CHAPTER 1.0: INTRODUCTION

In large parts of the world, groundwater is the main resource for drinking water supply and an important factor for economic growth. In Indian context, ground water is perhaps one of the most decentralized and democratic resources available. As of now, abstraction, control and management of groundwater have been vested largely with the State or large farmers/industries.

The increasing demand of water to meet the ever-increasing needs for a growing population has been putting an increasing stress on the available water resources of India in the last few decades. With the population expected to stabilize at 1640 million by the year 2050, the gross per-capita water availability is expected to decline from ~1820 cubic meter per year in 2001 to as low as ~1140 cubic meter per year.[1]

The development of ground water in different areas of the country has not been uniform. Highly intensive development of ground water in certain areas in the country has resulted in over - exploitation leading to decline in ground water levels and sea water intrusion in coastal areas.

Any discussion on legal and institutional framework should take into account the context of the overall situation facing the ground water sector. Hence, it is useful to give background information related to ground water resources and their development. It is based on secondary sources of data obtained mostly from various publications on ground water governance and institutional framework published by World Bank, Ministry of Water Resources, Planning Commission, volumes of seminars and workshops etc. The chapter also poses the problem of governance and draws attention to the need for the study.

1.1 Ground Water Scenario in India

The importance of water is too obvious to require much elaboration. Water is life. It is one of the most critical natural resources for the continuance of life on

---

[1] S. K. Gupta* and R. D. Deshpande, Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India, CURRENT SCIENCE, VOL. 86, NO. 9, 10 MAY 2004

earth. It is a scarce, precious and replenishable natural resource which cannot be created. Its true value can be known only when it is not available its value can be gauged by the energy and time spent in traversing to fetch a pot of water. The main sources of water are surface and ground water. To some extent, these are interdependent as the use of one source affects the availability of the other. Utilization of each source varies depending upon its availability.

The renewable water resources in the world as a whole have been estimated as 42,700 km^3. The availability in Asia, South America, Europe and Australia is estimated to be 13,500, 12000, 2,900 and 2,400 km^3 respectively. There has been a decrease in per capita availability of water due to population growth from 12,900 m^3 in 1970 to 7,600 m^3 in 1994. The reduction in Africa is 2.8 times, in Asia 2 times, in South America 1.7 times but in Europe it is only 16 percent.[2] At the same time, there has been growth in per capita water use. As a result, water is becoming increasingly scarce.

It has been estimated that India, Nepal, Bangladesh, Pakistan and China use over 300 billion $m^3$of ground water annually. The major consumer being agriculture, this constitutes nearly half of the world's total annual use. As can be seen from the table 1.1 given below, India is the largest user of ground water. In the case of South Asia, the utilization of ground water is mainly in private and informal sectors specially the farmers with no or very limited regulation. Policy measures to regulate ground water overdraft, such as enacting and enforcing ground water laws, installing licensing and permitting systems, establishing clear tradable property rights for water, pricing of ground water etc., have been advocated in South Asia and China. For example, the National Water Policy of India highlights the ground water development issues of over-exploitation and the need for regulation. But no Asian country has yet been able

[2] Central Ground Water Authority, Government of India *"Ground Water Management in India"* New Delhi, 2000.

to effectively deploy any of these measures despite continued deterioration in ground water level and quality.

Table 1.1: Extent of Ground Water Development in selected Countries[3]

Country	Annual Ground Water Use (Billion m^3)	Number of Ground Water Structures (million)	Extraction/ Per Structure (m^3/year)	Imputed Value of G.W. Used/ Year (billion $)
India	150	19	7900	6
Pakistan	45	0.5	90,000	1.2
China	75	3.5	21,500	2.5
Iran	29	0.5	58,000	NA
Mexico	29	0.07	414,285	NA
USA	100	0.2	500,000	NA

India has a highly seasonal pattern of rainfall, with 50 percent precipitation falling in just 15 days and over 90 percent of river flows occurring in just four months. The average annual precipitation in India in volumetric terms is 4000 Billion Cubic Meter (BCM). Due to topographical and other constraints, it is estimated that only 690 BCM of surface water can be effectively utilized. The annual replenishable ground water resources in the country are estimated to be 431BCM. Thus, the total utilizable water resources of India have been estimated at 1121 km^3. Total water use in the country was estimated by the National Commission on Integrated Water Resources Development (NCIWRD) of India at the level of 611 km^3in 2000 and is projected to be around 793 km^3 by 2025 and 1104 km^3 by the year 2050. These water demand projections are based on the population projections at the level of 1581 million by 2050. Irrigation constitutes the main use of water accounts for 84 percent of the total

[3] *K.D Sharma, Groundwater Governance: The Indian Scenario op.cit., 2007*

water withdrawal at present. The share of withdrawal by the domestic and industrial sectors is only 59 m^3 per person in India which is quite low, but it is expected to increase on account of increasing urbanization and industrialization.

In recent years, Ground water has become the preferred source for the various uses because of its advantages like the ubiquitous availability, good quality and above all the control that the user can exercise on its use. These factors along with invention and popularization of mechanical pumping technologies in the mid twentieth century, the availability of subsidized (or even free) electric power and diesel, have led to a phenomenal increase in the growth of ground water abstraction, therefore, ground water has received preference over surface water as a source of irrigation as well as for use in domestic and industrial sector, due to features, like dependability of supply, widespread distribution, ease of availability in the proximity of place of use, natural availability in pure form soon & so forth. Parallely, due to inadequate dam storage capacities and poor maintenance of the public irrigation infrastructures, contribution of public surface irrigation has been declining. On the other hand role of ground water has been increasing. Presently about 65 percent of the irrigation and about 90 percent of the domestic and industrial water requirements are met through private ground water resources. However, this precious resource has often been wrongly regarded by the users as infinite and inexhaustible resource. Consequently, important aspects relating to ground water like its scientific management, conservation and augmentation tend to be neglected by the general public at large.

Out of the annual replenishable ground water resource of 431 Billion Cubic Metres (BCM). 399 BCM is available for utilization, leaving aside 32 BCM for natural discharge. The total ground water draft is 231 BCM of which 92 percent is for irrigation (213 BCM) and 8 percent is for domestic and industrial use (18BCM). The overall stage of ground water development is 61 percent. A region wise summary of assessment of the dynamic ground water resources of the country conducted by CGWB 2009 is presented below:-

Table 1.2 : Ground Water Availability for Irrigation in Future[4]

Region	Net Annual GW available for future irrigation Development (in million ha.m / year)*
North	(-)12.7
North East	41.2
East	36.4
Central	48.4
West	18.4
South	30.3
Total	162.0

North: J&K, HP, Punjab, Haryana, Rajasthan, Delhi, Chandigarh; North East: Arunachal, Assam, Manipur, Meghalya, Mizoram, Nagaland, Tripura; East: Bihar, Jharkhand, Orrissa, West Bengal, Sikkim, A & N Island

Central: MP, Chhattisgarh, UP, Uttaranchal; West: Gujarat, Maharashtra, Goa, Dadra & Nagar Haveli

South: AP, Karnataka, Kerala, Tamil Nadu, Lakshadweep, Pondicherry);

*Figures in terms of million ha.m given in the original source have been converted to bcm to provide uniformity in different tables.

This shows that as of March 2009, there was 162 bcm dynamic ground water resources available in the country for future irrigation development though highly unevenly distributed in the different regions. The Western and Northern regions have low ground water availability with assessment units categorized mostly as critical and over-exploited.

---

[4] *John Kurien and Ashutosh Kumar Sinha, Groundwater Governance Issues in Irrigation Development- A Perspective, op.cit., 2007*

1.2 Varied Ground Water Scenario

India is a vast country with diversified geological, climatological and topographical set-up, resulting in divergent ground water situations. The prevalent rock formations, ranging in age from archaean to recent, which control occurrence and movement of ground water, are widely varied in composition and structure. At the same time, there are marked variations of land forms, from the rugged mountainous terrains of the Himalayas, Eastern and Western Ghats to the flat alluvial plains of the river valleys and coastal tracts, and the intermountain deserts of Rajasthan. The rainfall pattern, too, shows considerable region-wise variations. Based on the topography and rainfall control run-off and ground water recharge, one can expect variations in ground water situations in different parts of the country.

The high relief areas of the northern and north-eastern regions occupied by the Himalayan ranges, the hilly tracts of Rajasthan and peninsular regions with steep slope, provide considerable scope for high run-off and, therefore, little scope for rain water infiltration. Hence the ground water potential in these areas is limited to intermountain valleys. On the other hand, the large alluvial tract in the Indus-Ganga-Brahmaputra plains extending over a distance of 2000 kms from Punjab in the west to Assam in the east constitutes one of the largest and most potential ground water reservoirs in the world. The aquifer systems in these areas are extensive, thick, hydrologically interconnected and moderate to high yielding.

The entire Peninsular India is more or less occupied by a variety of hard and fissured rock formations and consolidated sedimentary (including carbonate rocks), with patches of semi consolidated sediments in narrow basins. Such topography has given rise to discontinuous aquifers, with limited to moderate yield potentials. The near surface weathered mantle forms the all important ground water reservoir, and the source for circulation of ground water through the underlying fracture systems. In the hard rock terrain, deep weathered sediments, low-lying valleys and abandoned river channels, generally contain adequate thickness of porous material, to sustain ground water development under favourable hydro meteorological conditions. Generally, the potential water saturated fracture systems occur down to 100 m depth, and in cases yield even up to 30 litres per second (lps). The semi consolidated sandstones also form moderate yielding aquifers. Auto flowing zones in these formations are not uncommon.

The coastal and deltaic tracts in the country form a narrow linear strip around the peninsula. The eastern coastal and deltaic tract and the estuarine areas of Gujarat are receptacles of thick alluvial sediments. Highly productive aquifers occur in these tracts. But these are exposed to salinity hazards. Hence, ground water withdrawal in such area needs to be regulated so as not to exceed annual recharge and not to disturb hydro-chemical balance leading to sea water ingress.

The quality of ground water in both hard rock and alluvial terrains is by and large fresh and suitable for drinking, agricultural, industrial and other uses. The specific conductance is generally less than 1000 micro semins/cm at 25° C. But there are a few areas where ground water is contaminated due to inherent properties of rock formations which hold water or through which the ground water passes. Poor quality of water has been due to fluoride and arsenic contamination, iron contamination and salinity (both inland and coastal) In coastal areas, estuarine tracts of Gujarat, Rann of Kutch and arid tracts of Rajasthan, the risk of mineralization of ground water is rather high. Moreover, salinity hazards are not uncommon.

Salinity in ground water is also found in arid and semi-arid areas of Punjab, Haryana, Uttar Pradesh, Rajasthan and Gujarat. The uneven distribution of ground water resources across different parts of the country is reflected in the table 1.2 projected earlier as well as in table 1.3 and 1.4 given below. The variations are obvious whether we make inter-basin or inter-state comparisons, data for both of which are presented below.

Table 1.3 : Basin-wise Ground Water Potential of the Country (bcm/year)*[5]

S.No.	Name of Basin	Total Replenishable Ground Water Resources
1	Brahmani with Baitarni	4.05
2	Brahmaputra	26.55
3	Cambai Composite	7.19
4	Cauvery	12.3
5	Ganga	170.99
6	Godavari	40.65
7	Indus	26.49
8	Krishna	26.41
9	Kutch &Saurashtra Composite	11.23
10	Madras and South Tamil Nadu	18.22
11	Mahanadi	16.46
12	Meghna	8.52
13	Narmada	10.83
14	Northeast Composite	18.84
15	Pennar	4.93
16	Subarnrekha	1.82
17	Tapi	8.27
18	Western Ghat	17.69
	Total	431.44

**Figures in terms of cubic km/year given in the original source have been converted to BCM to provide uniformity in different tables.*

[5] *B M Jha & S.K.Sinha, Towards Better Management of Ground Water Resources in India, BhuJal News Volume No. 24 , Number 4, Oct- Dec, 2009.*

Table 1.4 : State-wise Ground Water Resources (in BCM)[6]

Sl. No.	States / Union Territories	Annual Replenishable Ground Water Resource
	States	
1	Andhra Pradesh	33.83
2	Arunachal Pradesh	4.45
3	Assam	30.35
4	Bihar	28.63
5	Chhattisgarh	12.22
6	Delhi	0.31
7	Goa	0.22
8	Gujarat	18.43
9	Haryana	10.48
10	Himachal Pradesh	0.59
11	Jammu & Kashmir	3.70
12	Jharkhand	5.96
13	Karnataka	16.81
14	Kerala	6.62
15	Madhya Pradesh	33.95
16	Maharashtra	35.73
17	Manipur	0.44
18	Meghalaya	1.23
19	Mizoram	0.04
20	Nagaland	0.42
21	Orissa	17.78
22	Punjab	22.56
23	Rajasthan	11.86
24	Sikkim	-
25	Tamil Nadu	22.94
26	Tripura	2.97
27	Uttar Pradesh	75.25
28	Uttarakhand	2.17
29	West Bengal	30.50
	Union Territories	
1	Andaman & Nicobar	0.31
2	Chandigarh	0.02
3	Dadara& Nagar Haveli	0.06
4	Daman & Diu	0.01
5	Lakshdweep	0.01
6	Puducherry	0.17
	Grand Total	**431.03**

[6] *Dynamic Ground Water Resource of India (as on March 2009) CGWB publication in 2011.*

Table 1.5: Region wise availability of ground water in India[7] (Volume in BCM)

Name of Region	Annual Replenishable Ground Water Resource	Natural Discharge during non-monsoon season	Net Annual Ground Water Availability	Annual Ground Water Draft	Stage of Ground Water Development (%)
1	2	3	4	5	6
Northern Himalayan States	6.46	0.53	5.93	2.09	35.31
Eastern Hilly States	39.91	3.43	36.54	6.21	17.00
Eastern Plain States	128.28	11.03	117.24	57.21	48.79
North Western Plain States	57.25	4.99	52.25	66.39	127.07
Western arid States	30.30	2.15	28.15	27.52	97.75
Central Plateau States	87.92	4.82	83.10	40.16	48.33
Southern Peninsular States	80.38	7.98	72.40	43.68	60.33
Islands	0.32	0.02	0.30	0.01	4.49
	431.03	**35**	**396**	**243**	**61%**

There is a large variation in the country also with respect to stage of development of ground water as can be seen from the table 1.4, the stage of ground water development in March 2009 varied from 4.49 percent in Islands,

---

7 B M Jha & S.K.Sinha, Towards Better Management of Ground Water Resources in India, BhuJal News Volume No. 24 , Number 4, Oct- Dec, 2009.

to 127 percent in North Western Plains of India while the average for the country is 61 percent.

1.3 Phenomenal Expansion of Ground Water Structures and its Impacts

Ground water development has been proceeding at an accelerated pace ever since the country entered the phase of Green Revolution under which high yielding and high water demanding crops were introduced in agriculture. Irrigation using tubewells and borewells started on a large scale from the eighties of the last century. Water intensive crops like sugarcane, rice and coconut started replacing earlier crops like maize, cotton and groundnut in many parts of the country. The present scenario is more than 85 percent of the rural and 50 percent of the urban drinking and industrial water supplies and more than 50 percent of the irrigated agriculture water requirements are met from ground water. This expansion of ground water has been a factor in changing cropping pattern and in raising agricultural production and productivity. It has also helped in sustaining subsistence cropping for millions of small and marginal farmers. It has, therefore, played an important role in poverty reduction.

Structures during the past four decades as can be seen from the figures of growth in the number of dugwells, shallow tubewells (T/W) and public tubewells and pumpsets from 1951 onwards given in tables 1.6 and 1.7 (which are somewhat overlapping). As a result, at present in India, there are about 19 million ground water structures and 7900m^3/year water is extracted per structure.

Table 1.6: Growth of Ground Water Abstraction Structures (in thousands) and Irrigation Potential[8]

Year	Dug-wells	Private Tubewell	Public Tubewell	Total	Pumpsets		CumulativeIrrig. Pot. created from Ground Water
					Electric	Diesel	
March 1951	3860	3	2.4	3865.4	21	66	6.5
March 1980	7786	2132	33.3	9951.3	3965	2650	22.00
March 1985	8742	3359	46.2	12147.2	5709	3550	27.82
March 1990	9407	4754	63.6	14224.6	8358	4365	35.62
March 1992	10120	5379	67.6	15566.6	9391	4585	38.89
March 1997	10501	6743	90.9	17334.9	-	-	45.73

Table 1.7 : Growth of Wells and Pump Sets[9] (all figures in thousands)

Year	Total Dug Wells	Total STW&DTW	Total E&D Pumps	Total Area Irrigated by in hectare		Percentage of Dug Wells that are Energised
				Dugwells	Tubewells	
1950-51	3860	5.4	87	6661.4	23.6	2.1
1960-61	4540	30.9	430	7155	135	8.8
1968-69	6100	374.7	1810	7714	3087	23.5
1973-74	6700	1160	4180	7679	5604	45.1
1977-78	7435	1770	5650	7943	7641	52.2
1979-80	7786	2165.3	6615	8557	9307	57.2
1984-85	8742	3405.2	9259	8828	11566	67
1989-90	9487	4817.4	12781	9837	14049	83.9
1994-95	11198	6517.4	16203	11803	17894	86.5

---

[8] *Ground Water Management in India, CGWA, Workshop on Past Achievements and Future Strategies, MoWR, Government of India.*

[9] *Minor Irrigation Census, Government of India as quoted in Ground Water Management in India by M. Dinesh Kumar, STW-Shallow Tubewells; DTW-Deep Tubewells*

Over the past two to three decades, the major expansion in irrigation capacity has taken place in the private ground water irrigation because of which ground water has become the life line for agriculture during this period. As per the latest 3rd Minor Irrigation Census 2000, the number of minor irrigation structures existing in the country are:

Table 1.8 : Minor Irrigation Structures in India(in thousands nos.)[10]

Region	Ground Water				Surface Water		
	Dugwell	**Shallow Well**	**Deep Tubewell**	**Sub Total**	**Lift**	**Flow**	**Sub Total**
North	1,197.6	1,570.8	92.1	2,860.5	5.6	25.7	31.3
North East	10.3	80	0.9	91.2	3.2	47.4	50.6
East	876.5	1,300	15.9	2,192.4	157	148.6	305.6
Central	1,606.9	3,943.2	77.6	5,627.7	228.8	140	368.8
West	2,599.8	112.6	171.6	2,883.8	104.1	90.3	194.4
South	3,335.7	1,349	172	4,856.7	108.1	189.9	298
Total	9,626.8	8,355.6	529.9	18,512.3	606.8	641.9	1,248.7

It may be recalled here that ground water irrigation structures fall almost entirely in the minor irrigation category. Thus, we see that there are more than 18.5 million ground water structures as of 2000-01. The number would have increased further by now.

Some states have witnessed very fast growth of ground water. The following table gives an idea of the fast growth of the ground water sector in Andhra Pradesh.

---

10 *3rd Minor Irrigation Census 2000*

Table 1.9: Development of Ground Water in Andhra Pradesh[11]

Year	Dug Wells in lakhs	Bore Wells in lakhs	Area Irrigation under Ground Water in lakh ha.
1971-72	6.90	1.13	8.03
1980-81	9.33	1.90	11.24
1990-91	13.67	3.94	17.61
2000-01	11.55	15.33	26.92
2004-05	8.78	16.01	24.79

Type of ground water extraction structures has changed from dug wells to d[12]eeper borewells. Well density has increased from 5 wells per sq. km. in 1995 to 20 wells per sq. km. now. A similar picture emerges in the case of Punjab and Haryana as can be seen from table 1.10 given below.

Table 1.10 : Number of Tubewells in Punjab and Haryana (Lakhs)[11]

	1970-71		2003-2004	
	Diesel	Electrical	Diesel	Electrical
Punjab	1.01	0.91	2.88	8.56
Haryana	0.17	0.86	2.43	3.64

Data provided by the report on 3rd Census of Minor Irrigation Schemes (2005) has revealed that in many states the irrigation potential created by the reference year of 2000-01 has exceeded the ground water potential of those states. It is shown below:

11 *Director, Economics and Statistics, Government of Andhra Pradesh as quoted in a note of state ground water department.*

12 *Kaledhonkar, M.J. and others, Groundwater Governance, 2007*

Table 1.11: States with High Irrigation Potential Created through Ground Water(thousand ha.)[13]

State	Ultimate Irrigation Potential through Ground Water	Irrigation Potential reportedly already created through Ground Water
Gujarat	2756	4364
Haryana	1462	2424
Maharashtra	3652	4568
Punjab	2917	6287
Rajasthan	1778	5840
Tamil Nadu	2832	2961

Ultimate potential assessment has been made based on the dynamic ground water zone recharged by mainly rain water. Rain water harvesting by artificial means supplements the recharge already taking place and helps in partly recouping declining water levels. Thus, some of the lost irrigation potential due to decline in ground water can be retrieved.

Based on Ground Water Estimation Committee-1997 **(GEC-1997)** methodology, CGWB has given a picture of all the assessment units in the country as of March 2009. This is described in the following table 1.12.

[13] *Report of Expert Group on "Ground Water Management and Ownership Planning Commission, September, 2007.*

Table 1.12 : State-wise Categorization of Blocks/Mandals/Talukas in India[14]

Sl.No.	States / Union Territories	Total No. of Assessed Units	Semi-critical		Critical		Over-exploited		*Remarks*
			Nos.	%	Nos.	%	Nos.	%	
	States								
1	Andhra Pradesh	1108	93	8	26	2	84	8	38- Salinity Affected
2	Arunachal Pradesh	16	0	0	0	0	0	0	
3	Assam	23	0	0	0	0	0	0	
4	Bihar	533	4	1	0	0	0	0	
5	Chhattisgarh	146	14	10	0	0	0	0	
6	Delhi	27	5	19	0	0	20	74	
7	Goa	11	0	0	0	0	0	0	
8	Gujarat	223	20	9	6	3	27	12	14 - Salinity Affected
9	Haryana	116	9	8	21	18	68	59	
10	Himachal Pradesh	8	0	0	1	13	1	13	
11	Jammu & Kashmir	14	0	0	0	0	0	0	
12	Jharkhand	208	2	1	2	1	4	2	
13	Karnataka	270	34	13	11	4	71	26	
14	Kerala	152	22	14	3	2	1	1	
15	Madhya Pradesh	313	61	19	4	1	24	8	
16	Maharashtra in 2006	353	19	5	1	0	9	3	
17	Manipur	8	0	0	0	0	0	0	
18	Meghalaya	7	0	0	0	0	0	0	
19	Mizoram	22	0	0	0	0	0	0	
20	Nagaland	8	0	0	0	0	0	0	
21	Orissa	314	0	0	0	0	0	0	6 - Salinity

[14] *Source : Dynamic Ground Water Resource of India, CGWB (March 2009)*

									Affected
22	Punjab	138	2	1	3	2	110	80	
23	Rajasthan	239	16	7	25	10	166	69	1 - Salinity Affected
24	Sikkim	4	0	0	0	0	0	0	
25	Tamil Nadu	386	67	17	33	9	139	36	11 - Salinity Affected
26	Tripura	39	0	0	0	0	0	0	
27	Uttar Pradesh	820	107	13	32	4	76	9	
28	Uttarakhand	17	5	29	1	6	0	0	
29	West Bengal	269	38	14	0	0	0	0	
	Total States	**5792**	**518**	9	**169**	3	**800**	14	
	Union Territories								
1	Andaman & Nicobar	33	0	0	0	0	0	0	
2	Chandigarh	1	0	0	0	0	0	0	
3	Dadra & Nagar Haveli	1	-	-	-	-	-	-	-
4	Daman & Diu	2	1	50	0	0	1	50	
5	Lakshadweep	9	4	44	0	0	0	0	
6	Pondicherry	4	0	0	0	0	1	25	1 - Salinity Affected
	Total Uts	**50**	**5**	10	**0**	0	**2**	4	
	Grand Total	**5842**	**523**	9	**169**	3	**802**	14	**71 - Salinity Affected**

Blocks- *Bihar, Chattisgarh, Haryana, Jharkhand, Kerala, M.P., Manipur, Mizoam, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, UP, UttaraKhand, WB;* ***Taluks*** *(Command/Non-Command) – Karnataka;* ***Mandal****- Andhra Pradesh;* ***Taluks*** *- Goa, Gujarat, Maharashtra, NCT Delhi;* ***Districts (Valley)*** *- Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura;* ***Islands*** *- Lakshdweep, Andaman & Nicobar Islands;* ***Region*** *– Puducherry;* ***UT*** *- Chandigarh, Dadar& Nagar Haveli, Daman & Diu*

Assessment units vary from state to state. It is block in Bihar, Chhattisgarh, Haryana, Jharkhand, Kerala, Madhya Pradesh, Manipur, Mizoram, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, Uttaranchal, West Bengal; Mandals (command/non-command) in Andhra Pradesh; Talukas in

Goa, Gujarat, Karnataka, Maharashtra; Districts in Arunachal Pradesh, Assam, Delhi, Meghalaya, Nagaland; Districts (Valley) in Himachal Pradesh, Jammu & Kashmir; State in Sikkim; Island in Lakshadweep; UT in Andaman & Nicobar, Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Pondicherry.

Pumping technology facilitated by subsidized or free power along with changes in cropping pattern have been mainly responsible for the rapid expansion in over- exploitation of ground water resources in India. Over the last three decades, more than 148 lakh pump sets have been energized in the country and out of the above 85.65 lakh pump sets have been energized under REC financed schemes till March 2006. At the same time cropping pattern has been changing in favour of water intensive crops as these are found to be more remunerative by the farmers as for example the large scale cultivation of paddy in Punjab and Haryana. This, in turn, has been prompted by agricultural price policies as well as agricultural trade policies being followed in recent years.

Adverse Effects

Growth in ground water exploitation, however, has led to a steep fall in water table in several parts of the country. Use of ground water is becoming unsustainable day by day. This has resulted in drying up of open dug wells and depletion of all important shallow aquifers in those areas with adverse impacts on water quality, health, livelihood and environment. It results in reduced supply of ground water for irrigation. Ground water flow to rivers also decreases. Water quality is deteriorating not only due to arsenic, fluoride or naturally inherent causes but also due to seepage of agricultural and industrial wastes and chemicals. The fall in ground water level and deterioration in quality give rise to drinking water shortages. Cost of pumping of ground water in terms of both finance and electricity –usage is increasing. Costs are also incurred on replacement or modification of pumps. Due to fall in water level to depths greater than 40 meters in summer, people find it difficult to obtain water from hand pumps. It is the poorer segments of the society who suffer more due to decline in ground water level. They are forced to purchase water from better off segments. The falling water table is a matter of special concern since it tends to reduce the accessibility of the resource to small and marginal farmers due to increase in costs of extractions. Larger farmers also suffer on account of rising financial liability for deepening wells and purchasing new equipment and for rising cost of operation along with reduced yield.

The stage of ground water development increased from 37.2 per cent in 1998 to 58 per cent in 2004 and 61 percent in 2009. The over-exploited blocks increased to 839 in 2004. The increase in the numbers of 'unsafe' (semi-critical, critical and over-exploited) blocks over the last 14 years (1992-2005) is indicated in the table below.

Table 1.13 : Increase in Non-Safe Areas[15]

	Dynamic Ground Water Resource Assessment			
Block Categorization	**1992**	**1998**	**2004**	**2009**
Over-Exploited	-	-	839	802
Critical	309	416	226	169
Sub Total	**309**	**416**	**1,065**	**971**
Semi-Critical	16	448	550	523
Total	**325**	**448**	**1,615**	**1494**

Out of the 5842 assessment units, 802 are categorized as over-exploited and 169 are critical while 523 are semi-critical. The change in the number of assessment units from OE to critical and semi-critical is attributes to the efforts of Government for water harvesting & artificial recharge to ground water along with regulation and awareness. Slight change in rainfall also attributes in some parts of the country. The following tables throw further light on the extent of over-exploitation in several states.

In reference to the table 1.12, the situation is really alarming in Delhi, Punjab, Haryana and Rajasthan where over-exploited areas constituted more than half

[15] *Source : John Kurien and Ashutosh Kumar Sinah, Groundwater Governance, 2007 & Dynamic Ground Water Resources of India, 2009 (CGWB Publication)*

of total ground water utilized. It is a matter of special concern that the over-exploitation of ground water has become an acute problem in several agriculturally important states e.g. Punjab, Haryana, Gujarat, Maharashtra, Rajasthan, Uttar Pradesh and Tamil Nadu.

There has been a continuous rise in the number of over-exploited, dark and saline category talukas in Gujarat State too. As per the estimation committee report, in 1986, five talukas were over-exploited, one in dark and two in saline category, while as per year 2002 estimation, 30 talukas were in over-exploited, 12 in dark and 14 in saline category.[16]

Kerala in the extreme south exhibits a similar trend. Here, all the blocks were in safe category till 1992. But by 2004, 5 blocks were categorized as over-exploited, 15 as critical and 30 as semi-critical.[17]

It can be stated that ground water exploitation in India is not a major problem at an aggregate level since India uses only about 61 percent of the annual utilizable potential of ground water as per 2009 data. But there are a few states and a few districts in those states where ground water overexploitation has become quite serious as per data already provided. Moreover, though confined to particular districts and blocks, ground water overexploitation has serious implications at the national level since as much as 70-80 percent of the value of irrigated agricultural output in India depends on ground water irrigation. Thus a large proportion of India's agricultural production as well as GDP are tied to the availability of ground water. Moreover, the states or districts that suffer from overexploitation of ground water constitute agriculturally important states and districts of the country with a heavy dependence on ground water.

---

[16]Yagnik, V.M. and others: Ground Water Governance in Over-exploited/Dark and Saline Areas of Gujarat state in *Ground Water Governance: Ownership of Groundwater and Pricing* (ed.): Dr.Saleem Romani and others, Capital Publishing Company, New Delhi 2007.

[17]Ajitkumar P.N. and A.S.Sudheer "Control and Regulation of Ground Water through Pricing of Water in the Kerala Scenario in *Ground Water Governance: Ownership of Groundwater and Pricing* (ed.): Dr.Saleem Romani and others, Capital Publishing Company, New Delhi 2007.

The situation is getting worse from day to day. Authorities have not been able to evolve appropriate measures to manage the emerging pressures. Mostly supply side measures focusing on increasing the availability of ground water are adopted. One such measure often advocated and adopted is of artificial recharge through rain water harvesting and watershed development. Steps taken to increase ground water recharge through watershed development and artificial recharge have not given the expected results. According to some surveys, water scarcity continued to prevail in drought years even in successful watersheds. These measures may reduce the problem at specific locations and are therefore welcome but they cannot solve it altogether at the national level because of their limited potential. Hence, the need is to develop adequate demand side or non-structural measures for moderating demand so as to bring about equilibrium between demand and supply. However, management of demand has been quite weak in India due to factors like institutional inadequacy, general apathy and lack of political will.

Ground water is becoming an increasingly scarce resource because of its unabated and indiscriminate over-exploitation. The situation is fast deteriorating. The need of the hour is how to check the fast depleting ground water reserves has become a major challenge in India. The existing economic, technical, social and regulatory methods have almost failed to tackle the problem. If attempts are not made now to protect the future degradation of water table, the situation will be more critical in near future which would have serious implications for the welfare of future generation since ground water has become the primary source of irrigation, domestic and industrial use in India. There is an urgent need to change the focus from development to sustainable management of this resource through sound governance.

1.4 Need for the Study

The challenge of sound governance of ground water resources underscores the need for a review of the legal and institutional framework for regulating and managing ground water utilization under varying physical and socio-economic conditions. Information on this aspect was found to be inadequate about five years ago when the need for a study of this aspect was mooted. There was lack of a systematic all India study on the subject. It was not known whether and to what extent, the grassroots level implementing personnel like the Patwaris, Junior Engineers, Taluka Development Officers etc. were aware of the provisions of the prevailing legal and institutional set up for regulating use of ground water.

It was not known whether there was political will at the state level to enforce regulations of ground water exploitation in the larger social interest. Very little information was available on the extent to which Panchayati Raj Institutions or other institutions or associations at the local level were and could be involved in ground water utilization. Further,

- Were NGOs playing any part in this?
- Did the government have any effective administrative machinery at the grass-roots level to enforce its directives under the prevailing legal system?

Moreover, the legal and institutional back up for ground water was assessed to be quite weak because of which indiscriminate exploitation of ground water resulting in continuous increase in "non-safe" areas was taking place. A thorough all India study was needed before suggesting appropriate measures for strengthening the legal and institutional framework for ground water.