12 Groundwater Sustainability in Haryana: Challenges to Governance

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Abstract

In the alluvial heartlands of the Green Revolution, tube well technology played a significant role in the development of agriculture. Agriculture and particularly irrigation systems in this part of the country strongly depend on groundwater resources. Due to appropriateness of this technology, Haryana state is moving into crisis zone where the groundwater development has reached 133%. Pressure on groundwater resource has become linked to a few major developments in the cropping system. This change in the cropping pattern and certain governmental policies has negative effects on groundwater resources. Resultantly, Haryana has reached a stage where even their current level of groundwater extraction exceeding recharge and is therefore unsustainable. This research inquires the evolution, trends, present state of groundwater development, management, and governance. Some indicators like groundwater level and groundwater quality have been adopted to measure groundwater sustainability. This chapter argues that small landholdings, intensive agricultural and government policies are the main causative factors of groundwater exploitation in Haryana.

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Keywords

Governmentality · Groundwater · Haryana · Sustainability

12.1 Introduction

India's development has become strongly dependent on its groundwater resources. The rise in absolute and per capita water demands that is linked to population growth and changing consumption patterns is increasingly met from groundwater sources. The agricultural sector and the industrial both thrive from free access to water from wells. Governing the groundwater is simultaneously a growing challenge in large parts of the country, where the water table is steadily sinking. Overexploitation and quality deterioration are deterred by different policy and reform choices at federal, state, and local levels. The widening availability and demand gap is often held to be a governance problem, commonly interpreted as due to misguided policies, unenforceable legislation, inefficient bureaucracy, institutional fragmentation, low capacity, outdated knowledge, poor accountability, corruption, "vote-bank" politics, lack of stakeholder involvement, and so on. Quality deterioration suffers from partly the same conditions. The pressure on available groundwater resources in India necessitates sound, scientifically based reg-

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ulations to prescribe behavior relating to use and abuse. The situation with groundwater use is well described in several recent publications, such as Deep Wells and Prudence (World Bank 2010) and Taming the Anarchy (Shah 2009a, b).

In 2016, India had more than 19 million tube wells, compared to less than a million in 1960. This technological revolution has played an important role in the country's efforts to combat poverty, but the ensuing development of irrigation has, in turn, resulted in significant water stress in some regions of the country. Studies point to the large variation in future groundwater levels across India. Under future climate change, notably, some districts will do better and may even be able to rely solely on sustainable water supplies allowing groundwater levels to recover. Others will see slower rates of groundwater decline and yet others will experience declines for the first time. But most of Punjab and Haryana, northern areas of Rajasthan and Gujarat, and parts of Uttar Pradesh and Tamil Nadu will face a continued decline in groundwater level. As the levels become deeper, rising pumping costs can make extraction prohibitive and directly impact welfare.

It has been established that a large part of the Haryana plains constitutes a widely spaced topographic depression between the Shiwalik hills and the Aravalli hills which have created the typical internal drainage conditions. Resultantly, there is a falling groundwater table zone in eastern and southern parts (Yamunanagar, Karnal, Panipat, Sonepat (part), Faridabad, and Gurugram districts) of the state there is a rising water table zone, leading to soil salinization and degradation, in the central and western parts (Rohtak, Jhajjar, Jind, Bhiwani, Hisar, Sirsa, and part of Sonepat districts). The state can thus be broadly divided into two distinct zones: the rising water table zone (52% of the state) and the falling water table zone (eastern and southern parts) (Jeet 2001, 2005).

Haryana, from being a food deficit state in 1966 at the time of its inception, has now emerged as a major contributor to the national pool of food grains. Agriculture accounts for 31% of the state GDP and, along with Punjab, Haryana led India's Green Revolution. Grain yields are some 30–40% above the national average and with just 1.4% of India's area, this small state provides 30% of the national procurement of wheat and 10% of its rice (Hellegers 2007). Development of water for irrigation can be cited as one of the major contributors to Haryana's agricultural success. The Western Yamuna Canal (WYC) with a majority of its command area falling in Haryana and liberal use of groundwater can be the most significant influence on the agricultural turnaround in the state of Haryana. The state has total availability of surface and groundwater is 13.43 MAF against the requirement of about 32MAF at present of water. The Yamuna, Sutlej, Ravi-Beas, and Ghaggar rivers have water availability of 9.24 MAF. The available 4.21 MAF groundwater is used in irrigation through 607,098 tube wells.

However, this success resulted in second-generation problems, such as declining resource base, hydrological imbalance, decline in underground and above ground biodiversity, and pollution of soil, water, and environment. Also, there had been a gradual decline in water table in areas having good quality groundwater due to cultivation of high-water requiring crops like rice and sugarcane. On the other hand, inland basin with underground brackish water, introduction of canal irrigation with poor on-farm water management, in the absence of effective drainage, has resulted in the rise of water table and soil degradation (salinization, solidification, and waterlogging). In the southwestern region, having poor-quality groundwater and low rainfall, drastic decline in water table has taken place due to dominance of sprinkler system of irrigation.

This scenario of groundwater use and development in the state is indicating an unchallenged threat to groundwater sustainability. It is defined as "the maintenance and protection of groundwater and related ecosystems to balance current and future environmental, economic and human

Box 12.1 Sustainable Development Goals

Acknowledging the synergy and trade-offs between groundwater and sustainable development is paramount to successfully implementing the United Nations SDGs. The author through his research displays both the geophysical characteristics and significance of groundwater as well as its impact on human development broadly in the state of Haryana, India. In his understanding, groundwater here has untapped potentials which includes climate change adaptation, hydrological resilience, hydrogeological storage of carbon emission, and access to renewable energy, among others. However, as Haryana continues to use groundwater for domestic use, enabling food production and sustaining critical ecosystem's function, as it relates to various aspects of human development including poverty eradication, human dignity and wellbeing, sustainable groundwater use, and development of policies face a paradoxical challenge. In Haryana, this challenge has reached a stage wherein the current level of groundwater extraction exceeds recharge and is therefore unsustainable. As this chapter recognizes, groundwater is a key resource for the achievement of SDGs but is unfortunately weakly conceptualized in the sustainable development goals, targets, and indicators. There is tremendous potential for revising, revisiting, and redefining SDG targets 6.3, 6.4, and 6.6. Meanwhile, the planning wing of the Government of India—*Niti Aayog* has developed a "composite water management index" (CWMI) as a useful tool to assess and further improve the performance in the efficient management of groundwater resources. Together, between the CWMI and the SDGs there is tremendous potential for a dent in understanding and articulating the narrative around the meaning and value of sustainable groundwater use and management with an evolving framework of governance taking into consideration the interrelationship between various sectors, and what it will take to achieve them.

(social) requirements" (Gordon Report 2011). Once the groundwater sustainability issues have been identified, the indicators that best allow the assessment and monitoring of the issue should be selected and developed. Indicators help describe relevant information on *trends in groundwater systems* in a clear and simplified way. Without indicators, it would be difficult to organize and present the information in an accessible manner. The criteria needed to develop and design groundwater sustainability indicators need to be sensitive, scientifically robust, measurable, and representative. Indicators need to be created from available or obtainable information, be consistent and reproducible. Ideally, groundwater indicators should be reliable and appropriate at different scales, plus comparable between different hydrogeological regimes (Li 2013). Strong consideration should be given to selecting already established indicators from internationally recognized organizations. In the present study, indicators recommended by UNESCO (2007), namely, *quantity, quality, ecosystem, socioeconomic, and governance* are adopted to evaluate the sustainability in the state. However, established indicators from recognized organizations can be used as a starting point and as references, but the most useful indicators are often those designed and customized based on local issues and the historical indicators used in the study area.

12.2 Trends in Groundwater Sustainability

12.2.1 Groundwater Availability

Availability of surface water in the state is not sufficient to cater to the demand of water for irrigation and other uses. Over the past decades, the state has witnessed extensive development of groundwater through tube well irrigation. The number of tube wells in the state has increased from less than 40,000 in 1960 to 6.97 lacs (0.697 million) during the year 2011. Resultantly, there is unabated exploitation of groundwater. The unplanned and unchecked growth of groundwater uses has resulted in depleting groundwater and the state is quite concerned about the issue. The climate change scenario is likely to further increase the unabated usage of groundwater. Haryana has among the highest rates of groundwater extraction in the country. Based on information published in India's annual groundwater report, and by comparing the data in the 2009 report to the 2014 report, one can see the net level of groundwater availability has declined. A satellite-based study from NASA observed that, over the Indian states of Rajasthan, Punjab, and Haryana, groundwater is being depleted at a mean rate of 4.0 ± 1.0 cm/year equivalent height of water (i.e., 17.7 ± 4.5 km^3) between August 2002 and October 2008. During this period, groundwater depletion was equivalent to a net loss of 109 km^3 of water, which is double the capacity of India's largest surface water reservoir (Rodell et al. 2009). Mall et al. (2006) further suggest that changes in the cropping pattern and land use pattern, overexploitation of water storage, and changes in irrigation and drainage in the Gangetic basin show a reduction in the Ganges discharge by 60% over 25 years. This has led to about 50% drop in water availability in surface water resources (Adel 2002).

In February 2016, Haryana was reported to be the first state to complete the mapping of underground aquifers. Haryana was among the eight States for scientific mapping in the first phase. The State Agriculture Department in July 2016 claimed that 18 districts out of 21 had witnessed an alarming decline in the water level in the state since June 1974. There was a total of 71 overexploited blocks across the state where groundwater had been exploited above 100%, while 15 blocks were listed in critical category and 7 blocks were in semi-critical category.

The annual replenishable groundwater resource of the state has been estimated as 10.78 billion cubic meter (bcm) and net annual groundwater availability is 9.79 bcm. The annual groundwater draft is 13.05 bcm and the stage of groundwater development is 133%. Out of the total 116 assessed blocks taken for study, 71 blocks (61%) are overexploited, 15 blocks (13%) are critical, 07 blocks (6%) are semi-critical, and 23 blocks (20%) are in safe category. The analysis of present groundwater resource assessment indicates that there is a marginal decrease in net availability of groundwater resources as compared to the previous assessment carried out for the period 2004–2008. The groundwater draft has increased by about 5%. It has been observed that nine blocks have shown change to higher category owing to increased groundwater draft for irrigation and other uses.

12.2.2 Quality

Continued decline in the groundwater table accompanied by signs of declining quality is the single most important factor contributing to unsustainability. Several contributing factors are recognized. Excessive withdrawal over annual recharge is obviously the main issue. Most of the area receives a mean annual rainfall of about 600–700 mm. Puddling soils using tractor power prior to transplanting rice is an important energy intensive agronomic practice aimed at reducing infiltration to help maintain water on soil surface which is considered important for obtaining high rice yields.

As per Natural Resource Management Working Group Report (NRM Report 2015), there has been deterioration in the groundwater quality due to overexploitation of groundwater, and, consequently, mixing of brackish water from adjoining/deeper aquifers. Deterioration in the physical properties, as well as decline in water table and quality due to overexploitation of groundwater with a tendency to extend rice planting increasingly to rainless months, is the principal factor in this rice-wheat system zone. There are raving concerns over water-level declines, in several districts in Haryana, coupled with multiple contaminants occurring above their MPLs that challenges safe and sustainable drinking water supply. Out of a total of 119 blocks in the state, elevated fluoride and nitrate have been reported from groundwater from 53 and 63 blocks, respectively.

According to a report by the Central Groundwater Board (CGWB) 2013, groundwater in most of the area in 11 districts of southern and western Haryana is unfit for consumption. The reason for this is salinity or high concentration of nitrate or fluoride. According to the CGWB report, the worst hit districts are Bhiwani, Fatehabad, Jhajjar, Mewat, and Sirsa. As many as 70% of samples, drawn from wells and hand pumps, in these districts, failed the test as chemical parameters were higher than permissible limits. In five other districts, Faridabad, Gurugram, Hisar, Mahendergarh, and Rewari, 30–50% of water has potable quality as per the Bureau of Indian Standards (BIS) 2012. The report was finalized in September 2016 for the years 2015–2016 and is based on BIS 2012 norms. Parameters to evaluate suitability of drinking water were salinity, nitrate, sulfate, fluoride, hardness, and alkalinity.

According to CGWB report findings, groundwater in these districts is not only unsuitable for drinking but also for irrigation. Prepared by the north-western region of CGWB, the report has stated that Ambala, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Panchkula, Rohtak, Sonepat, and Yamunanagar have more than 50% water fit for human use. The salinity of water is checked through its electric conductivity, where low conduction (measured in microsiemen per centimeter or S/cm) shows low salinity. The Report said low salinity (<750 S/cm) was found mostly in Ambala, Gurugram, Panchkula, Panipat, Karnal, Kaithal, Kurukshetra, Sonepat, and Yamunanagar districts, water with intermediate salinity (750–3000 S/cm) was found mostly in all districts and samples with high (>3000 S/cm) salinity were found scattered in Bhiwani, Faridabad, Gurugram, Hisar, Jhajjar, Kaithal, Mahendergarh, Mewat, Palwal, Rewari, Rohtak, Sirsa, and Sonepat districts.

Declining quality of groundwater is a related and important aspect. Two main contributing factors are seen. First, the region is among the highest per ha use of chemical fertilizers. With most studies showing that efficiency of fertilizer uses rarely exceeding 40–45%, a significant fraction of applied fertilizers is likely to join water bodies including groundwater. Second, with declining water table in the region, there are fears that subsurface flows from adjoining high salinity groundwater in some areas are already causing water quality decline.

Similarly, there are about 8804 medium and large industrial units working in Haryana, bulk of them are concentrated in six cities, namely, Ambala, Yamunanagar, Panipat, Sonepat, Gurugram, and Faridabad. The major industries in Ambala are metal (127) and food processing (46). It is observed that the groundwater occurring at shallow depths is alkaline and is of $NaHCO_3$ type. Some of the well waters have been found with high NO_3 due to contamination with domestic sewage. Thermal power plant, Sugar mill, National fertilizer, and Panipat Oil refinery are some important units located in and around Panipat City. There are more than 175 handloom and textile units that use large amounts of chemicals for processing and dyeing of the textile. The groundwater in most parts of the nearby area has been polluted due to discharge of effluent either in ponds or cesspools or in the *Ganda nala* flowing through the city. Gurugram has several mechanical, electrical, textile, electroplating, and chemical industries. The waste generated by these units is dumped untreated either on land or into the city sewage drains. Faridabad and Ballabgarh are major industrial towns and there are about 1500 registered factories housed in these towns, some of which generate hazardous wastes. The waste from industries engaged in electroplating works, manufacture of textile, fertilizer, plastic, etc., are normally rich in toxic trace metals. Besides, industrial effluent, discharge of untreated sewage in the roadside unlined channels may pollute the groundwater due to seepage. Soils in the nearby areas have deteriorated, turned acidic, due to continuous release of spent wash on the soil during irrigation and mud in the fields by sugar mills with attached distilleries at Yamunanagar, Panipat, and Rohtak. Though waste from hospital and nursing homes are required to be collected separately, in most cities and towns in the state, such waste, form a part of municipal solid waste. The waste is normally dumped in the low-lying areas for natural decomposition. During rainy season, the waste emits foul smell and becomes a potential breeding ground for flies, mosquitoes, and other insects.

12.2.3 Socioeconomic Aspect

Depleting groundwater resources not only disrupt ecological balance but also put heavy financial burden on farmers and give rise to socioeconomic inequality in its distribution. For Haryana, water is the key issue for sustainable growth of agriculture. The General Circulation models predicted that the Indian Subcontinent will be warmer by about 1.5 °C during the middle of the current century. It is also the fact that each

1 °C rise in temperature will increase the demand for irrigation water by 2–3% to sustain production at the current level, and the competing demands of freshwater for drinking and industrial purposes will further reduce the availability of freshwater supplies for agriculture in the state. It implies that agriculture will be the major user of poor-quality waters; hence, unproductive loss of water through evaporation and other processes must be reduced to sustain food production. The productive and economic efficiency of water and other inputs are interlinked and could be increased by maintaining proper soil health, resource conservation and augmentation, selection of location-specific water management technology, and crop diversification as well as by shifting the focus from purely crop commodity approach to integrated farming system approach to help the resource-poor farmers of the state. Thus, the complex and interlinked issues concerning land use, soil and water resources, biodiversity, climate change, and environment need to be critically addressed in a holistic way for their critical monitoring, conservation, augmentation, and utilization for sustainable progress of agriculture in the state.

12.2.4 Irrigation

Irrigation in the region has largely involved conjunctive use of water (i.e., a combination of surface and groundwater). However, with an increasing variability, lower controls on groundwater extraction, subsidies in electricity needed for pumping groundwater, and improvements in groundwater extraction technologies, the trend is a significant increase in groundwater for crop production in Haryana. Around 2009, groundwater served 60% or more of irrigated lands (Shah 2009a, b). A study reposted by Erenstein (2009) estimates the water productivity indicator for paddy and wheat in the region. The Report indicates that, on average, farmers irrigated wheat 3.4 times, while they irrigated paddy 34.5 times. Estimated irrigation volumes for paddy are also a multiple of those for wheat: a factor of 8.4 in Haryana. Physical productivity markers (crop yield per volume of physical inputs) for paddy are therefore markedly lower than those for wheat, reflecting significantly higher water inputs in paddy cultivation with relatively similar yields (Table 12.1). Compared to wheat, financial water productivity is also lower for paddy in each site, as the higher net revenues for paddy are offset by the higher water inputs. Estimated physical water productivity indicators for wheat are about 1.5 kg/m^3 and about 0.2 kg/m^3.

Further, the latest published groundwater report (Government of India 2014) provides data on annual groundwater at the state level—as shown in the synthesis in Table 12.2. Total replenishable groundwater provides the overall level of inflow or recharge of groundwater. Total annual groundwater draft is the total level of extraction for different uses, primarily irrigation and domestic/industrial uses. The difference between these two gives the level of availability and, in the case of Haryana, this is a negative amount for the latest reported data in 2009. With a 127% overall groundwater development, Haryana is at the third highest level of groundwater development in a country that ranks highest in the world for groundwater use for irrigation.

In Haryana State, the number of tube wells have increased linearly since the mid-1960s (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

Table 12.1 Selected Crops and Irrigation Information for Haryana

	Paddy	Wheat	Sugarcane
Irrigation costs (INR/ha)	6820.18	4066.90	2680.43
Derived yield (quintal/ha)	44.14	50.78	654.52
Water productivity indicator (kg/m^3)	0.2		1.5
Area under principal crops (2007)	1041	2365	140

Source: IISD Analysis

Table 12.2 Annual Groundwater Status and Stage of Development for Selected States (billion cubic meter)

State	Annual replenishable groundwater resources			Natural discharge (non-monsoon)	Net annual groundwater availability	Irrigation	Domestic and industrial use	Total	Projected demands upto 2025	Groundwater availability for future irrigation use	Stage of groundwater development (%)
	Monsoon	Non-monsoon	Total								
Punjab	16.43	6.12	22.55	2.21	20.35	33.97	0.69	34.66	0.95	−14.5	170
Rajasthan	9.43	2.43	11.86	1.07	10.79	12.86	1.65	14.52	1.84	0.75	135
Haryana	6.22	4.26	20.48	0.68	9.80	11.71	0.72	12.43	0.79	−2.70	127

Source: Central Ground Water Board (2014a, b) which consequently decline water table (Foster and Rosenzweig 2005). Irrigation through groundwater uses high-capacity electric or diesel pump sets. In the case of electric agricultural pump (AP) sets, the electricity tariff applicable falls under two categories: AP metered consumers billed on an energy-consumption basis and AP unmetered consumers who are currently paying a flat rate based on pump rating per month. These categories are used to determine the quantum of subsidies to be set aside each year.

Haryana Electricity Regulatory Commission in its annual Tariff Order based on Annual Revenue Requirement filings by the state's distribution utilities. AP users must pay only a small fraction of the actual tariff, with the result that, each year, subsidies run into thousands of crores (1 crore = 10 million) for the agriculture sector. It must be noted here that the entire revenue gap in the AP consumer category is bridged by way of the AP subsidy from the state government, and no consumer category is cross subsidizing the AP consumers. However, the subsidy from the state government is not always reimbursed, which has invariably resulted in state DISCOMs operating in a state of perpetual loss and poor financial health. With such substantial levels of subsidies being afforded to farmers, the number of electric pump sets has risen steadily over the years in Haryana, as shown in Table 12.3. As per the latest figures, the total number stands at 772,310 pump sets with 556,664 (72%) being electric. A direct consequence of this surge in electric pumps has been mounting financial burden on the state's DISCOMs due to excessive use of electricity, nonpayment of bills, and drastic reductions in groundwater levels across the state.

Another interesting observation was the district-level distribution of pump sets, which perhaps could indicate the energy intensity of crops being sown. Sugarcane and paddy are water-intensive crops, and, hence, require more pumps per hectare than wheat, as can be seen from Table 12.4. The high density of pumps in their respective districts is indicative of this fact and represents the trend of opting for groundwater for irrigation due to very low electricity tariffs. This has been the major reason for the depletion of groundwater resources in these districts.

Over the last two and a half decades a shift has been observed in the cropping pattern for irrigated crops in Haryana. The area devoted to wheat cultivation has increased by more than 150%, and the area used for the cultivation of

Table 12.3 Agriculture Pump Sets in Haryana

Year	1970–1971	1980–1981	1990–1991	2000–2001	2010–2011
Diesel Pump sets	17,903	109,353	155,842	255,302	231,146
Electric Pump sets	86,455	222,674	341,729	334,171	492,311
Total	104,358	204,736	497,571	589,473	723,457

Source: Department of Agriculture and Statistical Analysis, Haryana (2012, 2013, 2014, 2015)

Table 12.4 District-Level Distribution of Pump Sets in Haryana

Crop	District	Types of pumps			Pump density (per 1000 ha)
		Diesel	Electric	Total	
Paddy	Karnal	184	43,416	43,600	382
	Kaithal	18,935	44,203	63,138	380
	Kurukshetra	8915	67,627	76,542	276
Wheat	Sirsa	19,062	39,147	58,209	688
	Hisar	19,556	11,416	30,972	566
	Fatehabad	8750	31,163	39,913	415
Sugarcane	Yamunanagar	5802	26,782	32,584	204
	Ambala	4873	22,919	27,792	189

Source: Department of Agriculture, Haryana (2014) paddy, a highly water-intensive crop, has increased threefold (Gangwar and van den Toor 1987). After remunerative price policies for paddy rice were initiated in the late 1970s, the area devoted to rice cultivation expanded, resulting in the exploitation of groundwater resources. Subsidies for the use of electricity in the rural sector and the lack of regulatory measures for the use of groundwater only exacerbated the exploitation and encouraged inefficient use of groundwater. As a result, the water table declined rapidly, especially in the semiarid region.

The study shows that there is an immense increase in groundwater draft since 1974, causing enormous burden on groundwater reservoir in the study area. Private-owned shallow tube wells have increased many folds during the last three decades, which are extracting huge quantity of groundwater in an injudicious and unplanned manner. It is observed that majority of districts have experienced more than 90% increase in groundwater development in this span of time. Therefore, according to Groundwater Estimation Committee (1997), these districts are overexploited and need thorough managerial attention from government agencies. Furthermore, these districts require exhaustive monitoring and evaluation for future groundwater development.

As far as countermeasures and possible means of controlling the groundwater economies of these regions are concerned, it is emphasized that current experiences derive from the development of groundwater and not from direct and proactive formal and institutionalized control of the resource users. The stakes are high and contradictory goals are at hand, one of maximizing poverty alleviation using groundwater and the other, the concern for sustainability of the endeavor. The impending and increasing dilemma as the resource gets scarcer in many areas is how to secure access to the resource of the poorest and generally deprived farmers. In water-rich, but poor regions a still unclear strategy needs to be formulated of how to better increase access to energy, as well as other basic inputs and requirements for production increases, for the millions of small-scale farmers with inadequate livelihood opportunities to escape poverty.

12.3 Need of Governance

Groundwater governance is a major concern in India, particularly in Haryana where irrigated agriculture heavily depends upon groundwater. The groundwater crisis in the country was ignored until recently because governments were under pressure to produce more food for the growing population and groundwater generated prosperity. Groundwater exploitation was, in any case, mainly privately financed. Government is only now beginning to develop a management policy to control groundwater issues.

Groundwater has become a major contributor to GDP in the state. It is the foundation on which agriculture, urban development, rural jobs, and safe drinking water supply systems depend. Indeed, access to groundwater through private tube wells was a key factor in the Green Revolution in this part of the country. This explosion of groundwater use has occurred in a largely unplanned and uncontrolled way, taking place almost unnoticed in many parts. Consequently, in many places, the unplanned and massive use of groundwater has resulted in serious and growing problems of depletion and quality deterioration. Because of its local availability and generally good quality, limiting treatment costs, groundwater is often cheap compared to alternative sources of supply. When nearing depletion, supply from groundwater will have to be replaced by more expensive alternatives, claiming valuable economic resources that are not available for other investments. Increased water costs will translate in higher water bills, impacting the urban poor and middle classes most, or in higher fiscal cost.

The exploitation of fresh groundwater resources provided an opportunity for farmers to supplement their irrigation requirements and cope with the vagaries of the surface supplies thus increasing accessibility and reliability of water, while increasing crop production. However, due to uncontrolled and unregulated use of groundwater, the problems of over-draft of the aquifer and saline water intrusion have emerged in many areas of the Indus Basin (Kijne 1999). In Haryana, more groundwater is being pumped out than is being recharged leading to declining water table in many areas (Meinzen Dick et al. 1997). The increasing water table depth and high diesel cost is making groundwater use quite uneconomical. Likewise, salinization associated with the use of poor-quality groundwater for irrigation has further compounded the problem(Foster and Chilton, 2003). Therefore, salt-affected soils are becoming an important ecological entity in the study area. Generally, the major reason for emerging groundwater problems is that the management of groundwater resources could not keep pace with its development. The major issues pertaining to groundwater governance in Haryana are high population density, exceedingly large number of groundwater users, low levels of resource management capacity, high share of agriculture in GDP, and dependence of rural livelihoods on tube well irrigation, poor institutional arrangements, and lack of information on groundwater use.

Governance is understood as the operation of rules, instruments, and organizations that can align stakeholder behavior and actual outcomes with policy objectives (Marcus et al. 2012). Essentially, there has been a surge in the uncontrolled private exploitation of resource, and governance frameworks have been ill-adapted to control it. The result has been depletion and quality deterioration and, in some cases, the misallocation of the resource to uses on which society places a lower value. Governance today has to take account of the reality that in many locations "the cat is out of the bag." Once groundwater rights also have been asserted ahead of any governance systems that might have contained them, it is incredibly difficult to recover control. This is especially true in countries, where all the incentives are in favor of development and abstraction, particularly where agricultural policy coincides with farmers' own motives to produce evermore. These external incentives are compounded by the powerful incentives inherent in the resource itself that lead farmers to prefer groundwater to all other water sources.

Governance frameworks have proved very frail in the past to resist such powerful motives. Traditional and local governance developed to manage springs or oasis have rarely been able to adapt to the new tube well technology. Very few governments have been able to align agricultural policy with good water resource management, and even fewer have been able to recover control over groundwater once that control has been lost.

This chapter provides an overview of established practices as well as recent trends in groundwater legislation. It discusses key challenges that legislation must address to manage and protect groundwater and to effectively counter the unsettling effects of groundwater depletion and pollution. The right to water entitles everyone to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic uses. The right to water poses an obligation upon the state to ensure such access in a nondiscriminatory manner. It has implications for water resources legislation and for the regulation of the water industry.

The existing legal framework governing groundwater is based largely on principles developed during the second part of nineteenth century and applied consistently until today. Basic rules governing access to and use of groundwater in Haryana were laid down in English decisions. Since judges developed this law, it should have given it ample scope for changing over time in line with changing circumstances and understanding of the science underlying the uniqueness of place. The system of land-based groundwater rights was developed at a time when groundwater was not a major source of freshwater, and the technology was not developed enough to facilitate the unsustainable extraction of groundwater. As such, groundwater was not a serious concern.

More recently, the calls for more effective interventions to halt aquifer depletion and deal with quality issues have grown. In response, many experts have shed light on the specific problems and possible solutions of groundwater in India. Not the least, this has happened within Steering Committees and Working Groups set up in connection with the Government's Planning Commission for preparation of its Twelfth Five-Year Plan (for 2012–2017). Some of these were commissioned to analyze the scope for reform of the law on groundwater.

The Central Government clearly wishes to promote institutional reforms at State level with more room for local adaptation and implementation. Part of this shift includes greater involvement and participation from local governments and communities (such as the elected village councils—Gram Panchayats—and Water Users Associations for irrigation).

However, to regulate and manage the groundwater development in Haryana, a draft bill has been adopted which is read as "Haryana State Groundwater Management and Regulation Act, 2013." This Act explicitly calls for a number of measures to protect and enhance recharge, namely, water harvesting, including rooftop rainwater harvesting, catchment conservation using appropriate groundwater structures or pits, the creation of protection zones in natural recharge areas and in areas that require special attention with regard to the artificial recharge of groundwater, programs for the recharge of aquifers, setting up artificial recharge structures, afforestation, and reforestation. This Act explicitly enables the relevant authority to issue guidelines for constructing appropriate rainwater harvesting structures in all residential, commercial, and other premises and larger open spaces.

The overall objectives of the Act, 2013 are to: (1) Regulate and control iniquitous groundwater use and distribution, based on priority of allocation to ensure that the drinking water/domestic needs of every person and irrigation needs of small and landless farmers can be met, (2) Ensure safe and secure drinking/domestic water for all people, particularly in groundwater-dependent regions, (3) Regulate the over-extraction of groundwater in order to ensure the sustainability of groundwater resources, equity of their use and distribution, and to ensure fulfillment of ecosystem needs, (4) Promote and protect community-based, participatory mechanisms of groundwater management, that is, adapted to specific locations considering resource, enhancement, and socio-economic set up, (5) Prevent and mitigate contamination of groundwater resources, (6) Promote and protect good conservation, augmentation (recharge) and management practices, and (7) Protect areas of land that are crucial for the sustainable management of groundwater resources and ensure that high groundwater consuming industries are not located in areas unable to support them.

12.4 Conclusion

There are several central and state groundwater authorities functioning in the state. These agencies have a wide network of monitoring wells from which the level of groundwater exploitation in a block or district can be calculated. The Haryana State does not restrict the number of connections awarded in a year based on these reports. The state water policies formulated by these agencies have started to advocate the use of artificial recharge methods to replenish the aquifers. Micro-irrigation techniques, which promote sustainable use of water, were not propagated much by the state government though some subsidies are now available. However, the villagers of the study area lack awareness on these technologies. A new proposal by the Soil Conservation Department allows a farmer with a certificate from the Horticulture/Soil Conservation Department showing that he is adopting sprinkler/drip irrigation for his plantation or vegetable crops, will provide him with priority access for a tube well connection by the Haryana State Electricity Board.

The government policy of appeasing the farmers lobby with zero electricity tariff can be a double edge to the sword as it can lead to unsustainable groundwater exploitation. The current need is the promotion of artificial recharge methods, which can replenish the aquifers, and adoption of micro-irrigation techniques, especially for the plantation crops. Under these circumstances, some stringent regulations are needed for better sustainability and governability.

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