Status of Groundwater and Policy Issues for its Sustainable Development in India

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Abstract

There has been unprecedented groundwater development in India due to which the irrigation potential has increased manifold from 6.5 M ha to 45.7 M ha by the end of the VIII Plan. Out of an estimated maximum irrigation potential of 81.4 M ha in the minor irrigation sector, 64.0 M ha (79 percent) is estimated to be associated with groundwater.

The present paper deals with the groundwater resources availability in different parts of the country, bringing out areas, which are under stress, and also areas where groundwater development is at a relatively low level and further development of groundwater is possible. The contamination of groundwater due to geo-genic sources is also discussed in this paper with special emphasis on the arsenic and fluoride contamination, which has adversely affected a large population in the country.

Several issues need to be addressed for a proper approach to sustainable management of groundwater. The approach so far has been more towards the development of the resource rather than the management of it, which has resulted in haphazard development and over-development in some areas and contamination in other areas. The legal provision of groundwater rights to the landowner has lead to indiscriminate development of groundwater. Shortages of water in many areas and also the land ownership rights have lead to the development of water markets all over the country and especially in the water scarce areas. Sustainable groundwater management would require that groundwater is not considered in isolation but should also include artificial recharge and conservation, conjunctive use, land use planning as per the availability of water, and taking appropriate measures to avoid pollution. In the present scenario of scarcity of groundwater resources, the provision of free or subsidized power in the agriculture sector also needs to be given a fresh look.

Introduction

People around the world have used groundwater as a source of drinking water and even today more than half of the world's population depends on groundwater for survival. Groundwater has played a significant role in maintenance of India's economy, environment and standard of living. Besides being the primary source of water supply for domestic and many industrial uses, it is the single largest and most productive source of irrigation. Out of the ultimate irrigation potential of

81.4 M ha in India, in the minor irrigation sector, 64.0 M ha (79 percent) is from groundwater. It also provides water security during prolonged drought periods.

Groundwater Scenario in India

The total annual groundwater recharge in India is estimated at 432 billion cubic meters (BCM). After deducting the natural loss to the system, the net annual groundwater availability in the country is 361 BCM. The total annual groundwater draft is 150 BCM. In the states of Haryana, Punjab and Rajasthan, the stage of groundwater development is more than 85 percent and in Haryana and Punjab, heavy groundwater withdrawal have likewise resulted in high stage of groundwater development. In some parts of the country, such as the North Eastern States, groundwater development has not picked up yet. Presently, 673 assessment units of the country (see explanation in Table 1) are 'over-exploited' where the annual groundwater extraction exceeds the annual recharge. 425 assessment units are 'dark' or 'critical' where the groundwater development has reached to a high level, i.e. > 85 percent. Remaining 7091 blocks have been categorized as 'safe', having adequate groundwater resources for further development (Table 1).

Apart from the dynamic resource, a vast amount of in-storage resource (non-replenishable) is available at deeper levels. A first approximation indicates that the total in-storage groundwater reserve is around 10,812 BCM. In-storage groundwater reserves are particularly abundant in the alluvial deposits of Indo-Gangetic-Bramhaputra valley spreading in the northern and northeastern parts of the country.

The behavior and distribution of groundwater in the Indian sub-continent is not even. In fact it is complicated due to the occurrence of diversified geological formations and complex tectonic framework, climatic dissimilarities and various hydro-chemical conditions. The state wise availability of groundwater is summarized in Table 2.

Priority issues in the groundwater sector vary from place to place depending on the existing hydro-geological setup and the stress effect on it as a result of human interference. Groundwater is becoming an increasingly popular resource because of the relative ease and flexibility with which it can be tapped. Groundwater development has also occupied an important place in poverty alleviation policies because of its role in stabilizing the Indian agriculture and as means for drought management. During periods of droughts, additional dependence is laid on this resource since storage levels in surface water reservoirs dwindle and the impact of vagaries of weather on groundwater is not as pronounced and is delayed.

The average stage of groundwater development in the country, as estimated in 1991, was 32 percent. In March 2003, the average stage of development had reached approximately 42 percent. This is also evident from the growth of groundwater abstraction structures from the pre-VIII plan period till date. The number of groundwater abstraction structures (dug wells, shallow and deep tube wells) has increased from merely 4 million in 1951 to more than 17 million in 1997. With the growth of groundwater abstraction structures, there has been an increase in irrigation potential created from groundwater from 6.5 M ha to 45.7 M ha by the end of the VIII Plan. This rapid pace is likely to continue till the full irrigation potential estimated to be available from groundwater is created by approximately 2007.

Table 1. Groundwater development levels in India

	States	Number of assessment units	No. of assessment units			
			Over-exploited		Dark/Critical	
			No.	%	No.	%
1.	Andhra Pradesh	1157	118	10.20	79	6.83
2.	Arunachal Pradesh	59	0	0.00	0	0.00
3.	Assam	219	0	0.00	0	0.00
4.	Bihar	394	6	1.52	14	3.55
5.	Chhattisgarh	145	0	0.00	0	0.00
6.	Delhi	6	3	50.00	1	16.07
7.	Goa	12	0	0.00	0	0.00
8.	Gujarat	180	41	22.78	19	10.56
9.	Haryana	111	30	27.03	13	11.50
10.	Himachal Pradesh	69	0	0.00	0	0.00
11.	Jammu & Kashmir	69	0	0.00	0	0.00
12.	Jharkhand	193	0	0.00	0	0.00
13.	Karnataka	175	7	4.00	9	5.14
14.	Kerala	151	3	1.99	6	3.97
15.	Madhya Pradesh	312	2	0.64	1	0.34
16.	Maharashtra	2316	154	6.65	72	3.11
17.	Manipur	29	0	0.00	0	0.00
18.	Meghalaya	39	0	0.00	0	0.00
19.	Mizoram	12	0	0.00	0	0.00
20.	Nagaland	52	0	0.00	0	0.00
21.	Orissa	314	0	0.00	12	8.70
22.	Punjab	138	81	58.70	80	33.76
23.	Rajasthan	237	86	36.29	0	0.00
24.	Sikkim	4	0	0.00	37	9.61
25.	Tamil Nadu	385	138	35.84	0	0.00
26.	Tripura	38	0	0.00	20	2.44
27.	Uttar Pradesh & Uttaranchal	819	2	0.24	61	22.18
28.	West Bengal	275	0	0.00	61	22.18
	Total States	7910	671	8.48	424	5.36
	Union Territories	18	2	11.11	1	5.56
	Grand Total	7928	673	8.49	425	5.36

Notes: 1. Unit of Assessment : Andhra Pradesh –Basin, Maharashtra –Watershed(Command/Non-command wise); Gujarat,Karnataka -Taluka : Rest of the States – Blocks 2. Methodology for Estimation : Groundwater Estimation Committee(GEC) Guidelines '97 – Andhra Pradesh, Chhattisgarh, Jammu & Kashmir, Kerala, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, Andaman & Nicobar Island. GEC '84 – Rest of the states. 3. Criteria for Categorisation – Over-exploited – GEC '84 > 100%, GEC '97 >100%. Declining trend in both pre & post monsoon water level.Dark – GEC '84 > 85% & < = 100%, Critical-GEC '97 < 100%, Declining trend in both pre & post monsoon water level OR > 100%.

Table 2. State wise availability of groundwater resources

Sl. No.	State	Total replenishable groundwater resource BCM/Yr	Provision for domestic, industrial and other uses BCM/Yr	Available groundwater resources for irrigation BCM/Yr	Net draft BCM/Yr	Balance groundwater resources for future use BCM/Yr	Level of groundwater development (%)
1.	Andhra Pradesh	35.29	5.29	30.00	8.57	21.43	28.56
2.	Arunachal Pradesh	1.44	0.22	1.22	-	1.22	Neg
3.	Assam	24.72	3.71	21.01	1.84	19.17	8.75
4.	Bihar	26.99	4.05	22.94	10.63	12.31	46.33
5.	Chattisgarh	16.07	2.41	13.66	0.81	12.85	5.93
6.	Delhi	0.29	0.18	0.11	0.12	-	-
7.	Goa	0.22	0.03	0.19	0.02	0.17	8.30
8.	Gujarat	20.38	3.06	17.32	9.55	7.77	55.16
9.	Haryana	8.53	1.28	7.25	8.13	0.00	112.18
10.	Himachal Pradesh	0.37	0.07	0.29	0.03	0.26	10.72
11.	Jammu & Kashmir	4.43	0.66	3.76	0.03	3.73	0.81
12.	Jharkhand	6.53	0.98	5.55	1.84	3.71	33.13
13.	Karnataka	16.19	2.43	13.76	4.76	9.00	34.60
14.	Kerala	7.90	1.31	6.59	1.46	5.13	22.17
15.	Madhya Pradesh	34.82	5.22	29.60	8.02	21.58	27.09
16.	Maharashtra	37.87	12.40	25.47	9.44	16.04	37.04
17.	Manipur	3.15	0.47	2.68	Neg.	2.68	Neg.
18.	Meghalaya	0.54	0.08	0.46	0.02	0.44	3.97
19.	Mizoram*	1.40*	0.21*	1.19*	Neg.	1.19*	Neg.
20.	Nagaland	0.72	0.11	0.62	Neg.	0.62	Neg.
21.	Orissa	20.00	3.00	17.00	3.61	13.39	21.23
22.	Punjab	18.66	1.87	16.79	16.40	0.00	97.66
23.	Rajasthan	12.71	1.99	10.71	9.26	1.45	86.42
24.	Sikkim	0.07*	0.01*	0.06*	Neg.	0.06*	Neg.
25.	Tamil Nadu	26.39	3.96	22.43	14.45	7.98	64.43
26.	Tripura	0.66	0.10	0.56	0.19	0.38	33.43
27.	Uttar Pradesh	81.12	12.17	68.95	32.33	36.62	46.89
28.	Uttaranchal	2.70	0.41	2.29	0.82	1.47	35.78
29.	West Bengal	23.09	3.46	19.63	7.50	12.13	38.19
	Total States	433.00* (431.77)	71.14* (70.92)	361.98* (360.73)	149.82	212.78* (211.53)	41.53
	Total Union Territories	0.442* (0.116)	0.025* (0.012)	0.384 (0.071)	0.160	0.348* (0.035)	
	Grand Total	433.882* (431.886)	71.165* (70.932)	362.364* (360.80)	149.97	213.128* (211.56)	41.57

Note: 1995 estimates are projected to 2003

* Total Replenishable Groundwater Resource of the country was estimated to be 433.68 BCM. However, as per decision taken in 1995, the agreed figure of 432 BCM is retained as rounded off figure of 431.88 BCM. The discrepancy actually has crept in due to inclusion of figures in respect of Mizoram, Sikkim and UT of Andaman & Nicobar at a later stage.

Groundwater Quality

The chemical quality of groundwater plays a vital role in its various uses. The geochemical and geothermal characteristics of groundwater are dependent on the interplay of meteorological, geological, pedological and topographical conditions, which have a direct bearing on the natural concentration of salts in groundwater. The chemical quality of groundwater occurring within shallow depths varies widely in the country because of human interference. Generally, the chemical constituents that affect the potability of groundwater, are within the permissible range in major parts of the country. In places, the groundwater has high geo-genic concentration of fluoride, nitrate, iron, arsenic, salinity and dissolved salts, which restricts its use for various purposes. The district wise problems of contamination of groundwater due to various contaminants are given in Table 3. The chemical quality of groundwater has been affected through domestic, agricultural and industrial pollution. Intensification of agricultural cultivation has lead to significant deterioration in groundwater quality in some areas. The principal problems are the leaching of nutrients, and pesticides, and increasing salinity in the more arid or coastal environments.

The subsoil and the underlying rock formations can eliminate or attenuate many water pollutants by natural, physical, chemical and biological processes. But this natural capacity does not extend to all types of water pollutants and varies widely in effectiveness under different hydro-geological conditions. Serious pollution of groundwater occurs when pollutants are discharged to, deposited on, or leached from the land surface, at rates significantly exceeding the natural attenuation capacity. This is occurring widely as a result of both the indiscriminate disposal of liquid effluents and solid wastes from urban development with inadequate sanitation arrangements, and of uncontrolled leakage of stored chemicals into the ground from industrial activities.

In many coastal areas, such as near Chennai and also in small islands, over-exploitation is leading to the intrusion of saltwater inland, causing effectively irreversible deterioration of groundwater resources.

Groundwater pollution is insidious and expensive; insidious because it takes many years to show its full effect in the quality of water pumped from deep wells; expensive because, by the time it is detected, the cost of remediation of polluted aquifers becomes extremely high. Indeed, restoration to drinking water standards is often practically impossible.

Groundwater Issues

Developing and managing this resource in a sustainable way poses many challenges. The major concerns of groundwater development and management in India are: low development in prospective areas and high rate of groundwater development leading to groundwater depletion, groundwater quality problem due to intrinsic properties of the rock formations and domestic, agricultural and industrial pollution, in other areas.

Table 3. Statewise details of contamination of groundwater in some areas of the districts due to various contaminants

S. No.	State	Salinity	Iron	Fluoride	Nitrate	Arsenic	Heavy metals
1.	Andhra Pradesh	East Godavari, West Godavari, Krishna, Guntur, Prakasam	—	Prakasam, Nellore, Anantapur, Nalgonda, Rangareddy, Adilabad	Vishakhapatnam, East Godavari, Krishna, Prakasam, Nellore, Chittoor, Anantapur, Cuddapah, Kurnool, Mehboob-nagar, Rangareddy, Medak, Adilabad, Nalgonda, Khammam.	—	Anantapur, Mehboobnagar, Prakasam, Visakhapatnam, Cuddapah, Nalgonda.
2.	Assam	—	Northern bank of Brahmaputra	Nagaon, Karbi Anglong	—	—	Digboi
3.	Bihar	Begusarai	Champaran, Muzaffarpur, Gaya, Munger, Deoghar, Madhubani, Patna, Palamau, Nalanda, Nawada, Banka	Giridih, Jamui, Dhanbad	Palamau, Gaya, Patna, Nalanda, Nawada, Bhagalpur, Sahebgunj, Banka	—	Dhanbad, Muzaffarpur, Begusarai.
4.	Gujarat	Banaskantha, Junagarh, Bharauch, Surat, Mehsana, Ahmedabad, Surendranagar, Kheda, Jamnagar	—	Kachch, Surendranagar, Rajkot, Ahmedabad, Mehsana, Banaskantha, Sabarkantha.	—	—	—
5.	Haryana	Sonepat, Rohtak, Hissar, Sirsa, Faridabad, Jind, Gurgaon, Bhiwani, Mahendragarh	—	Rohtak, Jind, Hissar, Bhiwani, Mahendra-garh, Faridabad	Ambala, Sonepat, Jind, Gurgaon, Faridabad, Hissar, Sirsa, Karnal, Kurukshetra, Rohtak, Bhiwani, Mahendragarh	—	Faridabad
6.	Himachal Pradesh	—	—	—	Kulu, Solan, Una	—	Purwanoo, Kalaamb

(*Contd.*)

Table 3. (*Contd.*)

S. No.	State	Salinity	Iron	Fluoride	Nitrate	Arsenic	Heavy metals
7.	Karnataka	Bijapur, Belgaum, Raichur, Bellary, Dharwar	—	Tumkur, Kolar, Bangalore, Gulbarga, Bellary, Raichur	—	—	Bhadrawati
8.	Kerala	Ernakulam, Trichur, Alleppey	—	Palghat	—	—	—
9.	Madhya Pradesh & Chhatisgarh	Gwalior, Bhind, Morena, Jhabua, Khargaon, Dhar, Shivpuri, Shajapur, Guna, Mandsor, Ujjain	—	Bhind, Moerana, Guna, Jhabua, Chhindwara, Seoni, Mandla, Raipur, Vidisha	Sehore	Rajnand-gaon	Bastar, Korba, Ratlam, Nagda
10.	Maharashtra	Amaravati, Akola.	—	Bhandara, Chandrapur, Nanded, Aurangabad	Thane, Jalna, Beed, Nanded, Latur, Osmanabad, Solapur, Satara, Sangli, Kolhapur, Dhule, Jalgaon, Aurangabad, Ahmednagar, Pune, Buldana, Amravati, Akola, Nagpur, Wardha, Bhandara, Chandrapur, Gadchiroli	—	—
11.	Orissa	Cuttack, Baleswar, Puri	Parts of Coastal Orissa	Bolangir	—	—	Angul, Talcher
12.	Punjab	Bhatinda, Sangrur, Faridkot, Firozpur.	—	Ludhiana, Faridkot, Bhatinda, Sangrur, Jalandhar, Amritsar.	Patiala, Faridkot, Firozpur, Sangrur, Bhatinda.	—	Ludhiana, Mandi Gobindgarh.
13.	Rajasthan	Bharatpur, Jaipur, Nagaur, Jalore, Sirohi, Jodhpur	Bikaner, Alwar, Dungarpur	Barmer, Bikaner, Ganganagar, Jalore, Nagaur, Pali, Sirohi.	Jaipur, Churu, Ganganagar, Bikaner, Jalore, Barmer, Bundi, Swai Madhopur.	—	Pali, Udaipur, Khetri.

(*Contd.*)

Table 3. (*Contd.*)

S. No.	State	Salinity	Iron	Fluoride	Nitrate	Arsenic	Heavymetals
14.	Tamil Nadu	Karaikal, Pondicherry, Nagapattanam, Quide-Millet, Pudukottai, Ramananthapuram, North Arcot Ambedkar, Dharampuri, Salem, Trichy, Coimbatore.	—	Dharampuri, Salem, North Arcot-Ambedkar, Villipuram-Padayatchi, Muthuramalingam, Tiruchirapalli, Pudukottai.	Coimbatore, Periyar, Salem.	—	Manali, North Arcot.
15.	Tripura	—	Dharamnagar, Kauleshaher, Khowai, Ambasa, Amapur and Parts of Agartala Valley	—	—	—	—
16.	Uttar Pradesh	Agra, Mathura, Mainpuri, Banda	—	Bulandshahar, Aligarh, Agra, Unnao, Rae-Bareli	Orai, Jhansi, Lalitpur, Faizabad, Sultanpur, Maharajganj, Gorakhapur, Deoria	Ballia	Singrauli, Basti, Kanpur, Jaunpur, Allahabad, Saharanpur, Aligarh.
17.	West Bengal	—	Midnapore, Howrah, Hooghli, Bankura	Birbhum	Uttar Dinajpur, Malda, Birbhum, Nadia, Midnapur, Howrah, Murshidabad, Purulia	Malda, S&N-24 Paraganas, Nadia, Hoogly, Murshidabad, Bardhaman, Howrah	Durgapur, Howrah, Murshidabad, Nadia.
18.	NCT of Delhi	Najafgarh, Kanjhawala, and Mehrauli Blocks.	—	—	City Shahdara and Mehrauli Blocks.	—	Alipur, Kanjhawala, Najafgarh, Mehrauli City and Shahdara Blocks.

While developing groundwater resources promises to help alleviate poverty in many areas, the most formidable groundwater challenge is to attain the sustainable use and management of groundwater in areas where the resource is under threat. The depletion of groundwater is becoming a major problem in many parts of the country. Groundwater overdraft has many negative consequences associated with it. The ultimate impact of groundwater depletion and water quality deterioration is on the health of large sections of rural population that depend directly on wells as their only source of drinking water supply. Depleting water tables is causing the drilling of deeper wells and an ever-increasing cost of tapping these aquifers.

Developmental Issues in Indo-Ganges-Brahmaputra Basin

The groundwater resource is not evenly distributed throughout the country. Several regions in the country have a good repository of groundwater, which are yet to be tapped. The most significant is the Indo-Gangetic-Bramhaputra basin that is bestowed with about 211 BCM of annual groundwater recharge, which is almost 50 percent of the total potential of the country. It also has a vast in-storage groundwater reserve. The groundwater development in this belt at a low level leaves a good scope for further development.

Developmental Issues in Punjab and Haryana

The success of the Green Revolution in Punjab and Haryana brought with itself the adverse impact on the groundwater regime in the form of over draft. The effect is so pronounced that out of 36 districts in these two states, 25 districts have areas where decline in groundwater levels have set in.

Developmental Issues in Rajasthan

In the western arid sector of the country, in Rajasthan, there is little natural recharge to the groundwater regime. In sharp contrast, the INGP command area faces the problem of land degradation due to water logging and consequent soil salinity. The problems of meteorological and agricultural droughts and land degradation due to water logging and soil salinity are required to be addressed on priority.

Developmental Issues in Deltaic and Coastal Sediments

The unconsolidated deltaic and coastal sediments along India's coastline contain thick and regionally extensive aquifers that have good yield potential and can sustain deep, moderate to high capacity tube wells. Although enormous fresh groundwater resources are identified in these areas all along the coast, its uncontrolled development suffers heavily from inherent salinity hazards. Coastal parts of Gujarat, Tamil Nadu and Andhra Pradesh are already suffering from the problem of salinity ingress.

Developmental Issues in Peninsular States

The peninsular states of Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala are characterized by hard rock formations, which lack primary porosity and have extreme heterogeneity and restricted storage capabilities of groundwater. Occurrence of groundwater is limited to areas where the structure of the rock formations favors storage and transmission of groundwater.

Groundwater Ownership Issues

A private individual investing his own resource can construct wells of any design, installing pumps of any capacity. Under the Land Easement Act of 1882, groundwater is considered an easement connected to land. Ownership of groundwater thus falls to the landowner who is free to extract and use it as he/she deems fit. When the Easement Act was promulgated, the popular and prevalent means of groundwater withdrawal were through dug wells. With the advent of electrically powered pumps and advanced drilling methods, the situation has changed drastically. The demand for groundwater has increased manifold. Between 1951 and 1992, dug wells increased from 3.86 million to 10.12 million, shallow tube wells from 3000 to 5.38 million, public tube wells from 0 to 68,000, electric pumps from zero to 9.34 million, and diesel pumps from 66,000 to 4.59 million. In the VIII plan, a further addition of 1.71 million dug wells, 1.67 million shallow tube wells; 114,000 deep tube wells 2.02 million electric pumps and 420,000 diesel pumps took place. Exclusive rights over water have resulted in not only exploitation of needy farmers but also that of the groundwater resources.

Management Options

Presently, groundwater management rather than development is the major challenge that is being faced. There are certain strong reasons suggesting the need for such a shift:

- The private sector predominance in this sector is strong.
- The expansion of groundwater management problems across many parts of the country at a rapid rate

With the sustainable limits of groundwater extraction being approached, competition between agriculture and other uses are intensifying. Naturally, allocation problems are particularly complicated in areas where overdraft, quality and pollution problems exist. In some areas, current levels of use are being maintained by mining groundwater resources. In these areas, cutbacks in extraction are essential, as are measures to dramatically increase the productivity per unit of water. In all areas, the challenge is to maintain extraction within sustainable limits.

The various management options to explore are:

- Legal framework regarding use of groundwater.
- Community support for this legal framework since the majority of the groundwater structures in the country are privately owned. This would lead to effective implementation of the regulations since there will be no opposition from the local populace.

- Development of water markets, if established within effective rights, institutional and regulatory framework could play a major role in providing water to various use sectors.
- Effective co-ordination and communication between various agencies dealing with various aspects of groundwater.
- Groundwater being in the dynamic state requires to be monitored on a continuous basis for quantity and quality. Detailed and precise studies using modern tools would lead to more accurate data generations, which shall ultimately result in a more accurate assessment of groundwater resources of the country.
- It should also include artificial recharge, conservation, conjunctive use, and land use planning as per the availability of water and taking appropriate measures to avoid pollution.
- The provision of free or subsidized power in the agriculture sector needs to be given a fresh look. Suitable cost of electricity is to be decided so that no misuse/ overuse of power takes place.

Measures for Attaining Sustainability of Groundwater Development

Recently, several initiatives have been taken to augment the groundwater supplies and ensure its sustainable utilization. Some of the important measures include the following:

Artificial Recharge

Harnessing surplus monsoon flows to recharge the aquifer system could, in principle, augment groundwater resources. According to a study conducted by the Central Groundwater Board, about 214 BCM of surplus monsoon runoff in 20 major river basins in the country could be stored as groundwater, out of which 160 BCM is considered to be retrievable. In the minor irrigation sector, percolation tanks, *nala* bunds, gully plugs, check dams, sub-surface dykes are some of the suitable structures, which can be effectively used, depending on the hydrogeological setting, to augment groundwater resources and also provide irrigation water to needy farmers. Stress should also be laid on conjunctive use of surface and groundwater in the irrigated command areas. This could boost the irrigation facility in the tail end areas.

Model Bill

In an effort to control and regulate the development of groundwater, the Ministry of Water Resources circulated a Model Bill to the states in 1970, which was again re-circulated in 1992 and 1996. So far, six states/union territories, namely Andhra Pradesh, Goa, Tamil Nadu, Kerala, Lakshadweep and Pondicherry have enacted the legislation. In two states, namely Gujarat and Maharashtra, the bill has been passed but not enacted. Action on the model bill has been initiated in 16 states/union territories.

Constitution of Central Groundwater Authority

Further, for the purpose of control and regulation of groundwater development, the Central Groundwater Board was constituted as the Central Groundwater Authority in January 1997 under the Environment (Protection) Act 1986. The authority has taken initiative in declaring areas as protected areas from the point of view of groundwater overexploitation. The other activities of the Authority include monitoring of groundwater contamination, registration of agencies involved in construction of wells, registration of persons/agencies engaged in sale and supply of mineral water from groundwater, clearance to groundwater-based projects, conducting mass awareness programs and training in rain water harvesting.

The Central Groundwater Authority has declared 11 priority areas for groundwater regulation and also notified 32 areas for registration of groundwater abstraction structures in the states of Rajasthan, Madhya Pradesh, Punjab, Haryana and Andhra Pradesh.

Amendment of Building Byelaws

In urban areas the Government of India has amended building byelaws and made rainwater harvesting, as a means of artificial recharge, mandatory. So far, Tamil Nadu, Delhi, Haryana have taken action. Other states are in the process of amending the building byelaws to make rainwater harvesting mandatory in the special class of buildings.

Correcting Sub-optimal Development of Groundwater

Development of groundwater is sub-optimal in certain parts of the country causing rejected recharge. The low development of groundwater is attributed to fragmented land holdings, lack of efforts in public funding for construction and energizing of wells/ tube wells. A scheme has been formulated to address this issue of inadequate development of groundwater resource. The scheme is proposed to be implemented throughout the country except the states of Haryana, Punjab, Rajasthan and Union Territories of Chandigarh, Delhi, Lakshadweep, Daman and Diu, where problems of either continuously declining groundwater level or that of quality deterioration exists. Under the scheme, stress would be laid on the development of groundwater in the Ganga-Brahmaputra basin where there is ample scope of development of groundwater. It is proposed to construct 2,680,100 structures at a cost of Rs. 153 billion. The additional irrigation potential likely to be created has been assessed at about 5.24 M ha.

Spring Development

Hard rocks mostly underlie the mountainous regions of northern and northeastern India. The total annual rainfall in these areas is generally more than 2000 mm. As the areas have high slopes, the run-off is generally very high. Further, absence of widespread, continuous aquifers has reduced the groundwater storage to a bare minimum. The major source of groundwater in such areas is springs, which have discharges ranging from 0.1 to 30 lps. These springs provide excellent quality of water and it is essential to take up studies regarding the occurrence, areas of recharge / discharge, movement of water through these springs to enhance the availability of sustainable drinking water supplies to the populace living in these high altitude areas.

Water resources development and management need to be planned in an integrated manner taking into consideration long term as well as short term planning needs. They need to incorporate environmental, economic and social considerations based on the principles of sustainability. An integrated groundwater development and management plan envisaging rational and efficient utilization of regional groundwater system requires a reliable data base, modeling tools to describe the regional flow pattern, proper definition of goals and related criteria and a monitoring network for groundwater flow and groundwater pumpage.