohtak	53.41	90.26	68.99	19.5	68.68	252.21	33.91	21.58	36	76
Sirsa	48.52	63.68	31.24	20.55	111.60	443.07	27.97	-47.92	42	175
Sonipat	45.43	80.20	76.53	26.2	88.86	239.16	19.23	-8.67	58	111
Yamunanagar	49.16	51.04	3.82	42.6	68.86	61.65	6.56	-17.82	86	135
Haryana	724.84	1029.67	42.05	607.98	1391.57	128.88	116.86	-361.90	84	135

Table 3.3 show per ha availability of ground water in the state which increased from 0.16 ha-m in 1995 to 0.23 ha-m in 2013. In terms of spatial pattern, in 1995 net annual water availability ranged from 0.07 ha-m in Mahendergarh district to 0.29 ha-m in Karnal. Most parts of the eastern and northeastern region have availability more than the state average 0.16 ha-m.

On the other hand southwestern and western parts of the state had per ha availability far less than eastern and northeastern regions. In 2013 highest per ha availability of groundwater was recorded in Jind district, i.e. 0.37 ha-m and lowest (0.12 ha-m) in Bhiwani district. There is a rise in the groundwater availability in the state over the period of 16 year, 1995 to 2013. It is evident that availability of groundwater has increased all over the state but growth is particularly concentrated in eastern and northeastern parts of the state.

Table: 3.3 Haryana: District-wise per Hectare Ground water Availability, Draft and Balance

Districts	Net Groundwater Availability (ha-m)		Net Annual Draft (ha-m)		Groundwater Balance (ha-m)	
	1995	2013	1995	2013	1995	2013
Ambala	0.19	0.33	0.13	0.32	-0.12	0.01
Bhiwani	0.08	0.12	0.03	0.20	0.05	-0.08
Faridabad	0.14	0.30	0.1	0.30	0.04	0.00
Gurgaon	0.14	0.17	0.13	0.17	0.01	-0.01
Hisar	0.18	0.21	0.05	0.31	0.13	-0.10
Jind	0.12	0.37	0.09	0.42	0.03	-0.05
Kaithal	0.2	0.23	0.27	0.53	-0.07	-0.29
Karnal	0.29	0.29	0.45	0.35	-0.16	-0.06
Kurukshetra	0.17	0.31	0.35	0.86	-0.18	-0.56
Mahendergarh	0.07	0.13	0.12	0.11	-0.05	0.02
Panipat	0.26	0.27	0.39	0.43	-0.13	-0.17
Rewari	0.1	0.20	0.13	0.18	-0.03	0.02
Rohtak	0.14	0.26	0.05	0.19	0.09	0.06
Sirsa	0.11	0.15	0.02	0.26	0.09	-0.11
Sonipat	0.21	0.35	0.12	0.39	0.09	-0.04
Yamunanagar	0.27	0.29	0.24	0.39	0.03	-0.10
Haryana	0.16	0.23	0.13	0.31	0.03	-0.08

On the other hand it was less than state average in Moderate Groundwater Availability regime (MGAR) (24 percent).

4. STATUS OF GROUND WATER DEVELOPMENT:

Groundwater development refers to ratio between annual groundwater recharge and draft expressed in percentage. The degree of development of groundwater is categorized as safe (below 70 percent), semi-critical (70 to 90 percent), critical (90-100 percent) and overexploited (above 100 percent). It is evident from Table 3.2 that in 1995 the level of groundwater development in the state of Haryana was 84 percent. That meant that the state as a whole had pumped out 16 percent less water than the annual recharge. Still there was a significant spatial difference in level of groundwater development in the state which ranged from 32 percent in Hisar district to 203 percent in Kurukshetra district. On the other hand six districts of the state, Ambala, Bhiwani, Hisar, Rohtak, Sirsa and Sonipat, fell under safe

category. Remaining 24 percent area was under critical and semi-critical categories of groundwater development (Table 3.6).

But the scenario of groundwater development fully changed by 2013. The level of groundwater development in the state as a whole increased to 135 percent from 84 percent in 1995. This meant that 35 percent more water than the annualrecharge was being extracted in the state. It is evident from Table 3.6 that about 78.62 percent of area of the state experience overexploitation of groundwater. Ambala, Rohtak, Rewari and Mahendergarh districts were the exception in this regard but these districts also fell under semi-critical and critical category of groundwater exploitation. Table 3.6 reveals that in 1995 about 54 percent area in the state was safe in terms of groundwater harnessing. Groundwater development level in this category is less than 70 percent. But one and half decade later there existed no safe area in the state. Rather during this period the proportion of overexploited area jumped from 25 percent to 79 percent. It also reveals that there was widespread over exploitation of groundwater in the state.

Table: 3.6 Haryana: Percentage Area under Different Categories of Groundwater Development

Level of Groundwater	Percentage of total Geographical Area	
Development	1995	2013
Below 70 (Safe)	53.71	0.00
70-90 (Semi-Critical)	14.86	12.22
90-100(Critical)	6.25	9.16
Above 100(Overexploited)	25.16	78.62

5. SPATIO-TEMPORAL PATTERN OF GROUND WATER LEVEL:

Extraction of groundwater in excess of its replenishment is a serious problem that has led to significant declines in the groundwater table. There is a sharp decline of groundwater table in many parts of state. It is evident from Fig. 3.5 and Table 3.7 that during early 1990s a large part of the state comprising eastern, northeastern and central plain area had the depth of water table less than 10 m below the surface. It covered about 61 percent of geographical area of the state. On the other hand the depth to water table exceeded 20 m in extreme southwestern region covering parts of Bhiwani, Rewari and Mahendergarh districts and accounting for about 7 percent of geographical area. Another 8 percent area in the adjoining western parts had water depth 15-20 m below the surface. But the depth of the groundwater in the state changed drastically during next two decades. It is evident that water table fell down drastically in the Aravalli region of south and southwestern parts of the state. This was the result of overexploitation of limited groundwater aquifers in the region. The water table reached 10 to 20 m below surface in the groundwater rich aquifers in northeastern plain (Kurukshetra, Karnal, Kaithal and Jind districts) and Ghaggar basin in Panchkula, Fatehabad and Sirsa districts. In 2015 about 27 percent area in the state had water table deeper than 15 m below the surface. But in the central part of the state ground water table rose up sharply. A large part of central Haryana comprising the districts of Rohtak, Jhajjar and Sonipat and northeastern and eastern parts of Bhiwani and Hisar district had water table less than 5 m. Some areas in this zone experiencedwaterlogging conditions too. In all about 10 percent area in the state had water table less than 5 m deep. About one-third area had 5-10 m water table depth in the state.

Table 3.7 Haryana: Percentage of Area under Different Categories of Depth to Water

Water table depth (m)	Percentage of Area	
	1992-93	2015-16
5 and Less	0.12	9.82
5.1-10	61.00	33.26
10.1-15	23.59	29.43
15.1-20	8.21	13.87
Above 20	7.08	13.62

6. DYNAMICS OF CHANGE IN WATER LEVEL:

There are significant spatial and temporal dimensions of the behavior of water table in Haryana. It's evident from Table 3.8 that between 1992 and 2015 that there was only 5 percent geographical area in the state which did not experience long term change in the depth of water table. This area, in fact, acts as a transition zone between the areas that experience fall and rise in the water table in the state. It's evident thatabout 53 percent area in the state has experienced decline in water table level. About one-fourth area of the state has water table fall up to 5 m. But about 11 percent area experienced a very drastic fall in the water table, i.e. more than 10 m. Fig. 3.6 reveals that the water level showed significant decline in a number of districts, i.e. Kurukshetra, Kaithal and Karnal in northeastern plain, Gurgaon-Faridabad Aravallis in the south and Mahendergarh, parts of Bhiwani and Rewari districts in southwestern Aravalli region. Broadly the northeastern plains except Siwalik foot hill region and south and southwestern Aravalli zone in the state have experienced decline in water table. Table 3.8 further reveals that contrary to the declining trend slightly more than two-fifth area in the state has rather experienced rise in water table between 1992 and 2015. In fact, in about 5 percent area of the state rise of water table ranged 4-6 m.

Table 3.8 Haryana: Percentage Area under different Categories of Water Level Change1992-93 to 2015-16

Decline in Water Table Depth (m)	Percentage Area
5 and less	24.53
5.1-10	17.67
10.1-15	8.40
15.1-20	2.31
Above 20	0.18
No Change in Water Table Depth	5.39
Rise in Water Table Depth (m)	Percentage Area
2 and less	12.92
2.1-4	24.00
4.1-6	4.60

In another 24 percent area water table rose between 2 to 4 m. Fig. 3.6 shows that the belt of groundwater table rise extended from Rortak-Jhajjar-Sonipat region in the east to Sirsa district in the west through northeastern part of Bhiwani district, Hisar and Fatehabad districts. Some areas in this belt in Sonipat, Rohtak, Hisar and Bhiwani districts face the twin problem of waterlogging and soil salinity. This belt of rising water table splits the area experiencing groundwater depletion into two non-contiguous zones. Shiwalik piedmont zone in Yamunanagar district has also experienced upward move in groundwater table.

7. CONCLUSION:

Groundwater irrigation has played very significant role in agricultural development in Haryana. But it has led to overexploitation of groundwater resources at a very large scale. This is despite the fact that over the period 1995 to 2013 the groundwater availability in the state increased by 35 percent. Alluvial plain in the state particularly in northeastern part is rich in terms of groundwater endowment. However, Aravalli region in south and southwestern region has had poor availability of groundwater. Interestingly, over the two decades since mid-1990s gross draft of water has increased at a faster rate in low tubewell intensity area in western Haryana. The intensity of groundwater draft is already very high in intensively tubewell irrigated area in northeastern plain. There is a widespread overexploitation of groundwater in the state as in about 86 percent of its area water draft exceeds the annual recharge. Persistent overexploitation of groundwater resources has culminated in depletion of this precious resource in a large part of the state. About 53 percent area of the state has experienced decline in water table. On the other hand in about two-fifth area of the state, particularly in the belt running from Rohtak-Bahadurgarh-Gohana area to Hisar and Sirsa, water table has come up resulting in twin environmental problem of water logging and soil salinity. The rise in the water table in the mid belt may be attributed to poor horizontal and vertical drainage, intensive canal irrigation and inability of the farmers to go for conjunctive irrigation due to saline and poor quality of groundwater. There are various factors responsible for rapid decline in groundwater table in different parts of state. The crop combination of two water intensive crops, wheat and rice in northeastern and eastern plain has led to large scale extraction of groundwater for irrigation and consequent depletion of groundwater resources. The drastic fall in the water table in Aravalli region in southwestern and south Haryana, however, may be attributed to intensive tubewell irrigation in the dry area to exploit shallow aquifers. Continuing ecological degradation and damage to aquifer caused by widespread mining and extraction of construction material are other factors aiding in groundwater crisis in the region.

REFERENCES:

[1]. Kumar J and Jaglan MS (2018). Dynamics and spatial pattern of groundwater depletion in Haryana. Indian Groundwater, 10: 76-92.
[2]. Kumar J and Jaglan MS (2016). Suitability of groundwater for drinking purpose in Bhiwani district Haryana: A spatio temporal analysis. Punjab Geographer, 12: 1-20.
[3]. Mukherjee S and Biswas D (2016). An enquiry into equity impact of groundwater markets in the context of subsidized energy pricing: a case study. Indian Institute Management Kozhikode Society & Management Review, 5(1) 63–73.
[4]. Ahamed AJ, Ananthakrishnan S, Loganathan K, and Manikandan K (2013). Assessment of groundwater quality for irrigation use in Alathur Block, Perambalur District, Tamilnadu, South India. Applied Water Science, 3:763–771
[5]. Kaur S and Vatta K (2015). Groundwater depletion in Central Punjab: pattern, access and adaptations. Current Science, 108(4): 485-490
[6]. Government of Haryana (2015). Statistical Abstract of Haryana, Department of economic and statistical analysis, Haryana.
[7]. Central Ground Water Board (CGWB) (2015-16). Groundwater Year Book of Haryana State. Central Groundwater Board, North Western Region, Chandigarh.

[8]. Nagaraju A, Sunil KK and Thejaswi A (2014). Assessment of groundwater quality for irrigation: a case study from Bandalamottu lead mining area, Guntur District, Andhra Pradesh, South India, Applied Water Science, 4:385–396.

[9]. Kshetrimayum KS and Bajpai VN (2012). Assessment of Groundwater Quality for Irrigation Use and Evolution of HydrochemicalFacies in the Markanda River Basin, Northwestern India. Journal Geological Society of India, 79: 189-198.

[10]. Sarkar A and Das A (2014). Groundwater Irrigation-Electricity-Crop Diversification Nexus in Punjab Trends, Turning Points, and Policy Initiatives. Economic and Political Weekly, 52: 64-73.

[11]. Sarkar A (2012). Sustaining livelihoods in face of groundwater depletion: a case study of Punjab, India. Environment, Development and Sustainability, 14: 183-195.

[12]. Gandhi VP and Bhamoriya V (2011). Groundwater Irrigation in India Growth, Challenges, and Risks. India Infrastructure Report, 90-117.

[13]. Sethi GK, Chaudhary BS, Goyal SK and Thakur PK (2012). Suitability analysis of groundwater quality for domestic and irrigation usage in Yamunanagar district, India: A GIS Approach. Journal of Indian Society Remote Sensing, 1: 155–165.

[14]. Ravikumar P, Somashekar RK and Angami M (2011). Hydrochemistry and evaluation of groundwater suitability for irrigation and drinking purposes in the Markandeya River basin, Belgaum District, Karnataka State, India. Environmental Monitoring Assessment, 173: 459-487.

[15]. Singh DK, and Singh AK (2010). Groundwater Situation in India: Problems and Perspective. International Journal of Water Resources Development, 563-580.