Report of the Expert Group on

"Ground Water Management and Ownership"

September 2007

Planning Commission
Yojana Bhawan
New Delhi-110001

GROUND WATER MANAGEMENT AND OWNERSHIP

Report of the Expert Group

GOVERNMENT OF INDIA
PLANNING COMMISSION
New Delhi

September 2007

We, the Members of the *"Expert Group to review the Issue of Ground Water Management & Ownership"*, hereby submit our Final Report.

Kirit S. Parikh
Chairman, Expert Committee
Member, Planning Commission, Government of India

Dr. Tushar Shah
Principal Scientist
International Water Management Institute

Dr.B.K. Chadha
Ex. Chairman
Central Ground Water Board

Navroz Dubash,
Associate Professor
National Institute of Public Finance& Policy

Nirmal Mohanty
Principal
Infrastructure Development Finance Company

Harnath Jagawat
Director
N.M. Sadguru Water &
Development Foundation

P. Chengala Reddy,
President
Federation of Farmer's Association
Andhra Pradesh

B.M. Jha
Chairman
Central Ground Water Board

Dr. M. Moni
Director General
National Informatics Centre

V.S. Dhumal
Pr. Secretary (WR), Government of Maharashtra

K.J. Mathew
Secretary, Government of Kerala

N.S. Palaniappan
Secretary (Irrigation), Government of Tamil Nadu

Kuldip Singh Takshi
Director (WR), Government of Punjab

Convenor

Avinash Mishra
Deputy Adviser(WR), Planning Commission

एम. एस. आहलुवालिया
MONTEK SINGH AHLUWALIA

उपाध्यक्ष
योजना आयोग
भारत
DEPUTY CHAIRMAN
PLANNING COMMISSION
INDIA

FOREWORD

India has 16% of the world's population but only 4% of the total available fresh water. We face many challenges in meeting the demand for water as most parts of the country face water scarcity during some parts of the year. Water scarcity creates conflicts, which need to be resolved in a rational way.

Ground water, which is 38.5% of the available water resources of the country, plays a major role in irrigation, rural water supply and even in meeting industrial and drinking water needs. Ground water is an open access common property natural resource and anyone can bore a well and pump out water without limit. The cost of such extraction in the case of agriculture is artificially low because of the very low rates for power for agriculture. This inevitably leads to excessive extraction and as a result the ground water table has gone down in many parts of the country. There is an obvious urgency about managing ground water in a sustainable way.

What action should the government take in this situation? What can it do, given the legal provisions concerning ownership of ground water? To explore the questions of ownership and management of ground water, the Planning Commission had set up an Expert Group under the Chairmanship of Dr. Kirit S. Parikh. The Group's report has examined issues relating to legal provisions concerning ownership of ground water and the right of the government to intervene in this area. Experience of ground water management in different States and some countries has been analysed and discussed.

The report has suggested an approach to sustainable management of ground water. It will be an input into policy formulation for the XI Plan and will help in sustainable development of ground water in the country.

(Montek Singh Ahluwalia)

योजना भवन, संसद मार्ग, नई दिल्ली-110001 दूरभाष : 23096677, 23096688 फैक्स: 23096699
Yojana Bhawan, Parliament Street, New Delhi-110001 Phones : 23096677, 23096688 Fax: 23096699
E-MAIL : dch@nic.in

डॉ. किरीट एस. परीख
Dr. Kirit S. Parikh

सदस्य
योजना आयोग
योजना भवन
नई दिल्ली–११० ००१
MEMBER
PLANNING COMMISSION
YOJANA BHAWAN
NEW DELHI-110 001

Preface

Ground water plays a crucial role in the country in increasing food and agricultural production, providing drinking water and facilitating industrial development. Ground water meets nearly 55% of irrigation, 85% of rural and 50% urban and industrial water needs. The use of ground water in the agriculture sector has expanded rapidly because of the short gestation lags with which it can be developed, control over irrigation that it provides, free or subsidized availability of power in some states and paucity of surface irrigation.

In many states, ground water extraction has exceeded annual recharge and water tables have gone down. Since ground water is an open access resource, the tragedy of commons often occurs where everyone tries to extract as much water as she can and degrades the resource. This raises a number of questions. How do we make ground water use sustainable? Who owns the ground water? What policies, institutional and legal framework can promote sustainable use of ground water?

The Mid Term Appraisal of the Xth Plan had expressed concern about these issues and suggested setting up an Expert Group to review the whole issue of ground water management and ownership. The Committee was constituted in October, 2005 and was to submit the report within four months. Given the complexity involved and wider consultation needed, the term of the Committee was extended upto 31st May, 2007.

It is my pleasure and also my privilege to thank all the Members of the Committee for their many important suggestions and for sparing their valuable time towards the finalisation of this report. I am thankful to Shri A. Sekhar (Ex. Adviser), Planning Commission for his significant contributions and Shri Ajay Shanker, Principal Adviser(WR), Planning Commission for his inputs. After Shri Shekhar left the Planning Commission, Shri Avinash Mishra, Deputy Adviser(WR) took over the responsibility as Member Convenor of the Group. For his contributions and help in drafting the report I thank him. I also thank Rana Chatterjee and Shri Shashank Sekhar, Scientist of Central Ground Water Board for their contributions that clarified many issues of ground water recharge. I also thank "Hemant Sahay and Associates" for providing advice on the constitutional issues of ground water ownership.

Finally, I want to thank Shri Sanjay Vasnik and Shri M. Radhayi for diligently, carefully and cheerfully typing many drafts of the report.

Kirit S Parikh

(Dr. Kirit S. Parikh)
Member (Water & Energy)
Planning Commission &
Chairman, Expert Group to Review the issue of
Ground Water Ownership in the Country

Dated: 08.08.2007

दूरभाष +91-11-23096568 टेलीफैक्स +91-11-23096569
Telephone : +91-11-23096568 Telefax : +91-11-23096569 e-mail : kirit.parikh@nic.in

A Water Prayer

The waters of sky,
the waters of rivers,
and water in the well,
whose source is the ocean,
may all these sacred waters protect me.

- Rig Veda

GROUND WATER IN SANSKRIT LITERATURE

The study of our scriptures reveals that ancient Indian thinkers such as Sarasvatu, Manu with scientific bent were not only interested in exploring the means of storing rain-water but also exploring the methods to locate ground water sources. Many Sanskrit works like Brihatsamhita of Varahamihira, Arthasastra of Kautilya etc., describe the interior of the earth to be full of water channels, like the veins in the human body, further subdividing into hundreds and thousands of streams at different levels causing life of different plants and trees on the earth. These works claim that on the basis of certain plants and trees, ground water resources can be explored in the areas where surface water is not available. There are other methods like smell of soil and character of rocks using which it can also be assessed whether water is sweet, saline, acidic or bitter.

Courtesy:
Prof R.N. Jha,
Jawaharlal Nehru University)

Contents

List of Tables

List of Figures

List of Boxes

Annexures

1. Introduction

1. The Mid-term Appraisal (MTA) of the Tenth Five Year Plan, carried out by the Planning Commission, was considered by the National Development Council (NDC) in its 51st meeting held on 27th and 28th June, 2005. The NDC broadly agreed with the goals and objectives of the MTA. In the water sector, the MTA has expressed concern about the rapid decline of ground water levels in some parts of the country. The MTA suggested setting up of an Expert Group to review the issue of ground water management and ownership.

2. The Planning Commission, vide its order 17(2)/05-WR dated 21st October, 2005 accordingly constituted an Expert Group under the Chairmanship of Dr. Kirit S. Parikh, Member (Energy & Water), Planning Commission. The constitution of the Expert Group and the terms of reference assigned to it are at **Annexure 1.1.** The Group was initially required to submit its report in four months. Subsequently, vide order dated 5th May 2007, the time for submission was extended to 31.05.2007. (**Annexure 1.2**)

3. The Group was required to address the following:

i) to take stock of the ground water situation in the country in regard to availability, present use and projected demand;

ii) to identify reasons for fall in ground water levels in certain parts of the country;

iii) to review the efficacy of ground water recharge schemes implemented so far;

iv) to study the effectiveness of legislation where enacted;

v) to review the present legal position regarding ground water ownership; and suggest modifications keeping in view international practices;

vi) to suggest other measures to tackle the ground water management problem; and

vii) any other issue which the Group may consider relevant.

4. The Group held four meetings viz. on 17th November 2005, 30th January, 2006, 21st April, 2006 and 4th May, 2007. Based on the deliberations held in these meetings and inputs provided by the Members of the Expert Group, the findings and recommendations of the Group were finalised and are presented in the ensuing sections of the report.

5. By way of introduction, a brief outline of the context of the review is in order. The primary source of fresh water is rainfall (which reaches people mainly at surface) and ground water. The demand for fresh water in the country has been rising over the years due to increased demand for food production and growing urbanisation and industrialisation. Currently, total water use (including ground water) is 634 BCM, of which 83% is for irrigation. The demand for water is projected to grow to 813 BCM by 2010, 1093 BCM by 2025 and 1447 BCM by 2050, against utilisable quantum of 1123 BCM.[1] Clearly, the *overall* demand will outstrip availability in another

[1] The average annual rainfall in the country is 1170 mm which corresponds to annual precipitation, including snowfall of 4000 billion cubic meters (BCM). Out of this volume of precipitation, only 1869 BCM appears as average annual potential flow in rivers. Due to various constraints, only 1123 BCM is assessed as the average annual utilisable water – 690 BCM from surface water and 433 BCM from ground water.

35 to 40 years, while ground water in particular will come under even greater pressure in the intervening years.

6. The problem is not as far away as it appears from an aggregate analysis. In reality, what really needs to be addressed is the demand-supply imbalance at the local level, which has already acquired serious proportion in some parts of the country, as manifested by declining water tables. This is not really surprising, as historically little control has been exercised on ground water pumping with landowners having the right to capture unlimited amount of groundwater from beneath their land without being liable for injury to neighbours. The approach may have been adequate earlier when demand from any given aquifer was limited, but not now, given that the demand has increased sharply. The aim of the new approach would be to attain greater 'sustainability in groundwater", defined as, "use of ground water in the manner that can be maintained for an indefinite time without causing unacceptable environmental, economic or social consequences".[2] In this context, the Group would attempt to find answers to the following questions:

- What is the state of ground water use in the country?
- What is the potential to increase the availability of ground water through augmented recharge of rain water harvesting?

Whatever may be the potential of water harvesting and ground water recharge, it will be limited and only provide short-term relief as the use of water keeps growing. The main question, therefore, is—

- How to promote sustainable use of water, given our Constitution, federal structure, legal framework and very small land holdings?

This raises other questions:

- Who has the right over ground water?
- What is the constitutional position?
- Since water is a State subject, what can the Central Government do?

Apart from these issues, there is also the question of deep aquifer reportedly with vast reserves of water accumulated over centuries. In a sense this is a wasting asset as the water overtime becomes unusable The issues here are—

- What is the potential of deep water aquifer?
- How much can be used annually?
- How to exploit it and how much will it cost?

We have addressed these issues.

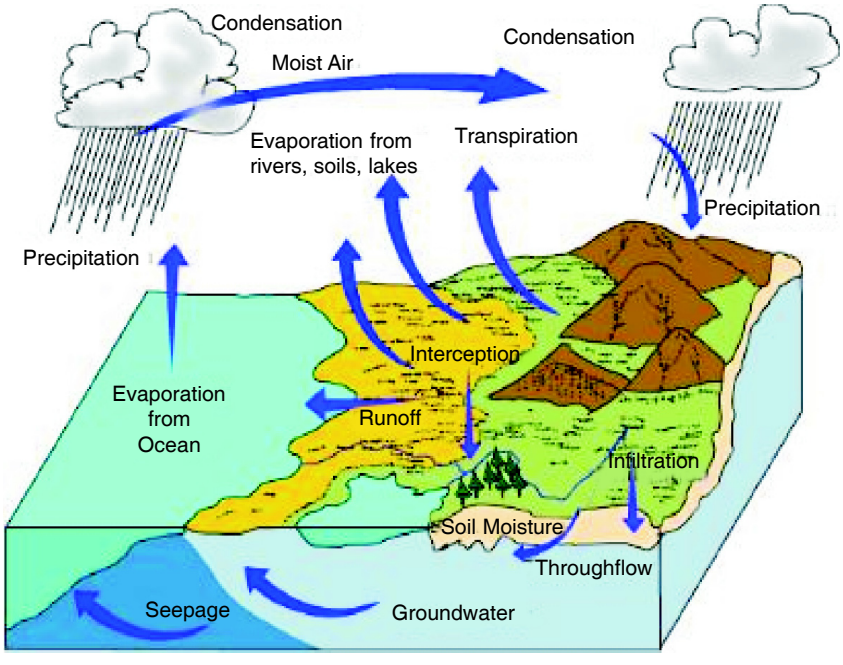
7. *Chapter 2* takes stock of the availability and use of groundwater and outlines the extent, causes and consequences of overexploitation. Subsequently, the scope and efficacy of groundwater recharge is discussed (*Chapter 3*). *Chapter 4* reviews the legal position and the emerging role of Central Government in groundwater management. *Chapter 5* and *Chapter 6* discuss the domestic and international experience respectively in groundwater management and draw lessons from them. In *Chapter 7*, a number of initiatives to promote groundwater sustainability has been suggested. *Chapter 8* concludes.

[2] This definition is adopted by the United States Geological Survey.

2. Emerging Scarcity of Ground Water Resources

2.1 Source of Ground Water-Hydrological Cycle

1. Most of the earth's water sources get their water supplies from precipitation, which may fall in various forms, such as, rain, snow, hail, dew etc. Rains no doubt, form the principal and the major part of the resultant supplies. When rain starts falling, it is first of all intercepted by buildings and other objects. When the rainfall rate exceeds the interception rate, water starts reaching the ground and infiltration starts. This is the source of ground water storage.



2. The average annual rainfall in the country is 1170 mm, which corresponds to annual precipitation, including snowfall of 4000 billion cubic meters (BCM). Out of this volume of precipitation, only 1869 BCM appears as average annual potential flow in rivers. Due to various constraints, only 1123 BCM is assessed as the average annual utilisable water – 690 BCM from surface water and 433 BCM from ground water.

3. The present total water use is 634 BCM of which 83% is for irrigation. This is projected to grow to 813 BCM by 2010, 1093 BCM by 2025 and 1447 BCM by 2050, against utilisable quantum of 1123 BCM. Thus the demand will outstrip availability in another 35 to 40 years. The Central Ground Water Board has estimated the present annual ground water draft as 230.6 BCM.

2.2. Availability and Use of Groundwater

4. Ground water is essentially a dynamic resource with both passive and active recharge zones. The annual replenishable groundwater resource (433 BCM) referred in *Chapter 1* is the recharge to the active recharge zone or dynamic

zone (unconfined aquifer where recharge takes place annually from the rainfall and other sources, infiltrating directly to the water table). The static fresh ground water resources lie beyond the dynamic zone and is called the passive recharge zone (See below).

5. The overall stage of ground water development in the country is 58%, indicative of a comfortable situation at the aggregate level. This however masks the high degree of variability in availability and development throughout the country (See *Table 1*, *Figure 2* and **Annexure 2.1**).[3] It can be seen from *Table 1* that in Indo-Gangetic and Brahmaputra plains, ground water potential is very high; such areas can support large scale development. In peninsular India and hilly states, however, groundwater potential is relatively much lower.

6. As regards use, the extent of extraction has increased significantly over the years, as indicated by the growth in the number of wells and tube wells served by ground water (*Table 2*). It is estimated that there are currently 19 million wells in the country, out of which 16 million are in use and are drawing about 231 BCM of water—213 BCM for irrigation and 18 BCM for domestic and industrial use—out of net annual ground water availability of 399 BCM (**Annexure 2.1**). It can be seen from **Annexure 2.1** is that there is

Table 1: Coverage and Potential of Ground Water Systems in the Country

System	Coverage	Ground water potential
Unconsolidated formations - alluvial	Indo-Gangetic, Brahmaputra plains	Enormous quantities up to 600 m. High rain fall and hence recharge is ensured. Can support large-scale development through deep tube wells
	Coastal states	Reasonably extensive aquifers but risk of saline water intrusion
	Part of Desert area – Rajasthan and Gujarat	Scanty rainfall. No recharge. Salinity hazards. Availability at great depths.
Consolidated/semi-consolidated formations - sedimentaries, basalts and crystalline rocks	Peninsular	Availability depends on secondary porosity developed due to weathering and fracturing. Scope for availability at shallow depths (20-40 m) in some areas and deeper depths (100-200 m) in other areas. Varying yields.
Hilly	Hilly states	Low storage capacity due to quick runoff

Table 2: Growth of Wells in the Country

(in thousands)

Year	Dug wells	Private & public tube wells	Total
1951	3860	5.4	3865
1980	7786	2165	9951
1985	8742	3405	12147
1990	9407	4817	14224
1992	10120	5446	15566
1997	10501	6833	17334

[3] Note:Stage of ground water use is defined as:

$$\frac{\text{Annual ground water draft}}{\text{Net annual ground water availability}} \times 100$$

a high degree of variability in annual groundwater draft vis-à-vis net availability across states. Another important point to note is that by the year 2025, the demand for domestic and industrial uses is projected to rise to 29 BCM from the current level of 18 BCM.

2.2.1 *ìStaticî Ground Water*

7. Aside from the aquifers of the active recharge zone which get charged every year and which constitute the dynamic fresh ground water resource, there are deeper aquifers below the zone of water level fluctuation. These deeper aquifers of passive recharge zone contain vast quantity of water. The water in these aquifers has accumulated over many years. This water is often called 'static' water though in reality it also flows but very slowly. "In the alluvial areas, these resources are renewable and get replenished over long period from recharge areas flanking the mountains. However, in some cases like the "Lathi aquifers" in Rajasthan the in-storage resources comprise fossil water, which is of non-renewable nature" [Romani (2006)]. The tentative estimate of in-storage fresh groundwater in the country is about 10,800 BCM (See *Table 3*).

Table 3: Static Fresh Ground Water Resource-Statewise

S. No.	States	Static Fresh Ground Water Resource		
		Alluvium/ Unconsolidated Rocks Km^3	Hard Rocks km^3	Total km^3
1.	Andhra Pradesh	76	26	102
2.	Assam	920	0	920
3.	Bihar	2557	11	2568
4.	Gujarat	92	12	104
5.	Haryana	420	1	421
6.	Himachal Pradesh	13	0	13
7.	Jammu & Kashmir	35	0	35
8.	Karnataka	0	17	17
9.	Kerala	5	6	11
10.	Madhya Pradesh	14	27	41
11.	Maharashtra	16	22	38
12.	Orissa	162	13	175
13.	Punjab	910	0	910
14.	Rajasthan	115	13	128
15.	Tamil Nadu	98	0	98
16.	Tripura	101	0	101
17.	Uttar Pradesh	3470	30	3500
18.	West Bengal	1625	1	1626
19.	Delhi	3	0	3
20.	Chandigarh	1	0	1
	Total	**10633**	**179**	**10812**

Source: Ministry of Water Resources (1999), "*Integrated Water Resource Development – A Plan for Action*", Report of the National Commission for Integrated Water Resources Development – Volume I.

Note: 1. In-storage Ground Water Resources = Volume of aquifer zone x Specific yield.
2. The estimations are for aquifer zones below the zone of water table fluctuation.
3. The estimation pertains to depth of 450 m in alluvial terrain and 100 m in hard rock terrain.
4. The estimate is based on district wise ground water resources.

8. The question that arises is that given the huge shortage of groundwater in some parts of the country, is there a case for exploiting this untapped 'static' water? Experts seem to agree on the ground that its under utilisation creates anear stagnant condition and over time, leads to deterioration in quality. Dr. Saleem Romani (2006), former Chairman of Central Ground Water Board, for example, observes *"there is ample scope of ground water development from deeper aquifers in Punjab, Haryana and U.P. The studies by CGWB in alluvial parts of Haryana and U.P. have revealed the existence of a huge reserve of ground water in the deeper aquifers, which has not been fully utilised. The thickness of the alluvium in the area exceeds 500 m. and only a small fraction of this is under active circulation due to prevailing shallow ground water development. The under utilisation of the ground water from deeper aquifers has resulted in near stagnant conditions at depth and provided the necessary time factor for the deterioration in quality of ground water. It was observed that calcium bicarbonate type water occurs in quality of ground water. This water gradually deteriorates to sodium bicarbonate type with depth, indicating a base exchange between the cations of ground water and the sub-surface clays. In the ground water discharge areas the potentiometric head of water in the deeper aquifers have been recorded to be higher than that in the shallow aquifers. Slowly but surely, the inferior quality water leaks upwards as well as laterally to deteriorate the quality of water in shallow aquifers of downstream areas"*.

2.3 Over-exploitation: Extent, Causes and Consequences

2.3.1 *Extent of Over-exploitation*

9. According to the report on *3rd Census of Minor Irrigation Schemes* (2005), the ultimate irrigation potential from ground water source is 64.05 m.ha., as compared to 46 m.ha. of land currently under groundwater irrigation, indicating further scope for developing ground water in some areas (such as the eastern and north-eastern parts of the country). The report (reference year 2000-01) has however revealed that in many states, the irrigation potential created has exceeded the ultimate potential, showing that mining of

Table 4: States With High Irrigation Potential Created/Utilised Through Ground Water

(thousand ha.)

State	Ultimate irrigation potential through ground water	Irrigation Potential reportedly already created through ground water	Irrigation potential utilised through ground water
Gujarat	2756	4364	2713
Haryana	1462	2424	2267
Maharashtra	3652	4568	3311
Punjab	2917	6287	5748
Rajasthan	1778	5840	3844
Tamil Nadu	2832	2961	1666

Source: Report on 3rd Census of Minor Irrigation Schemes, Ministry of Water Resources, 2005.

Note: 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.

ground water, that is exploitation beyond the dynamic resource, is already taking place. (*Table 4*)

The degree of exploitation has varied widely across the country. Some states have a large number of semi critical, critical and over-exploited assessment units (**Annexure 2.3**).[4] Out of the 5723 assessment units assessed jointly by State Ground Water Departments and CGWB in the country, 4078 are safe (71%), 550 are semi critical (10%), 226 are critical (4%) and 839 are over-exploited (15%) (*Figure 1*). Just six states [Gujarat, Haryana, Maharashtra, Punjab, Rajasthan and Tamil Nadu] comprising 1413 assessment units, have 762 assessment units which are semi critical, critical or overexploited (54% against national average of 29%).

10. How has the groundwater status of various parts of the country changed over time? Comparable time series data on proliferation of semi-critical, critical and over-exploited blocks in the country is unfortunately not available. In 1995, the Central Ground Water Board published

Table 5: Criteria for Categorisation of Assessment Units

Stage of ground water use	Status of decline in water level	Categorisation
<= 90%	no pre & post monsoon significant long term decline	Safe
>70% and <= 100%	Significant long term decline in either pre monsoon or post monsoon	Semi-critical
>90% and <= 100%	Significant long term decline in both pre monsoon and post monsoon	Critical
>100%	significant long term decline in pre or post monsoon or both	Over exploited

Note: Stage of ground water use is defined as:

$$\frac{\text{Annual ground water draft}}{\text{Net annual ground water availability}} \times 100$$

Table 6: Ground Water Status of Assessment Units in India

A. Ground Water Status, 1995

Assessment units	Total number of assessment units	Dark		Over exploited	
		No.	%age	No.	%age
No. of blocks	4272	107	3	231	5
No. of mandals (Andhra Pradesh)	1104	24	2	6	1
No. of taluks (Gujarat)	184	14	8	12	7
No. of Watersheds (Maharashtra)	1503	34	2	—	—
Total	**7063**	**179**	**3**	**249**	**4**

B. Ground Water Status, 2004

Assessment units	Total number of assessment units	Semi critical		Critical		Over-exploited	
		No.	%age	No.	%age	No.	%age
Blocks/Mandals/ Talukas	5723	550	10	226	4	839	15

[4] The CGWB norms for the various categories are given in Table 5.

data based on 1984 methodology of classification of such blocks. As per the data, the percentage of over-exploited and dark assessment units to total was about 7% (*Table 6 A*).

11. An estimate for 2004 based on the 1997 methodology, which was somewhat different from the earlier methodology is given in *Table 6 B*. According to the estimate, out of 5723 blocks, 1615 are semi-critical, critical or over-exploited (28%) (Statewise details are given in **Annexure 2.3**). Even though the 2004 estimates are not strictly comparable with the 1995 estimates, they clearly indicate a deterioration, as the differences between the two estimates are too large to be explained by the minor differences in the classification methodology used in the two estimates. The percentage of over exploited blocks, has increased from 4% to 15%, making over-exploitation of ground water a matter of concern.

2.3.2 *Causes of Over-Exploitation*

12. In most parts of the over-exploited areas, the prime cause of over-exploitation is the rising demand for groundwater from agriculture. [In some parts, it is growing urbanisation and industrialisation.] Further, in many groundwater irrigated areas, decisions on cropping pattern and cropping intensity, which are the predominant determinants of agricultural demand for groundwater, are being taken largely independent of the ease of ground water availability. Thus, water intensive crops have tended to be grown even in the face of scarcity of groundwater, if these crops are perceived to be relatively remunerative. Such distortions occur partly due to the legal/ regulatory regime governing groundwater (See *Chapter 4*) and partly to the minimum support price policy and agricultural trade policy currently being followed.[5]

13. The problem has been compounded by the availability of cheap/subsidised or even free power in many states, since power is a main component of the cost of groundwater. Moreover, electric supply is not metered and a flat tariff is charged depending on the horsepower of the pump. This makes the marginal cost of power zero and provides farmers with little incentive to use power or water more efficiently. **Annexure 2.4** gives the state-wise percentage of over exploited/critical blocks to total blocks, average tariff for agriculture sector and total subsidy for the sector. Power subsidy has undoubtedly encouraged greater use of groundwater.

2.3.3. Consequences of Over-Exploitation

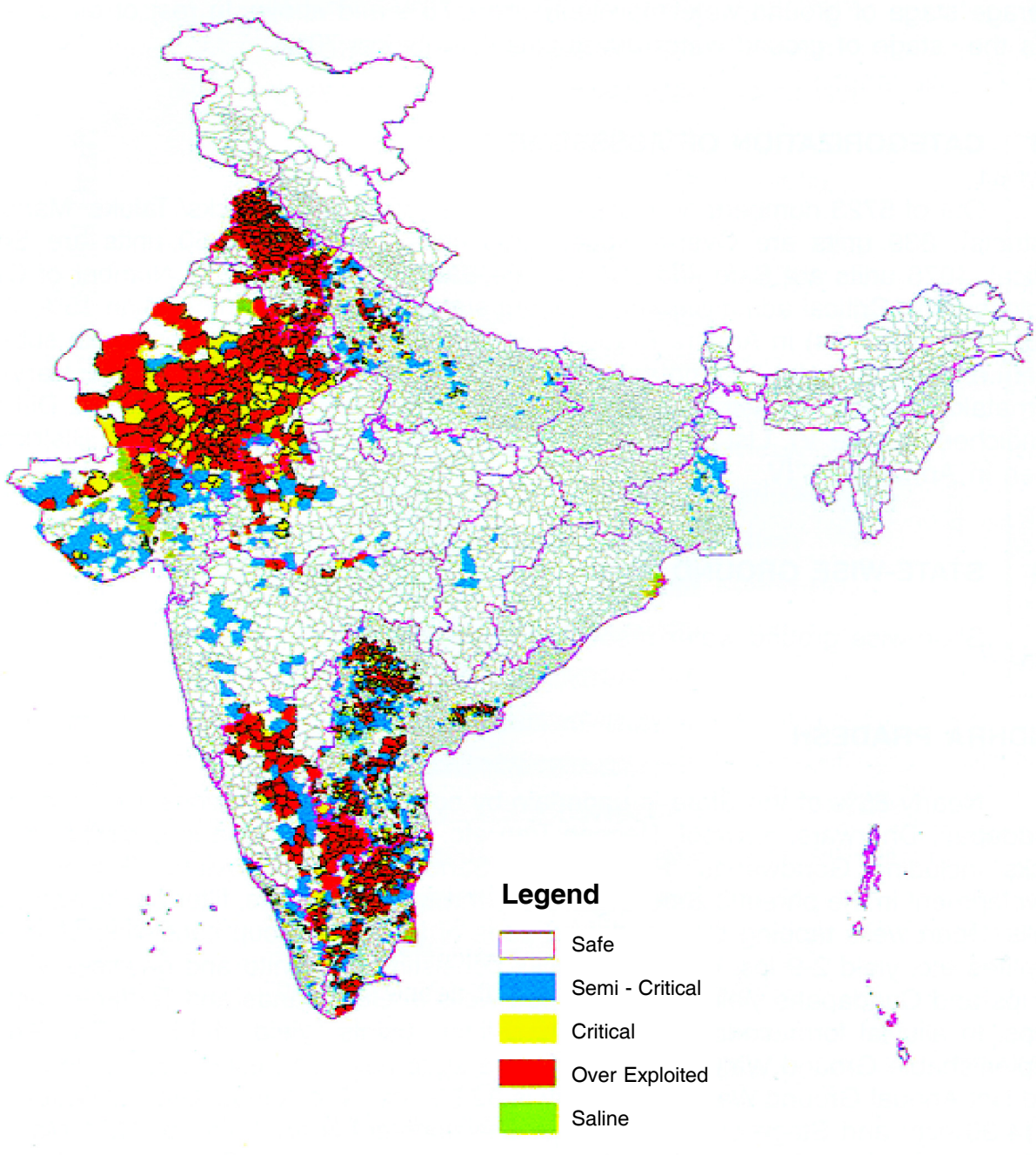
14. Overexploitation leads to (i) increase in pumping depths, reduction in well/tube well yields and rise in the cost of pumping ground water and (ii) widespread and acute scarcity of ground water in summer months for irrigation and drinking uses. This forces farmers to deepen their wells and install larger pumps. Rich farmers may cope with this challenge relatively easily, but small and marginal farmers, many of whose wells are supported by shallow aquifers, often find it difficult.

15. Another fallout of ground water over-exploitation has been contamination of ground water due to geogenic factors (i.e. because of particular geological formation at deeper levels), resulting in increasing levels of fluoride, arsenic and iron. Ground water in some parts of West Bengal and Gujarat, which are contaminated by arsenic and fluoride now, were safe at the time of

[5] Both these policies have strong influence on how remunerative a crop is. A discussion on these policies, however, is not within the scope of this report.

Figure 1

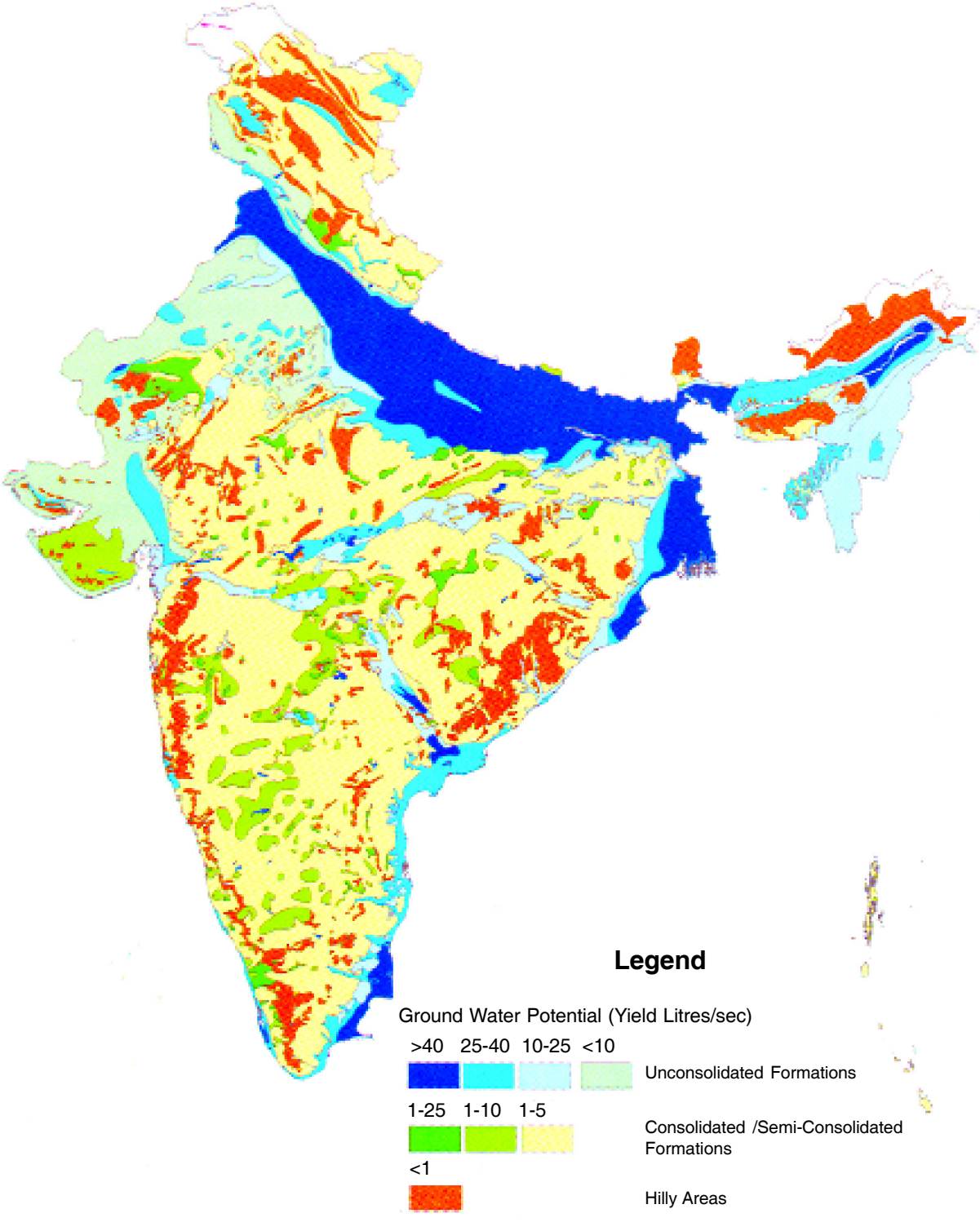
CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS AS ON MARCH, 2004



Source: *Dynamic Groundwater Resources of India (as on March 2004), Central Ground Water Board, Ministry of Water Resources, 2006.*

Figure 2

HYDROGEOLOGICAL MAP OF INDIA



Source: *Dynamic Groundwater Resources of India (as on March 2004), Central Ground Water Board, Ministry of Water Resources, 2006.*

independence. Since 85% of rural water supply programme depends on ground water as the source, effects on health of rural population due to such contamination is a matter meriting serious attention. Further, overexploitation in coastal areas leads to salinity ingress, which eventually results in fresh water turning saline. Environmental impact of overexploitation occurs in other ways too. It can, for example, potentially lead to reductions in essential base flow to rivers and streams, and diminished spring flows.

16. On both counts stated above (i.e., reduced quantity and lower quality) agricultural sustainability suffers. It may be observed that over-exploitation has occurred in agriculturally crucial states, such as Punjab, Haryana, Gujarat, Maharashtra and Andhra Pradesh. Further, to the extent the depletion of groundwater raises demand for electricity, it undermines the viability of the power sector, as power for agricultural use is highly subsidised.

3. Ground Water Recharge and Efficacy of Implemented Schemes

3.1 Groundwater recharge: Rationale, Methods and Potential

1. In view of the increasing thrust on development of ground water resources, there is an urgent need to augment these depleting resources in the active recharge zone. This can be augmented through natural or artificial recharge. Rainfall is the main source of both types of recharge. The rainfall occurrence in different parts of India is limited to a period ranging from about 10 to 100 days. The natural recharge to ground water reservoir is restricted to this period only and is not enough to keep pace with the excessive continued exploitation. Since large volumes of rainfall flows out into the sea or get evaporated, artificial recharge has been advocated to supplement the natural recharge. Artificial Recharge is the process by which the ground water reservoir is augmented through increased infiltration by using artificial structures. It may be noted however that to the extent artificial recharge reduces water flowing into existing lakes/ ponds/reservoirs lower down the catchment, it is not a net addition to available groundwater but only a re-distribution across different areas, which might be socially desirable.

2. The dominant method of artificial recharge is through the use of civil structures (such as percolation tank, check dams, recharge shafts etc) that arrest or slow down surface runoff, under suitable hydro-geological and hydrologic conditions. Some states such as A.P., Gujarat, Karnataka, Tamil Nadu, Rajasthan, Maharashtra, Madhya Pradesh have implemented few schemes for construction of these structures at scattered locations. Another method involves creation of additional bank storage in the flood plains of perennial rivers by withdrawal of ground water during non-monsoon season and facilitating recharge/infiltration of a fraction of floodwater during rainy season. Currently, few pilot project studies have been done on the river bank storage enhancement by CGWB and other agencies. [6]

3. What is the magnitude of annual potential recharge in the country? A study by Central Ground Water Board (CGWB) "*National Perspective Plan for Recharge to Ground Water by Utilising Surplus Monsoon Runoff, CGWB, 1996"* has indicated that the average monsoon runoff in the river basins of country is about 1548 BCM, of which non-committed surface water available for recharge is about 872 BCM. (**Annexure 2.2**). Out of this 872 BCM, a part can be stored in the sub-surface vadose zone (i.e. the saturation zone of the river basins up to 3 m below ground level), the scope for which has been estimated at about 214 BCM. In 2002, the *Master Plan for Artificial Recharge to Ground Water in India* was prepared by the CGWB taking into consideration feasible areas for artificial

[6] During rainy season, the flood water spreads over the plain and due to shallow water table the rejected recharge result in river out-flows. Central Ground Water Board constructed about 95 tubewells in northern part of Yamuna flood plain area in Delhi in the depth range of 38-50 m for Delhi Jal Board. On the basis of scientific study, it has been recommended that nearly 30 MGD of water can be safely drawn from the tubewells during monsoon and non-monsoon seasons to meet drinking water requirement. In this process a part of flood water (rejected recharge) is utilised to augment sub-surface storage.

recharge on the basis of depth and declining trend of ground water levels. The master plan quantifies the feasibility of artificial recharge in the country. It is estimated that annually about 36.5 BCM of surplus surface runoff can be used for recharging ground water.

3.2 Government Schemes for Recharge: Motivation and Results

4. Artificial recharge through rain water harvesting is being practised in different parts of the country. However, it is seen that the selection of sites and type of recharge structures are not always compatible with hydrological and hydro-geological conditions. As a result, the desired benefits have not been realised.

5. For developing model artificial recharge structures suited to different agro-climatic and hydro-geological set-ups, the CGWB initiated 165 artificial recharge schemes under Central Sector during the Ninth Plan with active involvement of State Government/UTs. The recharge projects were taken up in water-scarce areas having surplus monsoon runoff and sufficient sub-surface storage space and also in coastal areas affected by seawater ingress.

6. The studies to assess the impact of the scheme provide evidence that artificial recharging yields encouraging results in terms of arrest of rate of decline in ground water levels, reduction of run off, increased availability of ground water especially in summer months (when the demand is more), increase in irrigation, revival of springs, improvement of the environment through increase in soil moisture and improvement in groundwater quality.

7. The studies further reveal that the efficacy of an artificial recharge scheme is not uniform and depends largely on the source of water availability, capability of ground water reservoir to accommodate it (which depends on geological and hydrological features of the area), site selection and design of artificial recharge structure.[7] While percolation tanks, check dams, recharge shafts and sub-surface barriers are effective structures in hard rock areas, recharge trench and recharge tube wells are more suitable in alluvial areas. In the coastal tracts, tidal regulators which impound the fresh water upstream and enhance the natural recharge, help control salinity ingress effectively. In case of urban areas and hilly terrains with high rainfall, roof top rain water structures are most useful.

8. A consolidated summary of costs and benefits resulting from implementation of different types of artificial recharge structures is given in *Table 7*. It can be observed that the costs of recharging vary widely depending upon incident rainfall, agro-climatic conditions, land use pattern, geomorphology and hydrogeology of the area. Even within a given state, there is large variation in the cost of recharge depending upon the nature of formation (alluvium/hard rock). Further, within same rainfall, agro-climatic and hydro-geologic regime, the cost of recharge varies depending on the type of recharge structures. An important revelation of these studies is that the investment per hectare of land irrigated for many of these schemes is comparable to investment in surface irrigation, particularly when the cost of delays, which typically occur in the surface irrigation schemes, is adequately accounted for.

[7] The features, parameters and data to be considered in designing artificial recharge structures are geological boundaries, hydraulic boundaries, storage capacity, porosity, hydraulic conductivity, transmissivity, natural discharge of springs, water balance, lithology, depth of the aquifer and tectonic boundaries.

Table 7: Summary of Cost And Benefits of Select Pilot Recharge Schemes

Sl. No	Type of Recharge Structure (Nos.)	Area of Implementation	Benefits	**Capital investment cost of recharge (Rs/cubic metre of water recharged)
1.	Percolation tanks (21)	A.P., Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal	Water recharged 2 TCM (Thousand cubic meters) -225 TCM Cost range Rs.1.55 lakhs to Rs.71 lakhs Area benefited* 10-500 Ha. Rise in water level <1 up to 4m	20 to 193 (on the basis of 16 case studies)
2.	Check dams (13)	Andhra Pradesh, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Delhi and Rajasthan	Water recharged 1TCM-2100 TCM Cost range Rs.1.5 lakhs to Rs.1050 lakhs Area benefited* 3-30 Ha. Rise in water level <1 - 2.5 m	73 to 290 (on the basis of 5 case studies)
3.	Recharge trench/ shaft/well (10)	Andhra Pradesh, Chandigarh, Haryana, Kerala and Punjab	Water recharged <1TCM-1550 TCM Cost range Rs.1 lakh to Rs.15 lakhs Rise in water level 0.25-0.7 m	2.5 to 80 (on the basis of 6 case studies)
4.	Sub-surface barrier/dyke (11)	Kerala, Madhya Pradesh, Rajasthan, Tamil Nadu and West Bengal	Water recharged 2TCM-11.5 TCM Cost range Rs.7.3 lakhs to Rs.17.7 lakhs Rise in water level <1 - 3.8 m	158 to 455(on the basis of 4 case studies)
5.	Renovation of creeks and sub-creeks	Orissa coastal area	Water impounded 798 TCM	-

** Area benefited refers to area in which incremental rise in water level on account of implementation of artificial recharge scheme is observed.*
*** Capital investment cost has been estimated for recharge in a single year. The average life of recharge structures is around 25 years.*

9. In addition to throwing light on the costs and benefits of different recharge structures and the factors determining them, these schemes have also helped in:

- Identifying and evolving technologies and design for artificial recharge that are appropriate to specific agro-climatic and geological environments.
- Capacity building for artificial recharge
- Motivating replication of these structures elsewhere.

10. Besides these schemes, there are many examples of water harvesting and recharge projects reporting substantial improvement in water availability and agricultural production. Well-known among them is the restoration of water flow in the river Arvari in Rajasthan (which had dried up) through local cooperative efforts. While one may argue on the extent of net water recharge along the entire length of river due to these efforts, the benefits accruing to the local community cannot be disputed. Similarly, construction of roof top rain water harvesting

structures in some important buildings in NCT of Delhi, Jaipur (Rajasthan), Amritsar (Punjab) and Nagpur (Maharashtra) have facilitated greater recharge of available run-off during the rainy season. Moreover, there is evidence that in some cases, rain water harvesting is more economical than conventional water supply.[8]

11. Yet even with full development of artificial recharge, ground water availability would remain limited. If it is treated as an open access resource and its extraction continues as at present, pace over extraction would result in the end. It is, therefore, critical to find ways to limit the use of ground water to keep it sustainable. Cooperative management by users to facilitate ground water use in an equitable manner seems inescapable. While ground water recharge schemes may not be the final answer, they do call for community efforts and create the spirit of cooperation needed to subsequently manage sustainably ground water as a community resource.

[8] The cost of structures in Delhi varied between Rs.0.69 lakhs for recharging 0.837 TCM (Rs.82.4 per cubic metre) to Rs.8.23 lakhs to recharge 11.8 TCM (Rs.69.7 per cubic metre) depending on site specific conditions. With an assumed life of 15 years and real interest rate of 4 percent, the price of water per cubic metre comes to between Rs.6.0 to Rs.7.1. This is higher than what is charged for water in our cities e.g. Rs. 2/cubic metre in Delhi and Rs. 3/cubic metre in Mumbai. However, if the marginal cost of supply is appropriately measured in these cities, water through rain water harvesting may prove to be more economical than conventional supply.

4. Legal Position Regarding Ground Water

1. As was seen, to ensure sustainability it is critical to find ways to limit the use of ground water. In this context, the Group has examined the legal position, particularly:

- The legal provisions concerning groundwater use by individuals.
- What can be done to ensure sustainable use of groundwater under our laws? Who has the power and obligation to take needed actions?

2. The Indian legal system in respect of groundwater has two important characteristics. First, the system is 'mixed' or 'pluralistic'. and includes statutory provisions, precedential court decisions, doctrines and principles deriving from the British common law system, international agreements, religious (personal) law and customary law and practices. This scenario, in no sense unique to India, contributes often to dispensable complexity. Secondly, different parts of the system are not well integrated with each other, resulting in overlapping regulations in many areas. Methods for legal interpretation have to be adjusted accordingly.

4.1 Individualís Right to Use Ground Water

3. The right to groundwater in India is, as in many other legal cultures, seen as following the right to land. The source usually referred to in support of this is the Indian Easements Act 1882. An 'easement' is mostly agreed upon between two neighbours and an easement so created leads, according to Section 7(a) of the Act, to restrictions of certain basic rights. One such is the exclusive right of every real property owner (in civil law countries known as immovable property) to enjoy and dispose of this, and of all the products thereof. As real property chiefly denominates land, and groundwater legally is seen as a naturally inherent part of land, groundwater must hence be termed as real property – and not as a chattel. This and other relevant provisions of the Act build upon common law principles establishing a rule of 'absolute ownership' over all there is below the surface of the earth of each landowner. This doctrine, settled in England in the nineteenth century and in turn drawing from ancient Roman law, makes a distinction between water flowing in 'defined channels' under ground and percolating water. The landowners are perceived to have an unlimited right to appropriate whole of the latter.

4. The Indian Easement Act, 1882 links groundwater ownership to land ownership and this legal position has remained intact since then. In the Act 'easement' is defined *as a right which the owner or occupier of certain land possesses, as such, for the beneficial enjoyment of that land to do and continue to do something, or to prevent and continue to prevent something from being done, in or upon or in respect of certain other land not his own.*

5. Illustrations of the above referred rights stated in the Act include:

> *The right of every owner of land to collect and dispose within his own limits of all water under the land which does not pass in a defined channel and all water on its surface which does not pass in a defined channel.*

6. The definition of the right suggests that if your neighbour extracts too much water and lowers the water table you have the right to prevent him from doing it. Symmetrically the neighbour can prevent you from over exploitation. Thus there are limits to an individual's right to exploit ground water.

7. The limits to the right to use groundwater were tested recently in the Coca-Cola case in Kerala.

8. The Hon'ble High Court of Kerala in the matter of *Perumatty Grama Panchayat vs. State of Kerala*[9] also known as the landmark "Coca-Cola Case" decided on the issue of the excessive exploitation of ground water. Certain extracts of the judgement delivered by the Hon'ble High Court are reiterated below:

> *"Ground water is a national wealth and it belongs to the entire society. It is a nectar, sustaining life on earth. Without water the earth would be a desert… Our legal system – based on English common law – includes the public trust doctrine as part of its jurisprudence. The State is the trustee of all natural resources which are by nature meant for public use and enjoyment. Public at large is the beneficiary of the sea, shore, running waters, air, forests and ecologically fragile lands. The State as a trustee is under a legal duty to protect the natural resources. These resources meant for public use cannot be converted into private ownership (emphasis supplied)… In view of the above authoritative statement of the Hon'ble Supreme Court, it can be safely concluded that the underground water belongs to the public. The State and its instrumentalities should act as trustees of this great wealth. The State has got a duty to protect ground water against excessive exploitation and the inaction of the State in this regard will tantamount to infringement of the right to life of the people guaranteed under Art. 21 of the Constitution of India. The Apex Court has repeatedly held that the right to clean air and unpolluted water forms part of the right to life under Art. 21 of the Constitution… the Panchayat and the State are bound to protect ground water from excessive exploitation".*

9. This judgement clearly lays down that the State has a right and obligation to restrain use of groundwater if it causes harm to others. But who should legislate, the State Government or the Central Government? What are the constitutional provisions?

4.2 Constitutional Provisions

10. India is a federal republic and its constitution distributes the legislative power over some subject matters to the States, some to Centre and for some to both Centre and States.

11. The constitutional provisions in respect of allocation of responsibilities between the States and the Centre fall into three categories:

(i) The Union List (List I in the Seventh Schedule);
(ii) The State List (List II in the Seventh Schedule); and
(iii) The Concurrent List (List III in the Seventh Schedule).

12. Under the Constitution, "Water" is a matter included in Entry 17 of List II in the Seventh Schedule i.e. in the State List. This entry is

[9] 2004 (1) KLT 731

however subject to the provisions of Entry 56 of List I in the Seventh Schedule i.e. the Union List. The relevant provisions are reiterated below:

Entry 17 of List II in the Seventh Schedule (State List)

"Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of Entry 56 of List I."

Entry 56 of List I in the Seventh Schedule (Union List)

"Regulation and development of inter-State rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest."

13. As regards relations between the Union and the States, Article 246 of the Constitution of India deals with the subject matter of laws to be made by Parliament and by the Legislature of States, which is reiterated below:

"(1) Notwithstanding anything in clauses (2) and (3), Parliament has exclusive power to make laws with respect to any of the matters enumerated in List I in the Seventh Schedule (in this Constitution referred to as the "Union List").

(2) Notwithstanding anything in clause (3), Parliament, and, subject to clause (1), the Legislature of any State also, have power to make laws with respect to any of the matters enumerated in List III in the Seventh Schedule (in this Constitution referred to as the "Concurrent List").

(3) Subject to clause (1) and (2), the Legislature of any State has exclusive power to make laws for such State or any part thereof with respect to any of the matters enumerated in List II in the Seventh Schedule (in this Constitution referred to as the "State List").

(4) Parliament has power to make laws with respect to any matter for any part of the territory of India not included (in a State) notwithstanding that such matter is a matter enumerated in the State List."

14. Accordingly, it may be argued that "Water" as such is a State subject and that States have jurisdiction to regulate and control groundwater … as Entry 17 of the State List, clearly states "Water, that is to say, water supplies…" … where "water supplies" can be argued to include groundwater. However, the Parliament does have a concurrent power to make laws with respect to any matter for any part of the territory of India not included (in a State). Further, the Supreme Court has interpreted certain constitutional provisions as having indirect implications for ground water, which include Article 21 concerning "right to life" and Article 48 A directing the state to "endeavour to protect and improve the environment", thereby entailing certain obligations for the Government in general. The roles that the Government is expected to play in ground water development and management are outlined in two important policy statements: National Environment Policy and National Water Policy.

15. With the express intention to provide more decentralisation, the Constitution furthermore equips the State legislatures with a mandate to, on their part, bestow the locally elected Panchayati Raj Institutions (PRIs) with such powers and authority as may be necessary to enable them to function as institutions of self government. Drinking water and minor irrigation are

enumerated in the Eleventh Schedule as subject matters over which responsibility can be devolved from state to village level. Subsequently it is up to each and every state to pass regulations on the authority of the Panchayats on the 29 listed subjects. As per the Kerala Panchayati Raj Act passed in 1994, duties of village Panchayats in Kerala are 'maintenance of traditional drinking water sources' and 'management of water supply schemes'.

4.3 Centreís Obligations: Constitution of the Central Groundwater Authority (CGWA)

16. As regards groundwater regulation, specifically depletion, the Supreme Court of India has passed several orders in 1996, where under it has issued directions to the Government of India for setting up of Central Ground Water Authority (CGWA) under the Environment (Protection) Act, 1986 and to declare it as an authority under the Environment Protection Act and delegate powers under the said Act to the CGWA for the purposes of regulation and control of groundwater development. The Hon'ble Court further directed that the CGWA should regulate indiscriminate boring and withdrawal of groundwater in the country and issue necessary directions with a view to preserving and protecting the groundwater.

17. The Hon'ble Supreme Court of India in the matter of Vellore Citizens Welfare Forum vs. Union of India[10] has held that:

> *"Keeping in view the scenario discussed by us in this judgment, we order and direct as under that – the Central Government shall constitute an authority under Section 3(3) of the Environment (Protection) Act 1986 and shall confer on the said authority all the powers necessary to deal with the situation created by the tanneries and other polluting industries in the State of Tamil Nadu. The authority shall be headed by a retired judge of the High Court and it may have other members preferably in the field of pollution control and environment protection to be appointed by the Central Government. The Central Government shall confer on the said authority the powers to issue directions under Section 5 of the Environment Act and for taking measures with respect to the matters referred to in Clauses (v), (vi), (vii), (viii), (ix), (x) and (xii) of subsection (2) of Section 3... It is thus obvious that the Environment Act contains useful provisions for controlling pollution. The main purpose of the Act is to create an authority or authorities under Section 3(3) of the Act with adequate powers to control pollution and protect the environment."*

18. A similar view as above was also taken by the Hon'ble Supreme Court of India in the matter of *Indian Council for Enviro Legal Action vs. Union of India*[11] where it was held that Sections 3 and 5 of the Environment Protection Act empowers the Central Government to give directions and take measures for giving effect to the appropriate environmental protection agency.

19. In pursuance of Supreme Court orders on a PIL, the Central Ground Water Authority was constituted under sub-section (3) of the Environment (Protection) Act, 1986 on 14.01.1997 for purposes of regulation and control of groundwater development and management. The

[10] AIR 1996 SC 2715
[11] AIR 1996 SC 1446

Authority is headed by the Chairman, CGWB and has representatives of the CGWB, MoWR, MoEF, CWC and ONGC. The above referred section 3(3) of Environment Protection Act is reiterated below.

> *"The Central Government may, if it considers it necessary or expedient so to do for the purposes of this Act, by order, published in the Official Gazette, constitute an authority or authorities by such name or names as may be specified in the order for the purpose of exercising and performing such of the powers and functions (including the power to issue directions under Section 5 of the Central Government under this Act and for taking measures with respect to such of the matters referred to in sub-section (2) as may be mentioned in the order and subject to the supervision and control of the Central Government and the provisions of such order, such authority or authorities may exercise the powers or perform the functions or take the measures so mentioned in the order as if such authority or authorities had been empowered by this Act to exercise those powers or perform those functions or take such measures."*

20. Pursuant to the above, under the said notification the CGWA has been granted the powers to, amongst others, regulate and control, manage and develop groundwater in the entire country and to issue necessary directions for this purpose.

21. The areas of activities of the Central Ground Water Authority:

i) notification of areas for regulation of ground water development in severely over-exploited areas in the country.

ii) regulation of ground water abstraction by industries in over exploited/critical areas in the country.

iii) registration of drilling agencies for assessment of pace of development of ground water and regulation of well drilling activities.

iv) representation in the National Coastal Zone Management Authority and other Expert Committees of the Ministry of Environment & Forests.

v) undertaking country-wide mass awareness programmes and training in rain water harvesting for ground recharge.

22. Thus to conclude, as such it can be argued that the State Governments have the jurisdiction and the authority to control and regulate the development groundwater within the territorial jurisdiction of the such State concerned. However, in pursuance of the provisions of the Environment (Protection) Act, 1986 and the decisions of the Hon'ble Supreme Court of India, the Central Government, acting through the Ministry of Water Resources, has devolved a role to oversee the overall planning for the development of groundwater resources, establishment of utilisable resources and formulation of policies of exploitation and for overseeing and supporting State level activities in groundwater development on a basis that groundwater is a prime natural resource and its planning, development and management need to be governed by national perspectives.

4.4 National Environment Policy

23. Since the Centre's power to legislate on groundwater is based on environmental grounds, the National Environment Policy has suggested the following action points in relation to ground water:

- take explicit account of impacts on ground water tables of electricity tariffs and pricing of diesel.

- promote efficient water use techniques, such as sprinkler or drip irrigation among farmers. Provide necessary pricing, inputs and extension support to feasible and remunerative alternative crops for efficient water use.

- support practices of contour bunding and revival of traditional methods for enhancing ground water recharge.

- mandate water harvesting in all new constructions in relevant urban areas as well as design techniques for road surfaces and infrastructure to enhance ground water recharge.

- support R&D in most effective techniques suitable for rural water projects for removal of arsenic and mainstream their adoption in rural drinking water schemes in relevant areas.

4.5 National Water Policy

24. The Ministry of Water Resources, Government of India ("Ministry") is responsible for laying down policy guidelines and programmes for the development and regulation of country's water resources. Amongst others the Ministry has been allocated the function of "overall planning for the development of groundwater resources, establishment of utilisable resources and formulation of policies of exploitation, overseeing of and support to State level activities in groundwater development."

25. The Revised National Water Policy (2002) has the following recommendations relating to ground water.

- exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity. The detrimental environmental consequences of over exploitation of ground water needs to be effectively prevented by the Central and State governments. Ground water recharge projects should be developed and implemented for improving both the quality and availability of ground water resource.

- integrated and coordinated development of surface water and ground water resources and their conjunctive use should be envisaged right from the project planning stage and should form an integral part of the project implementation.

- over exploitation of ground water should be avoided especially near the coast to prevent ingress of sea water into sweet water aquifers.

26. Sensing the need for model uniform regulators, the Centre has prepared and circulated model bills to the states from time to time[12]. The purpose of such a bill is essentially to form a template for the states in their own regulations of rain water harvesting, notification of areas, requirements for applications for permits prior to digging and drilling of new wells, registration of existing wells and all existing water users. The bill suggests that quite far reaching power would be vested with the State governments, on behalf of the private landowners, and the State Ground Water Authorities are to be established for handling of management and development

[12] It may be noted that this role of the Central Government predates the Supreme Court judgements stated above.

questions. The salient features of the Model Bill are:

i) States to establish a Ground Water Authority.

ii) Authority to have powers to notify areas for control and regulation of ground water development.

iii) Authority to grant permit for extraction and use of ground water in notified areas.

iv) Existing users in notified areas and new users in non-notified areas to register with the Authority.

v) Penalties prescribed for offences.

vi) States to implement rain water harvesting for ground water recharge.

27. The recommendations in the National Water Policy and the National Environment Policy should be the cornerstone of the ground water development and regulation policy in the country. However, the above policy statements are neither supported by institutional infrastructure and mechanisms nor by enabling legislation nor by supporting economic incentive structure.

28. Some of the State governments have enacted ground water legislation as below:

4.6 Conclusions

29. As individual's right to use groundwater is limited by the need to contain environmental consequences, such as lowering of the water table, of such use, the Central Government has the obligation to see that groundwater use does not lead to environmental degradation.

30. The State Governments have the right to legislate on water including groundwater.

31. The model groundwater bill suggested by the Centre for States to adopt and enact is required to be made more effective for the following reasons:

(i) It relies on restricting the number of tube wells through permits. Such a control mechanism to be administered by officers, as experience shows, slows down the regulation process.

Andhra Pradesh	Andhra Pradesh Water, Land and Trees Act, 2002 **Note: Available in website** http://www.ielrc.org/water/documents/APWateLandTreesAct.doc
Goa	Goa Ground Water Regulation Act, 2002
Tamil Nadu	The Chennai Metropolitan Area Ground Water Regulation Amendment Act, 1987 **Note: Available in website** http://www.tn.gov.in/acts-rules/maws/water.htm
	Tamil Nadu Ground Water (Development & Management) Act, 2002 **Note: Available in website** http://www.groundwatertnpwd.org.in/gwact.htm
Lakshwadeep	Lakshwadeep Ground Water (Development & Control) Regulation, 2001
Kerala	Kerala Ground Water (Control & Regulation) Act, 1997 **Note: Available in website** http://keralalawsect.org.keralacode/ground_water.html
Pondicherry	Pondicherry Ground Water (Control & Regulation) Act, 2002
Maharashtra	Maharashtra Ground Water (Regulation of Drinking Water Purposes) Act, 1993
West Bengal	West Bengal Water Resources Conservation, Protection and Development (Management Control and Regulation) Act, 2005

(ii) Even if the number of tube wells is restricted, farmers can change the power of the pumps and draw more water, thus may lead to inequitable distribution.

(iii) Also, this bestows right to use groundwater on those who have already sunk a well excluding others. It is thus inequitable.

32. As the depletion of Ground Water may lead to environmental hazard, people's participation along with awareness is required. The people's participation is required in regulator mechanism through more pro-active approach. Also that State Governments need to monitor the Ground Water levels through scientific methods.

4.7 Changes and Enactment Required

33. As has been indicated in this Report that as per the Indian Easement Act, 1882 the ownership of the ground water will be governed by the ownership of the land to the extent the uses (exploitation) of ground water is not causing depletion in the ground water levels so the similar rights of the adjoining land owners and public at large are not encroached upon as this natural resource is meant for public use and it should not be allowed to be exploited beyond replenishable level. Therefore, there is a need of an "Act" at the State level to monitor the ground water levels through scientific methods by piezometers under the advisory guidance of Central Ground Water Board (MoWR).

34. The State Government will also ensure that ground water levels should not fall below the replenishable level and accordingly will take necessary measures for regulation/restriction of the ground water uses in the area.

35. The enforcement for the regulation/ reduction/restriction in the ground water usage should be made effective by the State Government through the users group/community participation/ involvement of Panchayat. The users group shall be responsible for regulating the ground water usage among various sectors i.e. irrigation, drinking and industrial. Such regulations by the user group will be made effective on the advise of State Ground Water Board (State Government).

36. The Central Ground Water Board along with the State Ground Water Board will assist the State Government in controlling the over exploitation through negative and positive incentives such as restricting institutional loans, limiting electricity supply, strengthening the oversight of the community specially that by the user group. The positive incentives can be supported for rain water harvesting and watershed development. Also the CGWB and SGWB will prepare suitable guidelines for aquifer water management based planning for use of ground water. The efforts should be made to converge the schemes for watershed development, rain water harvesting etc. along with the involvement of panchayat in critical and semi-critical areas.

37. The Centre's intervention will be required when the ground water level deplete below the replenishable level then such area as per the Environment Act will be declared as the area under environment threat and any exploitation of ground water will be regulated. The Central Ground Water Board i.e. Central Ground Water Authority with the proviso of Environment Act, 1986 will be empowered to declare such area as the area under environment threat due to over exploitation of ground water and the State Government will ensure that any exploitation in the area is regulated as well as take necessary measures for artificial recharge of ground water to restore the level.

5. Statesí Approach to and Experience with Groundwater Regulation

1. Some state governments have enacted ground water legislation (See below). An attempt has been made in this *Chapter* to examine some individual states' approach to and experience with groundwater regulation.

5.1. Kerala

2. The net annual ground water availability in the State has been assessed as 6.23 BCM. The present annual draft for irrigation is 1.82 BCM and 1.10 BCM for domestic and industrial uses (total 2.92 BCM). The stage of development is assessed as 47%.

3. The Kerala Ground Water (Control and Regulation) Act, 2002 came into effect in December 2003 and the Kerala Ground Water Authority was constituted a month later. As per Section 6(1) of the Act, the Authority can recommend to the Government to notify any area within the State for the purpose of regulating groundwater extraction in that area in public interest. The notification is to be gazetted, published in two daily newspapers and exhibited on the notice board of the office of the Gram Panchayat or Municipality. [13] If at a later date the availability of ground water improves, the

BOX 1: Coca Cola Case

A case that has received a great deal of attention during recent years involved the Coca Cola Company and the elected village council, the Panchayat, to which the function of local water supply is delegated from the State. The Company set up a factory for manufacturing bottled beverages at a site in Kerala in 2000, but was soon accused of causing severe water shortage in the vicinity. The Panchayat, under pressure from the village community, decided in 2003 not to renew the Company's licence. The High Court ruled a few months later that ground water is a 'common pool resource' that belongs to no one. While holding that the Panchayat did not have the authority to cancel a granted licence in such a manner, the Court allowed the company to draw water from its land equivalent to what a normal farmer in the area, with the same size of land, would.

The Company appealed to the Court's Division Bench, which decided in April 2005 to overrule the previous outcome. The Judges stated that the Panchayat had no ownership rights to private water sources. Based upon a ground water budget model for the area, it was found that of the annual available ground water resources, the Company could safely be allowed to draw the 500 kL/day required for its production. The company was, however, asked to provide the local people with drinking water.[14]

[13] The Authority has recommended to the State Government to declare 5 blocks in the State, which are over exploited, as 'notified areas' under the Act.

[14] At the end of August 2005, the Kerala State Pollution Control Board ordered the plant to shut down because of the Company's inability to explain cadmium levels in the sludge effluents being 400-600 times above the permissible limit, and because the plant did not have an adequate waste water treatment facility. The matter is now before the Supreme Court.

Authority can recommend the cancellation of the notification.

4. Also, every owner of existing wells in a notified area should apply to the Authority in a prescribed form for registering the well. Dug wells used for domestic purpose are exempted. After site inspection, the Authority can grant or refuse registration.

5. A permit from the Authority will be required for constructing a new well or deepening or enlarging an existing well (except dugwell used for domestic purposes). Permit is also required for energising an existing unenergised well if the horsepower exceeds 1.5 HP in the case of dug wells and 3 HP in the case of borewells. The request is processed after site inspection.

5.2 Tamil Nadu

6. The predominant source of water for the state is rainfall from both the South West and North East monsoons. The average rainfall in the state in a water year (June to May) is 961.8 mm. The annual replenishable ground water resources in the state is 23.07 BCM. The state has a gross irrigated area of about 3.1 m.ha., 38 percent of which is from ground water (open wells and tube wells). The stage of groundwater development in the state is 85%. On the basis of the revised norms of groundwater estimation, as of March 2004, out of a total of 385 assessed blocks, the state had 142 overexploited, 33 critical and 57 semi-critical blocks. Clearly, the groundwater situation in the state is among the worst in the country and is a matter of concern.

7. Till 1965 the groundwater draft and development was largely through open wells and through sporadic energised pumps for public water supply in small towns. In the beginning, a cell was formed in the Tamil Nadu PWD in 1965 for catering to the industrial water supply around Chennai. Later under the UNDP assisted programme, scientific assessment of the groundwater availability was done from 1965-1972. Thereafter this was followed by some more macro and micro level studies. In 1987, the Chennai Metropolitan Area Ground Water (Regulation) Act, 1987 was enacted and after a gap of 16 years, in 2003, the State enacted the TN Ground Water (Development and Management) Act 2003. The latter Act is yet to be notified as rules are under formulation.

8. The salient features of the Chennai Metropolitan Area Ground Water (Regulation) Act 1987 (amended as on November 2002) are as under.

- It extends to the whole of Chennai city and specified 302 revenue villages in the surrounding Kancheepuram and Thiruvallur districts.
- Any person desiring to sink a well in the scheduled area shall apply to the competent authority for the grant of permit.[15] The permit can be cancelled if the holder of the permit is found to be violating any of its provisions.
- No person shall extract or use ground water in the scheduled area for any purpose other than domestic use; permit is to be obtained for the extraction of groundwater for transport by any means.
- The use of groundwater for agriculture is allowed only from those wells, which

[15] In Chennai, the authority is Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) and in districts, it is the Collector or an Officer not below the rank of the Tahsildar.

existed before enforcement of this act, and new wells meant for agriculture must obtain the permit of the authority.

- The competent authority has powers to refuse permit for the extraction of groundwater citing reasons.
- Contravention of the Act by either an individual or a company entails a fine of Rs. 2000 on first instance. For second and subsequent offences, the fine is Rs. 5000 or imprisonment for 6 months.
- Court shall take cognisance of the offence under the Act only on a written complaint from the competent authority.
- The competent authority has powers to break open and enter the property, seal the well and recover the cost of such action from the violator.
- There are prescribed license fees for extraction of groundwater for other than domestic purpose ranging from Rs 500 to Rs 5000 for different pump capacities.
- The person aggrieved by an order made under the Act may appeal to such authority as the government may specify in this behalf.
- All buildings to have rain water harvesting as prescribed and water bodies to be used only for storing the water and not for any other purpose.

9. CMWSSB, the competent authority for the Chennai city, notes that the exploitation of groundwater in the city for commercial purpose has drastically declined since the implementation of the act in 1987 when there was a thriving tanker water supply. The authority has stopped issuing the permit for extraction and sale of groundwater from 1996-97. However this is exempted for tankers owned by the hospitals, schools etc., since CMWSSB is unable to meet the full requirement of these institutions. The Thiruvanmayur aquifer in South East Chennai, for example, which bore the brunt of the commercial exploitation, has gradually recovered since then and so is the case with the aquifers in North Chennai. The exploitation of groundwater has now shifted away from the notified areas. However, now the authorities are impounding all the tankers bringing groundwater from far off areas (away from the notified ones) when they enter the city with the help of revenue and police officials. Some of the private tanker owners who have gone to the court against this action of competent authority have not got any favourable decision from the courts.

10. The Tamil Nadu Groundwater (Development and Management) Act 2003 extends to the whole state of Tamil Nadu except the areas covered under the Chennai Metropolitan Area Groundwater (Regulation) Act 1987 and is to be implemented by the TN Groundwater Authority. Like the Chennai Metropolitan Area Ground Water (Regulation) Act, 1987, this Act is generally prohibitive in nature and relies heavily on permit system. An important feature of this Act is that it does not allow the supply of electrical energy from the Tamil Nadu Electricity Board (TNEB) for energising wells sunk in contravention of the provisions of the Act.

- The Act exempts wells used for domestic purposes (extracting devise up to 1 HP) wells sunk by State and Central Governments for scientific purposes and wells of small and marginal farmers.
- The Act is to be implemented by the TN Groundwater Authority.

- The authority has powers to
  - notify areas for development, control and regulate groundwater extraction.
  - monitor the groundwater regime in the mining area and may direct the disposal of mine water suitably.
  - to lay down or adopt standards for water quality depending on the kinds of water use.
  - alter, amend or cancel terms of certificate of registration, permit or license.
- Enter upon any premises (including break open the door), to inspect, take specimen and copies of relevant records, serve notice and seize and take possession of wells.
- Provision for groundwater management by identifying and notifying suitable areas for conjunctive use of surface and groundwater.
- All wells sunk in the state on or after the date of commencement of this Act (including notified and non notified areas) have to be registered with the authority.
- Electrical energy from TN Electricity Board (TNEB) will not be supplied for energising wells sunk in contravention of the provisions of the act.
- Any person aggrieved by the order or decision of the authority may appeal to Government.
- The offences under the act are cognisable.
- Penalty for failing to comply with the act is fine of Rs.1000 for first offence, for second or subsequent offence Rs.2000, for continuous contravention of the provisions the fine is Rs.500 per day.
- State Assembly may make modifications or the Assembly may decide that the rules or notification should not be made or issued.

11. The restrictions posed on the notified area are:

(i) Every groundwater user to obtain a certificate of registration from Authority for recognising their existing groundwater use.

(ii) Sinking of wells without permission is prohibited.

(iii) Transport of groundwater without the permit from authority is prohibited.

(iv) Carrying on the business of sinking wells without license from the authority is prohibited.

12. The Act shall come to force on such date as the Government may, by notification, appoint and different dates may be appointed for different areas and for the different provisions of this Act.

13. While subsidised power has stimulated irrigation it has also led to over extraction of ground water. From 1991 to 15.3.2003 free power was being provided in Tamil Nadu for agriculture. Before that, the tariff was ranging from 8 paise/ unit from 1970-71 to Rs. 50/annum for motors up to 10 hp and Rs. 75/hp/annum for motors higher than 10 hp in 1990-91.The energy consumed for agriculture is 6,910 million units in 1996-97 for around 15.67 lakh pumpsets in the state with an average of 4409 unit per pumpset/annum. From March 2003 the energy charges were raised to Rs. 250/hp. However because of agitation against increased costs the Government resorted to pay the farmers through Cash Support Scheme under which for a half yearly period the Government was directly subsidising farmers at the rate of Rs. 500 for pumps below 5 hp and Rs. 625 for pumps

above 5 hp. From 2004-05 onwards this amount is directly being paid to TNEB by the Government through budget. The subsidy amount given to TNEB over the last seven years has come down from 590 crores in 1999-2000 to 196 crores in 2005-06 and the TNEB is not getting the full amount from the Government as grant for supplying free power to the agriculture sector.

14. A study by the Madras Institute of Development Studies (MIDS) on the characteristics of groundwater usage for irrigation in the Vaigai, Noyyal and Palar river basins of Tamil Nadu, brings to light some important characteristics of groundwater irrigation in the state, specifically:

- Early adopters with better resource base (land, education, access to capital) have benefited but the late adopters with lower resource base have faced difficulties.
- Once individuals have access to groundwater irrigation, the incentive they face to contribute to community water systems (tanks, ponds lakes) erodes, concomitantly disturbing the safety net present for the poor who are dependent on the community water systems.
- The hard rock nature of land exacerbates the uncertainty of water availability. This results in skewed seller dominated groundwater markets weakening the position of water buyers.
- Small farmers are unable to keep up with the competitive well deepening resulting in heavy indebtedness.
- The price paid for water is often dictated by the nature of water supplier. If the state is the water provider the price paid is insignificant. On the other hand, farmers pay up to one third of their gross produce or Rs.40 per hour towards water when supplied by a private well owner.
- The existing power subsidies are heavily biased in favour of the wealthy.

15. The groundwater development in the state is showing mixed results. Though the groundwater development has helped the agriculture sector in the beginning, it is showing lot of strains due to poor groundwater yields, thriving informal groundwater markets which has put financial strains on farmers and overexploitation leading to lowering of water quality making water unfit for irrigation due to pollution from industries in some basins (Palar and Noyyal river basins being typical examples). The energy subsidy has helped wealthy farmers and has not resulted in reaching the poor and needy. Targeted subsidies, early notification of the Ground Water Act 2003 and strict implementation on ground, tightening the pollution control mechanism under the existing laws will improve the groundwater scenario in the state. Charging electrical energy reasonably and resorting to Andhra Pradesh model of demand side management (installing capacitors and friction free footvalves, using PVC pipes etc.) will reduce the energy subsidy burden and discourage overexploitation.

5.3 Punjab

16. Punjab is a predominantly agrarian state having 85% of its geographical area under cultivation with an average cropping intensity of 188%. The water demand for the kind of agricultural practices followed in the state is very high and a large part of it is for groundwater. Out of the 137 blocks in the state, only 25 are safe; 103 are over exploited, 5 critical and 4 semi-critical.

17. Punjab is not in favour of ground water legislation as it apprehends that such a step will cause hardship to farmers. Instead, to tackle ground water over exploitation, the State is in favor of the following initiatives.

i) Crop diversification – extending minimum support price to other crops to wean away farmers from paddy cultivation, which is water intensive. Contract farming for sowing alternative crop of chick-pea has been successfully tried.

ii) Large scale artificial recharge – through construction of check dams, use of drainage water and roof top rain water harvesting.

iii) Electricity supply – controlled, regulated and metered supply in critical areas.

iv) Micro irrigation – promotion of drip & sprinkler to conserve water.

v) Alteration in crop calendar – encouraging late sowing of paddy after 16th June to decrease evapotranspiration.

vi) Encouraging industries.

18. The state is also contemplating complete ban on new tube wells and restricting horse power to 10 HP so that the deeper aquifers are not tapped. The pumps need to be replaced with energy efficient pumps. Conjunctive use of saline and fresh water will also help in bringing down the demand for fresh water.

5.4 Andhra Pradesh

19. Out of the 1231 assessment units (mandals) in the state, 219 are over exploited, 175 are semi critical and 77 critical. The stage of ground water development is 45%.

20. The A.P. Water, Land and Trees Act (WALTA), enacted in the year 2002, aims inter alia at controlling and regulating the use of ground water and propagating tree-plantation on farm. The State Government has designated the Commissioner, Rural Development as the Administrator for the purpose of the Act. Some of the critical provisions in the area of Ground Water management are:

- Registration of all the borewells with concerned Revenue Authorities at the Mandal level.
- Prior permission for digging of new borewells from Revenue Authorities.
- Registration of all the rigs with the Government.
- Prohibition of water pumping in certain area.

21. The Government of Andhra Pradesh constituted a Commission on Farmers' Welfare (Jayati Ghosh Commission) in September 2004. The Commission has made several recommendations on various issues affecting agriculture and farmers, including 11 pertaining to ground water. The gist of the recommendations and the response of the Government are given in **BOX 2**. A notable recommendation was that the State Government should, in the medium term, take over all existing borewells after paying compensation to the current owners and thereafter provide water from these borewells on payment of water cess. The State Government has not accepted this.

BOX 2: Recommendations for Ground Water of the Andhra Pradesh Commission for Farmers Welfare		
	Recommendation for Ground Water	**Decision of the State government**
1.	While in the medium term the State government should aim for public control over ground water, in the interim, there must be active involvement of the agricultural extension services and the revived APIDC in methods of recharging borewells with rainfed water and in techniques of water conservation.	Accepted
2.	The Government should immediately begin the process for registration of borewells in the State.	Accepted
3.	Extension services must also focus on reviving and developing crops and cultivation practices suitable for rainfed agriculture and adverse irrigation conditions.	Accepted
4.	With regard to micro-watershed programmes, the focus should be on ensuring adequate resources to cover the watershed taken up; even though this may imply fewer such projects. This is important to ensure success in at least those projects.	Accepted
5.	In allocating resources towards such schemes in future, it is important to ensure that contractors are avoided and that the local farmers and community are able to exercise some control, either through panchayats or through the watershed committees. Watershed works can also be taken up under the Employment Guarantee Scheme.	Accepted
Medium term proposal:		**Medium term proposal:**
1.	It has already been noted that ground water use is currently irrational because it had effectively been privatised. Therefore, in the medium term the State government should aim for the public takeover of ground water resources. All the existing borewells would have to be taken over, after paying appropriate compensation to the current owners. All new borewells would be dug by and be owned by the State government. The A.P. Irrigation Development Corporation (APIDC) should be revived and could made into the nodal agency for the management of ground water. Thereafter, water would be provided from the borewells on payment of water cess on the basis of volumetric measurement through tamper-proof meters, at the same rates as those applicable	All the private borewells cannot be taken over by Government. Anyhow under Indira Prabha Government takes responsibility of providing borewells, wherever it is feasible and WALTA will be strictly implemented.

	for command area farmers. The local management of the water would regulate the use of ground water, provide more democratic access, and reduce the costs incurred by farmer for digging of borewells. It should be noted that WALTA 2002 already makes the provision for such control in its Clause 6(a) and (b) which specify that the Authority set up by the State government shall perform the following functions "promote water conservation and enhancement of tree cover in the state and regulate the exploitation of ground water and surface water in the state"	
Power supply:		
1.	Efforts should be made to increase power supply for agricultural purposes for a longer period every day. There should be systematic efforts to reduce problems of erratic supply and irregular voltage, to ensure continuous and stable supply for a minimum of nine hours preferably in the daytime.	7-8 hours of quality supply shall be ensured
2.	The State government may consider a scheme of regularising the existing rural connections up to a certain date and declaring all future connections to be invalid unless registered by the appropriate authority.	Started regularising in phased manner
3.	The State government should make efforts to improve the quality of the power equipment supplied to farmers through appropriate regulation. Extension services should assist farmers in the proper use of such equipment.	Accepted
4.	Transmission & Distribution losses and inefficiency can be reduced with better management practices in the power sector, including more democratic and accountable functioning of the generating and distributing agencies. It is usually the case that the residual use is attributed to agriculture since this sector does not have meters.	Accepted
5.	Free power up to 50 units per month should be provided to all BPL rural domestic users.	The Government are subsidising Rs.10/- per month towards the cost of consumption of one 40 Watt bulb (for 6 hours per day) during the month for every consumer. Presently 13.92 lakh consumers belonging to BPL families consuming up to 15 units per month are getting this benefit.

22. In a significant initiative, the AP Irrigation Development Corporation in collaboration with Government of Netherlands has implemented the A.P. Well Project with community based usage and management of ground water. Activities of the Project that involve people's participation include:

- Hydrological cycle monitoring through measurement of inflows, outflows and rainfall, water level etc.
- Preparation of water budget, which guides the activities of the farmers that involve water usage.
- Digging of community borewells where groups of farmers come together for digging of borewells, its subsequent maintenance and for withdrawal of water. The farmers raise the pre-decided crops and allocate water accordingly among themselves. The water usage is further regulated through adoption of drip systems which are generally gravity based low cost system. The farmers are also encouraged to follow horticulture crops as water saving method and as a measure of drought proofing.

23. The project also envisaged and implemented the ground water recharge structure for each borewell dug and also simultaneously implemented the activities pertaining to watershed treatment in some areas.

5.5 Gujarat

24. Out of the 223 blocks in the state, only 97 are safe while 69 are semi critical, 12 are critical and 31 over exploited. The per capita availability in north Gujarat and Saurashtra-Kutch is very low (130 m^3 to 424 m^3), putting tremendous pressure on ground water. The maximum fall of ground water level that has been observed in the monitoring wells of CGWB in the over exploited blocks is around 3m per year. At some places the piezometric surface of the deeper confined aquifer has gone down to 130 m.

25. The life of tubewell is also much less in Gujarat. While it costs Rs.10 lakhs to drill a tubewell, its life is only 10 years against a normal 30. Ground water is saline as also fluoride contaminated.

26. To ensure sustainability, however, the State has taken a wide range of conservation initiatives.

i) under Sardar Patel Participatory Water Conservation programme, 54000 check dams have been constructed to improve the quantity as also quality of ground water by recharge. A total expenditure of Rs.1000 cr. has been incurred of which beneficiary contribution is Rs.300 cr.

ii) 1700 ponds have been deepened at a cost of Rs.105 cr. with 10% beneficiary contribution. 1.5 lakh farm ponds have also been constructed. These measures have helped in alleviating drinking water problem and developing dairy.

iii) along the coast, tidal regulators, check dams, recharge reservoirs, 'nala' plugs have been constructed and afforestation done in 5867 ha. to check salinity ingress.

iv) direct lifting of water from irrigation canals in projects in Saurashtra (cutting canal method) to save on seepage losses in distribution system.

v) restriction on electrification of tubewells in over exploited, dark and saline areas and restriction of new tubewell construction to decelerate rate of ground water depletion. A significant innovation having a bearing

on groundwater management in Gujarat is the Jyoti Gram Yojana, under which separate electric supply is given to domestic and agricultural users. Earlier, supply of electricity for both categories was from the same source in the village and was provided in three phases for eight hours for agriculture, but in single phase for twenty four hours for domestic users. Many farmers, however, overcame the indirect restriction on groundwater extraction by illegally converting single phase into three phase and thereby completely paralysing the rural domestic electricity supply system. By separating supply feeders to the two user categories, the Jyoti Gram Yojana has been able to assure 24-hour supply for domestic use and 8-hour supply for agricultural use. This has helped in curtailing the excessive pumping of ground water through illegal means. Further, greater reliability of power supply—albeit for limited hours—has led to more efficient use of groundwater.

5.6 Maharashtra

27. Maharashtra is mainly an agricultural state with 82% of the rural population relying on agriculture. Earlier, the use of groundwater was insignificant. Subsequent to 1972, occurrence of frequent droughts, development of cheap drilling devices and availability of relatively low cost institutional finance, and energisation led to proliferation in irrigation dugwells. The number of such wells rose from about 7 lakhs in 1974 to 15.6 lakhs in 2004 and the area under well irrigation increased from about 10 lakh ha. to 29 lakh ha. during the same period. Out of the 318 blocks in the state, 287 are safe while 23 are semi critical, 1 is critical and 7 over exploited. The stage of ground water development is 48%.

28. The motivation for ground water legislation came from the specific need to protect drinking water supply sources. It was however found that public drinking water supply sources in many parts of Maharashtra was getting affected due to sinking of wells in close vicinity and high density and unregulated extraction of water from such wells. This situation made it difficult for authorities to provide minimum prescribed drinking water to the local population. To overcome this situation, increasing and repetitive measures had to be taken to provide dependable and adequate supply of water to many villages, which ultimately led to huge financial burden on the state government. In view of these developments, the Government of Maharashtra enacted and enforced "Maharashtra Ground Water (Regulation for drinking water purposes) Act, 1993", for the limited purpose of protecting the availability of drinking water supply.

29. The main provisions of the Act include the following:

- Prohibition of sinking of wells without prior permission, (except on behalf of the State government or local authority for being used as a drinking water source) for any purpose within 500 m of a public water source, if both the sources are in the area of the same watershed.

- Appropriate authority also have the right to prohibit, restrict or regulate from time to time extraction of water from permitted wells to suit the public interest. For example, having regard to quantum or pattern of rainfall or any other relevant factor, if the appropriate authority is of the view that the public water source in an area is likely to be affected, it may regulate abstraction from wells up to 1 km distance from public drinking water resources, except for drinking water purpose.

- Prohibits sinking of well for any purposes in an over exploited watershed.

30. The 1993 Act has not been successful in advancing its prime objective of ensuring protection of drinking water sources. The limited perspective of protecting only the drinking water sources is also a hindrance to achieving the objective of sustainable and equitable use of ground water among all stakeholders. Further, it has been found that it is not easy to regulate the extraction of ground water without involving the local community and sensitising them about the need for cooperative action to ensure groundwater sustainability.

31. Given the inadequacy of the 1993 Act, Government of Maharashtra (GoM) has adopted a comprehensive approach and formulated the "State Water Policy" in 2003. The Policy lays down the following directives for assessment, development and management of ground water resources of the State.

- The ground water resources should be periodically assessed on a scientific basis.
- Ground water resources should be so developed as not to exceed the limits of annual replenishability.
- Conjunctive use of surface and ground water shall be envisaged right from the project planning stage and shall form an integral part of the project.
- Over exploitation of ground water shall be avoided near the coast to prevent the ingress into sweet water aquifers.

32. The GoM is also preparing a draft Act for Development & Management of Ground Water. The Maharashtra Water Resources Regulatory Authority has been set up, which is proposed to function as the State Ground Water Authority. Under the proposed Act, it is envisaged that in over exploited watersheds Water Resources Committees would be set up comprising stakeholders to regulate and manage ground water.

5.7 Experience with Water Market in India

33. In a water market, an individual can have access to water from others for a fee. Water markets that exist in India are informal and are generally limited to localised water trading between adjacent farmers and the practice is quite common especially for groundwater. It is often a substitute to owning a well. While water markets are widespread in Gujarat, Punjab, Uttar Pradesh, Tamil Nadu, Andhra Pradesh and West Bengal, they are most developed in Gujarat. The extent of area irrigated through water markets, which is often considered to be a surrogate for the magnitude of water trading, varies across regions as well as over time depending on a number of factors such as rainfall, groundwater supply, cropping patterns, and the cost and availability of electricity (Saleth 1994). In water scarce pockets of Gujarat, Tamil Nadu and Andhra Pradesh, a substantial area is irrigated through groundwater markets. There is no systematic estimate at the national level of the magnitude of water trading. The area irrigated through water markets has been projected to be about 50 percent of the total gross irrigated area with private lift irrigation systems (Shah 1993). Other estimates, using a methodology based on pumpset rental data, put the figure at 6 million hectares or 15 percent of the total area under groundwater irrigation (Saleth 1999).

34. Trading of groundwater has no legal basis in India. States, however, have been tolerant of the practice, possibly because of the difficulty in enforcing any kind of restriction. Besides, it

has been serving two useful purposes: promoting efficient use of ground water and providing poor farmers unable to afford wells, an access to water. There is however some evidence of decline in groundwater table caused by competitive water withdrawal due to intense water marketing activities (Moench 1992). Besides, there is an equity question; (rich) sellers can get a payment from the very group whose water rights get infringed by the seller's activities (Saleth 1994).

35. Gujarat's Jyoti Gram Yojana under which feeder separation and limited hours of supply for irrigation has in certain areas reduced the availability of water for farming, leading to increase in price of water for their neighbours particularly to poor farmers. (Shah & Verma 2007)

5.8 Overall Assessment of Statesí Approach and Experience

36. Despite repeated circulation of the Model Groundwater Bill by the Central Government, states have generally exhibited lethargy in legislating on groundwater. So far, only a few states—particularly those that have been severely affected by groundwater extraction—have opted for legislation. In this regard, Punjab has been a notable exception. The State believes that legislation could cause hardship to farmers and has hence favored alternative strategies focusing mainly on conservation. Commonalities among state legislation include:

- Excessive reliance is on state imposed control mechanisms and very little emphasis on cooperative management.
- Sanctions are over limited area and over limited period of time. Penalties are coercive, heavy-handed and in the nature of criminal sanctions.
- Typically, the process involves licensing procedures to regulate digging of wells (number of wells, depth of wells).

36. Some states have however unique features. For example, Tamil Nadu has a separate legislation for Chennai and its surrounding areas, as distinct from the one for the rest of the state. The 1993 Act of Maharashtra focused primarily on drinking water, while other states had a more balanced approach. Maharashtra is also the only state to introduce a regulatory authority, separate from the Government. Gujarat made a successful experiment in electricity supply that had a strong bearing on ground water management without resort to any dedicated legislation.

37. The approach of state legislations, based on model groundwater bill of central government, however, it has the following inherent shortcomings:

- It relies on control mechanism (a permit system) to restrict the number of wells, which typically slow down the development process.
- Even if the number of tube wells is restricted, an individual farmer can render the regulation ineffective by increasing the power of the pumpset and drawing more water.
- Procedures for appeals against sanctions provide scope for misuse of power, corruption and waste of time.
- Also, the Bill bestows right to use groundwater on those who have already sunk a well, while excluding others. It is thus inequitous.

38. A state-wise study of ground water situation in pre and post legislation periods would no doubt reveal how effective legislation has been. Such data/analysis is not available and most states have only a very short legislative history. Based on anecdotal experience, however, the following lessons can be drawn:

- Enforceability of the Act has been a problem - no state has reported actual number of violations detected and penalty meted out. Even when the legislation is narrowly focused on protecting drinking water sources, enforcement became a huge problem. Such an outcome is not surprising, given that there are already 19 million wells existing in the country. It is difficult to imagine having enough supervisory resources to deal with so many well owners.

- States often unduly delay in notifying an area for regulation even if a suggestion is made.

- In active management areas under notification, legisation does act as a deterrent to indiscriminate expansion of ground water structures and some discipline is introduced in the system by way of registration of wells and seeking of permission for new structures.

- The MIDS study in Tamil Nadu has shown that small and poor farmers are affected more by controls on ground water exploitation and benefit less from power subsidies as compared to wealthy farmers. On the other hand Shah and Verma (2007) have noted adverse impact on small farmers who buy water from their neighbours of restricted hours of power supply to farmers.

- While the approach has resulted in outcomes that are far short of expectations, there is strong evidence that in Chennai it has put an effective check on the thriving commercial exploitation of ground water.

- There have been some efficiency gains from the operations of ground water trading, thanks to the hands-off approach by states. The market has also provided poor farmers access to water. The negative consequences of the market have arisen from the absence of withdrawal limits.

6. International Experiences in Ground Water Management

6.1 Ground Water Governance in Western United States

1. In most ways, the US has been a pioneer both in facing the environmental fallout of intensive ground water irrigation as well as in devising ways to minimise or counter its impact. The western US, which has a 150 year history of extensive ground water irrigation development, has been a fertile ground for technological and institutional experiments in ground water management. Various states have tried a mix of several approaches to respond to ground water overdraft viz., formation of ground water districts, buying out ground water rights from farmers, supply of imported surface water in lieu of ground water pumping, notification of 'active management areas' where a 'water master' is appointed to undertake district administrative/ legal action by courts.

2. Management of ground water depletion in western US has been centrally about reducing withdrawals, commonly through reducing areas irrigated with ground water. The State of Colorado decommissioned 1000 irrigation wells by force and Idaho purchased water rights from irrigations and closed 2000 wells where pumping from increased depths became so expensive that irrigations were more or less ready to have their operations bought out. Ironically it cost millions of dollars of tax payers money to buy water rights back that the state gave away for free.

3. Out of the 431 ground water basins in California, 19 are actually managed with some restrictions on pumping. In the rest 412, ground water management is passive involving federal grants to build infrastructure to import surface water and supply it to ground water users in lieu of pumping.

4. To sum up, the institutional and regulatory action to improve ground water governance may not have solved the problem to the desired extent. Ogallala aquifer continues to be depleted. Kansas experiences widespread falls in ground water level of significant magnitude that are non-recoverable in large areas. In Arizona, over exploitation and falling water levels are addressed by legislation that mandates balancing abstraction with recharge but it is not clear that targets will be met.

6.2 Ground Water Demand Management in Arid Countries

5. Oman's successful strategy for sustainable ground water management has deftly combined demand-side measures to control, protect and conserve water resources with supply side measures to augment the resources. The former include obligatory registration of all wells, introduction of well permits, prohibition of wells at less than 3.5 km from the mother-well of a 'falaj', filling up of illegally constructed wells, confiscation of drilling contractor's equipment involved in illegal drilling, a national well inventory, well-metering, well-field protection zoning, water treatment, leakage control, improving irrigation techniques and public awareness campaigns for water conservation. Supply side strategies depend on large recharge dams (both for flood control and ground water recharge). Treated waste-water is reused in lieu of ground water pumping in the Muscat area for

watering municipal parks, gardens and roadsides. Public water supply in this capital area depends mainly on desalinated sea water.

6.3 Ground Water Management in Spain

6. Spain, like many parts of the world, until 1985, bestowed private property rights over ground water resources. However, the 1985 Water Act in response to intensive ground water use changed the rules of the game. For one, ground water was taken away from the private domain and ownership rights bestowed upon the state. Second, River Basin Management Agencies were given a role in managing ground water, and finally, they were also vested with the power to grant permits for ground water use that started after 1985. It also gave authority to the river basin agencies to declare an aquifer as over exploited, and once it was so declared, to formulate an aquifer management plan for recovery of the aquifer. Some features of such a plan were the reduction in volume of withdrawals or rejection of new applications for wells. In addition, all users of the aquifer were required to organise themselves into ground water user associations in order to encourage user participation. So far, some 16 aquifers have been declared totally or partly over exploited, while such user associations have been formed in only five and implemented in only two aquifer areas. Further amendments to that act were made in 1999 and 2001 which emphasised the role of the ground water users in aquifer management.

7. An evaluation of the current implementation status of this law paints a rather gloomy picture. For one, even after more than 15 years, recording of ground water rights still remain incomplete, and less than a quarter of all ground water structures have been registered. The reason for such tardiness is insufficient human resources with the implementing agency, and this not only affects well registration, but also the monitoring of registered wells. Thus, Spain, with some 0.5 million wells is still grappling with the most basic issue of identifying and recording ground water users. Given Spain's long tradition of successful surface-water user's associations (some in Valencia are centuries old), the new water law has emphasised the formation of ground water user's associations particularly for management of over exploited aquifers. Thus, while thousands of small ground water user's associations have been formed, the majority of them are geared towards 'collective management of the irrigation network', and only a handful have a larger mandate of 'collective management of aquifers' and of these not all are success cases. Thus, even in Spain, which has relatively fewer wells, small aquifers and lesser direct dependence on ground water irrigation, but stronger farmers' lobbies than South Asia, the implementation of various clauses of ground water legislation has proved to be very difficult. All in all, in Spain, studies show that most Ground Water User Associations are defunct and the water law widely bypassed.

6.4 Water Sector Reforms in Mexico

8. Perhaps no other country has reformed its water laws as extensively as Mexico has since 1992. By the law of the Nation's Waters of 1992, water was declared as a national property and it became mandatory for existing users to legitimising their rights through procuring water concessions. The National Water Commission (CNA) was entrusted with the responsibility of registering water user associations, set up a regulatory structure to enforce and monitor their concessions granted and also to collect a volumetric fee from all users, except small-scale irrigators. Aquifer Management Councils (COTAS) were promoted by CNA as user organisation aimed at managing ground water.

9. Response to the reforms so far has been mixed at best. The large industrial and commercial water users have been quick to apply for concession and pay water fees. However, the real challenge has been registering water rights of the agricultural users, who withdraw at least 80% of total volumes withdrawn, and monitor their withdrawals. Among the agricultural users, the tube-well owners have responded to the law quite positively and have applied for water concessions. The major reason for such compliance has been the 'carrot' of subsidised electricity that has been promised to tube-well owners who regularise their connection through registration of the wells with the CNA. This shows that farmers respond well to direct economic incentives. Monitoring of actual extraction has proved more intractable.

10. While the COTAS were planned to be involved in technical capacity building, institutional capacity building, creation of local awareness about water issues and most importantly creating alternative sources of income through developing various services that water users might value enough to hire and pay for, the most serious flaw in the design of COTAS is that it has failed to provide services that the majority of its potential members (the farmers) value most, viz. unrestrained access to ground water. Not many farmers are willing to take up membership of an institution which has been created to limit their access to water.

11. This merely shows that passing of laws and executing administrative barriers is not likely to work unless social and economic realities are taken into consideration. Thus Mexico, even with an ambitious water law is still grappling with the basic issues such as registered wells and issuing water permits. Recently, a move to withdraw unused portion of water quotas seems to have encouraged farmers to pump more ground water than they would otherwise have, lest they lose their quotas.

6.5 Lessons from International Experience

12. Spain & Mexico reformed their water laws to make ground water a national property. However, their success in getting water rights of agricultural users registered has been insignificant. If Spain with 0.5 million wells and Mexico with 0.09 million wells find it difficult to enforce the new water law, the situation in India with 19 million wells can be imagined should we also declare ground water a government property. The US experience of buying out ground water rights and supplying surface water by trans-basin diversions has huge cost implications which we may not be able to afford. The strategy adopted by Oman of deftly combining demand side measures to control, protect and conservate water resources with supply side measures to augment the resources has the potential for successful replication in India.

7. Way Forward

1. The first six *Chapters* have brought out the complexities involved in ground water management in the backdrop of the legal position and the international and domestic experience so far in handling the problem. We can summarise what emerges as follows:

- The rate of extraction of ground water is increasing and in many blocks exceeds the rate of recharge leading to lowered water tables. 28% of blocks are now semi-critical, critical or over exploited.
- The number of dark or over exploited critical is increasing rapidly as it has grown from 4% in 1995 to 15% in 2004.
- Since ground water is an open access common property resource, the tragedy of the commons where each user tries to maximise his/her own share winds up lowering everyone's share. When groundwater gets lowered, it increases costs for all as they need to deepen their wells and require more powerful motors.
- Artificial recharge can augment ground water supply and delay the crisis. Not all water recharged through such measures, however, is a net gain for the basin as a whole as augmented recharge upstream may lower availability of water downstream. Nonetheless, this redistributes water in favour of upland farmers who often do not benefit from irrigation projects.
- Artificial recharge generally requires community action. An important gain from successful project is that the community gets organised to behave in a cooperative manner. Such cooperation is critical for sustainable use of ground water.
- The experience of states with ground water legislation shows that by itself it is not very effective and requires community cooperation.
- International experience also indicates limitations of legal measures.

2. Given the domestic and international experience in groundwater management, new initiatives to depart from the current system may be considered in the following areas:

i) Policy and legal environment,
ii) technical,
iii) electricity pricing and supply,
iv) incentives for efficient use,
v) cooperative management, and
vi) institutional changes.

7.1 Policy and Legal Environment

3. The National Water Policy (NWP) 2002 and National Environment Policy include a wide range of measures covering both demand-side and supply-side management (See *Chapter 4*). These policy measures are in line with international best practices and should form cornerstone of the groundwater management strategy and legislation should adequately back them.

4. Ground water has been considered a private property and till recently there has been no real clash of interest between various users. Thus

there was no need for legal intervention by the Government. The Indian Easement Act 1882 links ground water ownership to land ownership and this legal position has remained intact since then. The recent Kerala High court ruling in Coca Cola case seems to indicate that the right is not unfettered and the extraction has to be within a reasonable limit. From the discussion in *Chapter 4*, it is clear that while the right to use ground water is to be governed by the ownership of the land above it, the extraction rights can and should be curbed by the State if the use of groundwater is considered "excessive", which certainly covers situations involving sustained—and not just seasonal—decline in groundwater level. Given this emerging legal position, no change in basic legal regime relating to groundwater seems necessary. In any case, new legislation to amend the Easement Act to make ground water say a community or state property is complex, both from the point of view of the legal steps involved and the follow-up administrative regulation and monitoring activities required, as has been the experience of Mexico.

5. While no change in basic legal regime relating to ownership / use rights is being suggested, some changes in state legislation to make the regime effective is considered necessary. Many states have yet to legislate on the regulation and management of groundwater. The few states that have legislation in this area, have done so by adopting (with some modifications) the model groundwater bill. It has been observed earlier in the report that the model bill is restrictive, iniquitous, difficult to enforce and can be rendered potentially ineffective. To address these issues, there is a need to rely less on control mechanisms and more on decentralisation and cooperative action. The State Act must oblige the State Government to involve the panchayati raj institutions and facilitate the creation and effective functioning of water user groups.

6. The Centre's intervention will be required when the ground water level falls below the replenishable level. In such events, the affected area as per the Environment Act will be declared as an area under environment threat and any exploitation of ground water will be regulated. The Central Ground Water Authority, under the provisions of Environment Act, 1986, will be empowered to make such declarations and it would be the responsibility of the State Government to ensure that any exploitation in the area is regulated as well as to step up its efforts toward artificial recharge. Since water users would have to necessarily curb their extraction following such declarations, it would hurt them economically one way or the other. For example, farmers may be compelled to cut down on irrigated area or change cropping pattern and municipalities may be compelled to cut down domestic supplies and so on. Thus if the threat of such declaration is prompt and credible (based on scientific analysis and transparent procedures), water users would be induced to 'responsible behavior' in normal times.

7. Further, there is a need to differentiate the legal approach in urban areas from that in rural areas. In urban areas, legislation to protect water sources for domestic use, such as in Chennai Metropolitan Area Ground Water (Regulation) Act 1987, which relies on a system of permit for transport of ground water by any means, has been successful because of easier enforceability. For example, water tankers bringing water from nearby ground water sources in villages around Chennai can be stopped from entering the city at check posts. In rural areas, policing at individual farmer level is difficult. Further, prohibition of new entrants in urban areas does not raise equity issues, given that the management objective in such areas is to protect drinking water sources. Thus, in urban areas that are water-stressed it is both feasible and desirable to have separate legislations that rely on state controls.

8. As we have seen in *Chapter 4*, the Centre can intervene in ground water management on environmental considerations. In pursuance of Supreme Court orders on a PIL, the Central Ground Water Authority was constituted under sub-section (3) of the Environment (Protection) Act, 1986 on 14.01.1997 for purposes of regulation and control of groundwater development and management. The Authority is headed by the Chairman, CGWB and has representatives of the CGWB, MoWR, MoEF, CWC and ONGC.

9. Under the said notification the CGWA has been granted the powers to, amongst others, regulate and control, manage and develop groundwater in the entire country and to issue necessary directions for this purpose.

10. Considering States' experience with the regulation and the issue of equity and enforceability outlined earlier, ground water management may require legal measures but also requires the following supplementary measures:

- provision for water to be held in the public trust in areas of substantial decline, giving the state a legal basis for more active intervention when necessary. In cases where the public trust doctrine is invoked, an explicit strategy for intervention should be formulated up front in consultation with relevant stakeholders, particularly smaller users;

- emphasis on management of ground water with stakeholders participation and delegation of many responsibilities to taluka and village level;

- an emphasis on integrated solutions across surface and ground water, supply and demand based approaches, sustainability of groundwater resource and viability of electricity suppliers..

7.2 Technical Measures

11. The first line of defence should be to augment the available ground water. Experience of many NGOs as well as pilot studies on artificial recharge at the behest of the CGWB have shown positive results. Government of Gujarat has reported encouraging results in the Sardar Patel Participatory Water Conservation Programme, where 54,000 check dams have been built at a cost of Rs.1,000 crore with beneficiaries contributing 30% of the cost.

12. The Central Ground Water Board has prepared a master plan for artificial recharge to ground water in India at a total cost of Rs.24,500 crore to recharge 36 BCM of surplus surface run off every year. Of this, artificial recharge structures in rural areas account for Rs.19,874 cr. and roof top rain water harvesting structures in urban areas account for Rs.4,586 cr.

13. Investments in watershed development, water conservation and artificial recharge, which have been given priority in the rural employment guarantee scheme, are expected to rise significantly, as the scheme picks up momentum. Renovation of traditional water bodies including desilting of tanks is also included in the scope of the scheme. These are steps in right direction. Moving forward, an integrated multi-disciplinary approach is required for the formulation of rain water harvesting and artificial recharge schemes on the basis of specific technical studies by various Central & State Government organisations such as Central Ground Water Board, Central Water Commission, State Ground Water Organisations, NIC, NRSA, State Remote Sensing Agencies etc. These studies could be funded under a Central Sector Scheme. Further, technical

capacity building of PRIs to build and operate various types of water harvesting structures assumes paramount importance.

14. The effectiveness of ground water management (including artificial recharge) could be substantially improved through the application of advanced tools such as remote sensing, Geographical Information System etc. integrated with information technology systems. The use of these tools can help in making the ground water management plan more accurate, holistic and efficient.

15. 'Static' water is often a wasting asset. Studies by CGWB in alluvial parts of Haryana and UP have revealed the existence of huge reserves of ground water in the deeper aquifers which has not been utilised. There is a need for a comprehensive scientific study for ground water development in deeper (confined) aquifers in these areas. The study should comprise a detailed mapping of deeper aquifers and an assessment of how much of the deep aquifer water can be extracted, where and at what rate, needs to be carried out. Based on this, a plan for its use can be prepared. Abundant caution is necessary in attempts to extract water from deep aquifers. If, for example, a deep aquifer feeds a shallow aquifer at some distance, the latter can get affected over time by extraction from the former. Caution is also necessary to ensure that there is no interference or mixing of groundwater from different aquifers, which can drain dynamic recharge zone water to deeper aquifers.

16. The flood plains in the vicinity of rivers are good repositories of ground water, which can be used throughout the year, as demonstrated by the experience in the northern parts of Yamuna flood plain area in Delhi (See *Chapter 3*). A planned management of this resource offers scope to meet additional requirement of water. In view of the positive experience in pilot studies, a detailed country-wide study in identified areas needs to be taken up to explore the scope for scaling up this strategy.

7.3 Pricing and Supply of Electricity

17. Farmers in most States are given electricity free or at a very low price. Even where the price is not very low, supply is not metered and a flat tariff is charged depending on the horse power of the pump. This makes the marginal cost of power zero and provides little incentive to economise on power or water. It is often suggested that metered power at an appropriate tariff will induce farmers to cultivate less water intensive crops and reduce over extraction of water by farmers.

18. While undoubtedly some impact on cropping pattern and water use will take place in response to metering and tariff rationalisation, the impact may be small. Since the landholdings are generally small in vast majority of cultivated areas, farmers trying to maximise their income find that land is the binding constraint and not water. Cost of ground water (and by implication, of power) plays a relatively small role and cropping pattern therefore typically remains unchanged even for large changes in price of electricity.

19. Another problem with metered supply with high electricity price is that it will restrict water markets. Well owners who sell water to their neighbours without wells, constituting mainly small and marginal farmers, would sell less or charge a higher price. This is observed in Gujarat where farmers who are charged flat tariff and those who are given metered supply co-exist in the same district. Farmers with metered supply charge 30% to 60% more for water compared to farmers with flat tariff (Shah and Verma 2007). Of course, if the tariff is lower, this premium would be smaller. Thus we have a dilemma. If

the tariff is high so that farmers reduce the extraction of water, the small and marginal farmers have to pay more and get deprived of water. On the other hand, if the tariff is low, impact on ground water use will be small.

20. Politically, it is difficult to raise power tariff for agricultural users. It is also unfair to do so when canal water is given at a low rate. However, in order to make farmers account for the marginal cost of pumping water, farmers may be given an entitlement upfront of say, Rs.6,000 corresponding to 3000 kwhr at Rs.2/kwhr. The charges for their consumption will be deducted from this amount and the surplus, if any, will be handed over to the farmers at the end of the year. This approach may be tested on a pilot basis to examine if the transactions costs of implementation can be kept manageable.

21. A "no-regrets' initial step is to separate feeders for agricultural pumps. This will help monitor and manage electricity supply to farmers, and also ensure that current non-agricultural losses of electricity are not wrongly attributed to farmers. Feeders' separation can also provide a way of reducing ground water extraction in situations of rapid drawdown by restricting supply of electricity. With separate feeders for agricultural pumps, power can be supplied for fixed hours. If this is done during off peak hours, the opportunity cost of power can be reduced and the burden of subsidising agricultural power is also lowered. If uninterrupted power is supplied at stable voltage during pre-specified period, farmers might welcome it for the reliability of supply and might feel encouraged to use water more efficiently.

22. Experience in Gujarat shows that this can significantly reduce agricultural power consumption and by implication, ground water use. However, it does have an adverse impact on ground water market in some areas (high yield aquifers particularly deep aquifers). Less water can be pumped for sale. The small and marginal farmers bear the brunt of less water and higher price.

23. Restricted power supply can help in some situations but not all and of course with time, farmers will demand supply for longer hours and eventually 24 X 7 supply just like others. The benefits of restricting ground water use will then disappear. Measures such as feeder separation should therefore be part of a longer term strategy through which metering and supply at closer to cost recovery rates are both tied to duration of supply and reliability, thus creating incentives for more efficient energy and water use.

7.4 Incentives for Improvement in Management Efficiency

24. Instead of banning further exploitation in semi critical and critical blocks, government should offer incentives for community management of new wells, for construction of recharge structures, for energy saving devices like installation of capacitors and frictionless foot valves and for adoption of micro irrigation.

25. Studies have shown that there is a 35.4% to 69% reduction in gross draft with use of micro irrigation. Overall ground water withdrawal can thus be controlled by using micro irrigation techniques. The subsidy regime for micro irrigation needs to be attractive for promoting drip and sprinkler irrigation in ground water stressed areas provided the farmer does not consume additional quantum of water by expanding area under micro-irrigation. In areas where abundant potential exists, however, no subsidy should be introduced as greater exploitation of ground water in such areas will prevent water-logging and reduce pressure on surface water. In any case, since the water table is high in such areas, the cost of energy for pumping is generally low, making the use of groundwater an attractive option.

7.5 Cooperative Management

26. Sustainable use of ground water is possible only when users restrict average extraction to long term recharge. Even when recharge is augmented artificially, restraint on use will be required in water scarce regions. In a common property resource, individuals will restrict their use only if there is a credible agreement among all users to limit their use. Cooperative management of ground water by the users is thus necessary. Peer group pressures can generate socially responsible behaviour as has been observed in self-help groups. However, ground water aquifers do not map neatly to units of social organisation such as villages, blocks or districts. Moreover, implementation of such cooperative schemes raises formidable questions of local governance, including equity in principle and practice, efficient use, and open and transparent institutions. Hence, developing collective action institutions for ground water requires additional care and is best undertaken through a pilot testing approach.

27. The elements of a successful arrangement for sustainable use of ground water can be as follows:

- The CGWB/SGWB should monitor ground water situation through scientific methods (such as by use of piezometers) and make their findings public. They should assess the average annual recharge that takes place in the aquifers and be responsible for preparing a suitable plan and guidelines for aquifer water management. These would provide technical and managerial support to user groups.
- The panchayat would organise a village Ground Water Cooperation Committee (GWCC) under suitable existing water management schemes like Swajaldhara, Watershed Development Programme, Accelerated Rural Water Supply Programme (ARWSP) etc. which will allocate water rights and oversee that farmers restrict their use of ground water within their rights.
- The modalities for enforcement may be left to the GWCC.
- When artificial recharge is carried out and the amount of extractable water increases, the rights may be revised. Alternatively all or part of the additional water may be assigned to community tubewells for supplying water to small and marginal farmers.

28. In order to provide incentives to communities to use water sustainably, a *paani puraskar* may be given to the panchayat where the ground water table has been maintained or improved over the past five years.

7.6 Institutional Changes

29. To facilitate implementation of the suggested management options, certain institutional changes would be required. Sufficient ground water data has been generated by the Central & State Ground Water Boards but its effective dissemination at taluka and village level is required. The mandate of the Central Ground Water Board (and the Central Ground Water Authority) needs to be shifted to a role of a facilitator rather than a regulator. The State Ground Water Boards need also to be similarly addressed. The proposed new National Rainfed Authority's mandate should include ground water since this is the main water resources in rainfed areas. Where new water regulators are established, their role in coordinating and developing new institutions for ground water management should be explicitly defined. Coordination among relevant electricity bodies would also be required if electricity pricing or supply restriction is to be an important management tool for ground water.

8. Summary and Conclusion

1. Groundwater development in the country has expanded significantly in the past few decades. Overexploitation of the resource in certain parts of the country has led to rapid decline in water table. This has begun to threaten not only the food security of the country, but also the environment. Further, depletion of groundwater resource has been hurting the small and marginal farmers the most, threatening their livelihood in many cases. The problem is getting intensified and more widespread over the years.

2. An important way of addressing the issue is by augmenting groundwater supplies in shallow aquifers. Artificial recharge of groundwater has been found to be a useful tool. A recharge scheme implemented by the Government of India in different parts of the country showed recharging can be made much more effective by the use of scientific inputs and analyses than otherwise. It may however be noted that even if the entire potential of recharge is utilised, shortage will still persist, underscoring the need for limiting extraction. Yet another option is to tap the huge "static' water reserves in deeper aquifers, which have hitherto been untapped. This is not an easy option, as it requires detailed scientific studies to examine its long-term viability, impact on other aquifers and abundant caution in extraction. The upshot is that there is no substitute for limiting extraction to sustainable levels.

3. In limiting extraction, the first thing that needs to be addressed is the legal regime. Under the current legal regime, which dates back several decades, the landowner is given the right to capture an unlimited amount of groundwater from beneath his/her land, without being liable for injury to adjacent landowners caused by excessive or harmful pumping. By relying on this regime, our historical approach has been to exercise little control on groundwater pumping. The approach may have been adequate when the overall demand for groundwater in any given aquifer was limited, but with the threat of large-scale withdrawals looming large, there is a need for change in approach.

4. The international experience of attempts to make groundwater a national property has not been encouraging. Spain with 0.5 million wells and Mexico with 0.09 million wells find it difficult to get water rights of agricultural users registered. In view of this, the option of declaring groundwater a government property in India, which has 19 million wells over a much larger area, is not a sensible one.

5. The recent court rulings have emphasised the role of State as the trustee of all natural resources, including groundwater, which by nature are meant for use and enjoyment of public at large. Pursuing this position, courts have held that the State has got a duty to protect ground water against excessive exploitation and the inaction of the State in this regard will tantamount to infringement of the right to life of the people guaranteed under Art. 21 of the Constitution of India.

6. The attempt must therefore be to balance the landowner's right to capture groundwater with the public interest in managing groundwater resources for all users, including the environment, and to ensure that both the present and future needs of the communities dependent upon these resources are accounted for.

7. In this context, the Central Government has to play a key role. The Central Government's role in the management of groundwater emanates from the provisions of the Environment (Protection) Act, 1986. As overexploitation of groundwater is gaining momentum, environment is increasingly under threat. So, even though states have the primary responsibility of ensuring groundwater sustainability, the Government of India is expected to play an expanded and more effective role (than at present) especially in overseeing and supporting state level activities in groundwater management. The technological and managerial expertise of the Central Government does not appear to have been adequately utilised by the current groundwater regime, possibly because of lack of incentives under the current management practices to seek such support.

8. While the measures suggested in the National Water Policy and the National Environment Policy to promote sustainability of groundwater should be the cornerstone of the ground water development and regulation strategy in the country, these policy statements have been supported by neither institutional infrastructure nor enabling legislation nor appropriate economic incentive structure.

9. Experience with regulation in some states shows that it is not possible to have significant control over use of groundwater through legal provisions because of difficulties in enforcement. This has been corroborated by international experience also. Further, current regulations tend to discriminate against new users. Some modification of the current framework will make regulations more equitable and easier to implement. The main theme of such a transition would be a shift in focus (i) from controls by states to management by user groups and (ii) from attenuating crisis after it occurs, to averting crisis.

10. In the light of the above, the Group emphasises the need for all states to introduce a modified groundwater legislation encompassing inter alia the role and responsibility of water user groups and the Government. Involvement of Panchayati Raj institutions should be a key part of the strategy.

11. Further, given the enforcement problems relating to prohibitive measures, greater reliance needs to be placed on community management of the resource, supported by adequate technical inputs, complementary institutional changes and appropriate incentives (such as a subsidy regime for micro-irrigation), rather than on 'controls by state' for reasons stated earlier. State legislations can of course strengthen such strategy by endorsing community action, supportive institutions and use of technical inputs and incentives.

12. The balance between individuals' rights and the Government's obligation, referred to earlier, can be achieved by adopting for all groundwater management units a sustainable-yield management goal, which means that average withdrawals should not exceed long-term recharge. Towards this end, CGWB and SGWB should be responsible for scientific monitoring of groundwater level and for estimating a sustainable level of groundwater usage. These inputs would form the basis for planning the use of ground water resources by the user groups.

13. Should the ground water level fall below the replenishable level, the Central Government should intervene, under the provisions of the Environment Act, by declaring the affected area as "environmentally threatened". This should be the basis for invoking public trust doctrine and trigger formulation of an explicit strategy in consultation with stakeholders.

14. The tools of indirectly regulating extraction such as fixing the energy charges beyond certain limit for agricultural uses or separating agricultural feeders and restricting electricity supply etc. can be decided by individual State governments. The Committee has observed that while huge electricity subsidy may have contributed to depletion of groundwater, a cut in subsidies could have only marginal positive impact on extraction. A long-term strategy, however, that links extent of subsidy with the reliability and duration of power supply can have positive results for both groundwater management and viability of power sector.

15. It is time India recognises its dependency on groundwater resources, which is only going to increase in the coming years, partly because of growing urbanisation and industrialisation. In view of the growing seriousness of the problem, it is necessary that a political consensus build up quickly on a management strategy, which takes into consideration domestic and international experience. Delay in this matter could spell crisis of a much larger scale than has been experienced so far.

References

1. Central Ground Water Board, 2005, "*Dynamic Ground Water Resources of India" (As on March, 2004).*

2. V.S. Dhumal, Principal Secretary (WSS), Government of Maharashtra, "*Ground Water Development & Management in the State of Maharashtra*".

3. Ajit Seshadri, "*Initiatives by Community Participation on Ground Water Management, A NGO Experience*", Vigyan Vijay Foundation, New Delhi.

4. Central Ground Water Authority, June (2003), "*Activities & Achievements*".

5. K.S. Takshi, Director (WR & Env.), Government of Punjab, "*Note submitted to the Expert Group on Ground Water in Punjab*".

6. M. Moni, Deputy Director General, NIC, "*Mainstreaming ICT for Integrated Water Resources Planning and management at Grassroots level*". Note submitted to the Expert Group.

7. M.S. Patel, Secretary (WR&WS), Government of Gujarat, "*Water Resources Scenario of Gujarat state*". Note submitted to the Expert Group.

8. Jenny Gromwell, "*Ground water rights in India – the Coco Cola Case*". Paper presented in the International Ground Water Conference, New Delhi.

9. Tushaar Shah, "*Ground water regulation – International Experience*". Paper submitted to the Expert Group.

10. Central Electricity Authority, "*Statistics regarding consumption of electricity in irrigation and tariff/average rates of electricity for agriculture sector*". Data furnished to Expert Group.

11. D.K. Chadha, former Chairman, Central Ground Water Board, "*Ground Water Potential, Development and Regulation. A critical review*". Note submitted to Expert Group.

12. Dr. Saleem Romani, Chairman, Central Ground Water Board – August, 2005, "*Ground Water Management, a key for sustainability*", Centre for Earth Science Studies, Tiruvananthapuram.

13. S.P. Tucker, Principal Secretary, CAD, Government of Andhra Pradesh, "*Material on AP Commission on Farmer's Welfare, AP Well Project*". Submitted to the Expert Group.

14. Indian Easement Act, 1982.

15. K.J. Mathew, Principal Secretary (WR), Government of Kerala, "*Note on present status of Ground Water Resources in Kerala State*". Note submitted to the Expert Group.

16. Shah, Tushaar and Shilp Verma (2007), "*Real-time Co-management of Electricity and Groundwater: An Assessment of*

Gujarat's Pioneering Jyotirgram Scheme", discussion paper, International Water Management Institute (IWMI), www.iwmi.org/nrlp

17. Romani et al, (2006), "Groundwater Governance – Ownership of Groundwater and its Pricing", "*Proceedings of the 12th National Symposium on Hydrology, November 14-15, 2006",* Capital Publishing Company.

18. Romani Saleem (2006). "*Groundwater management – emerging challenges*" Paper in "*Ground Water Governance – Ownership of Groundwater and its Pricing*", "*Proceedings of the 12th National Symposium on Hydrology, November 14-15, 2006*", Capital Publishing Company.

19. Ministry of Water Resources (MOWR) (1996), "*World Bank India Water Resources Management Sector Work, Report of the sub-Group on Ground Water*", New Delhi

20. World Bank, (1999), "*Ground Water Regulation and Management*", New Delhi

21. Saleth, R. Maria (1996), "*Water Institutions in India: Economics, Law and Policy*", New Delhi

22. Saleth, R. Maria (1994), "*Groundwater Markets in India: A Legal and Institutional Perspective*", Indian Economic Review, Vol. 29, No. 2, 157–76.

23. Saleth, R. Maria (1999), "*Water Markets in India: Economic and Institutional Aspects*", in K.W. Easter et al. (ed.), Markets for Water: Potential and Performance, Kluwer, Dordrecht.

24. Marcus Moench (1992), "*Chasing the Water Table: Equity and Sustainability in Groundwater Management*", Economic and Political Weekly, Vol. 27, Nos. 51–2.

25. Shah, Tushaar (1993), "*Groundwater Market and Irrigation Development*", Oxford University Press, New Delhi.

26. Singh, Chhatrapati (ed.) (1992), "*Water Law in India*", Indian Law Institute, New Delhi.

Annexure 1.1

No.17(2)/05-WR
Government of India
Planning Commission
(Water Resources Division)

Yojana Bhawan, Sansad Marg,
New Delhi - 110 001, dated the October 21, 2005

ORDER

Sub: Setting up of an Expert Group to review the issue **of ground** water **ownership in the country.**

1. In its 51st meeting held on 27th and 28th June 2005, the National Development Council broadly agreed with the goals and objectives of the Mid-Term Appraisal (MTA) of the Tenth Five Year Plan carried out by the Planning Commission.

2. In the water sector, the MTA has-expressed concern about the rapid decline of ground water levels in some parts of the country. It has been noted that ground water legislation, where enacted, has not been found effective and has suggested setting up of an Expert Group comprising officials, NGOs, academicians and experts to review the whole issue of ground water management and ownership and suggest line of action for implementation in the Eleventh Plan.

3. Accordingly, an Expert Group with the following composition is constituted,

i) Dr. Kirit S. Parikh, Member, Planning Commission - Chairman

Members

ii) Dr. Tushaar Shah, Principal Scientist, International Water Management Institute, Anand

iii) Dr. B-K. Chadha, Chairman, Central Ground Water Board (Retd.)

iv) Shri Navroz Dubash, National Institute of Public Finance & Policy, New Delhi

v) Shri Nirmal Mohanty, Vice President, Infrastructure Development Finance Corporation, Mumbai

vi) Shri Hamath Jagawat, Director, N.M. Sadguru Water & Development Foundation, Dahod

vii) Shri P. Chengala Reddy, President, Federation of Farmer's Association, Andhra Pradesh, Hyderabad

viii) Chairman, Central Ground Water Board

ix) Dr. M. Moni, Deputy Director General, National Informatics Centre, New Delhi

x) Secretary to the Government of Maharashtra — in charge of ground water

xi) Secretary to the Government of Punjab-in charge of ground water

xii) Secretary to the Government of Tamil Nadu - in charge of ground water

xiii) Secretary to the Government of Kerala - in charge of ground water

xiv) Adviser (WR), Planning Commission - Convenor.

contd...

The Terms of Reference to the Committee will be:

i) to take stock of the ground water situation in the country in regard to availability, present use and projected demand;

ii) to identify reasons for fall in ground water levels in certain parts of the country;

iii) to review the efficacy of ground water recharge schemes implemented so far;

iv) to study the effectiveness of legislation where enacted;

v) to review the present legal position regarding ground water ownership, and suggest modifications keeping in view international practices;

vi) to suggest other measures to tackle the ground water management problem; and

vii) any other issue which the Group may consider relevant.

4. The Group may co-opt other officials, experts, NGOs as may be considered necessary.

5. The expenditure on TA/DA of non-official members will be borne by the Planning Commission as admissible to Class I officers of the Government of India as per SR 190 (a). The expenditure on TA/DA of the officials will be borne by the respective Ministries/ Departments/ State Governments to which they belong.

6. The Expert Group will submit its report to the Planning Commission within 4 months from the date of its constitution.

7. The Expert Group will be serviced by the Water Resource Division of the Planning Commission.

(K.K. Chhabra)
Under Secretary to the Govt. of India

To

Chairman and all Members of the Expert Group

Copy also for information to:

1. PSs to Deputy Chairman/MOS (Pig.)/ Members/ Member-Secretary, Planning Commission.
2. Cabinet Secretary, Cabinet Secretariat, Rashtrapati Bhavan, New Delhi.
3. Secretary to the President, Rashtrapati Bhavan, New Delhi.
4. Principal Secretary to the Prime Minister, South Block, New Delhi.
5. Secretary, Ministry of Water Resources, Shram Shakti Bhavan, New Delhi.

Standard distribution within Planning Commission.

(K.K. Chhabra)
Under Secretary to the Govt. of India

Annexure 1.2

No. 17(2)/2005-WR
Government of India
Planning Commission
(Water Resources Division)

Yojana Bhavan,
Sansad Marg New Delhi, 5th May, 2007

ORDER

Sub:- Expert Group to review the issue of ground water ownership in the country ó Further extension of its time.

In continuation of Planning Commission's Order of even number dated 4th May, 2006, it has been decided with the approval of the competent authority to further extend the tenure of the above Expert Group to submit its report to the Planning Commission upto 31.5.2007.

2. All other terms and conditions shall be the same as per Order of even number dated 21.10.2005.

(K.K. Chhabra)
Under Secretary to Government of India

To

Chairman and all Members (including Convenor) of the Expert Group.

Copy also for information to:

1. PSs to Deputy Chairman/MoS(Planning)/Merabers/Member-Secretary, Planning Commission.
2. Cabinet Secretary, Cabinet Secretariat, Rashtrapati Bhavan, New Delhi.
3. Secretary to the President, Rashtrapati Bhavan, New Delhi.
4. Principal Secretary to the Prime Minister, South Block, New Delhi.
5. Secretary, Ministry of Water Resources, Shram Shakti Bhavan, New Delhi-110001.

(K.K. Chhabra)
Under Secretary to Government of India

STATE-WISE GROUND WATER RESOURCES AVAILABILITY, UTILIZATION AND STAGE OF DEVELOPMENT INDIA

(in bcm)

Sl. No.	States / Union Territories	Annual Replenishable Ground Water Resource					Natural Discharge during non-monsoon season	Net Annual Ground Water Availability	Annual Ground Water Draft			Projected Demand for Domestic and Industrial uses upto 2025	Ground Water Availability for future irrigation	Stage of Ground Water Develop-ment (%)
		Monsoon Season		Non-monsoon Season		Total			Irrigation	Domestic and industrial uses	Total			
		Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	States													
1	Andhra Pradesh	16.04	8.93	4.20	7.33	36.50	3.55	32.95	13.88	1.02	14.90	2.67	17.65	45
2	Arunachal Pradesh	1.57	0.00009	0.98	0.0002	2.56	0.26	2.30	0.0008	0	0.0008	0.009	2.29	0.04
3	Assam	23.65	1.99	1.05	0.54	27.23	2.34	24.89	4.85	0.59	5.44	0.98	19.06	22
4	Bihar	19.45	3.96	3.42	2.36	29.19	1.77	27.42	9.39	1.37	10.77	2.14	15.89	39
5	Chattisgarh	12.08	0.43	1.30	1.13	14.93	1.25	13.68	2.31	0.48	2.80	0.70	10.67	20
6	Delhi	0.13	0.06	0.02	0.09	0.30	0.02	0.28	0.20	0.28	0.48	0.57	0.00	170
7	Goa	0.22	0.01	0.01	0.04	0.28	0.02	0.27	0.04	0.03	0.07	0.04	0.18	27
8	Gujarat	10.59	2.08	0.00	3.15	15.81	0.79	15.02	10.49	0.99	11.49	1.48	3.05	76
9	Haryana	3.52	2.15	0.92	2.72	9.31	0.68	8.63	9.10	0.35	9.45	0.60	-1.07	109
10	Himachal Pradesh	0.33	0.01	0.08	0.02	0.43	0.04	0.39	0.09	0.02	0.12	0.04	0.25	30
11	Jammu & Kashmir	0.61	0.77	1.00	0.32	2.70	0.27	2.43	0.10	0.24	0.33	0.42	1.92	14
12	Jharkhand	4.26	0.14	1.00	0.18	5.58	0.33	5.25	0.70	0.38	1.09	0.56	3.99	21
13	Karnataka	8.17	4.01	1.50	2.25	15.93	0.63	15.30	9.75	0.97	10.71	1.41	6.48	70
14	Kerala	3.79	0.01	1.93	1.11	6.84	0.61	6.23	1.82	1.10	2.92	1.40	3.07	47
15	Madhya Pradesh	30.59	0.96	0.05	5.59	37.19	1.86	35.33	16.08	1.04	17.12	1.74	17.51	48
16	Maharashtra	20.15	2.51	1.94	8.36	32.96	1.75	31.21	14.24	0.85	15.09	1.52	16.10	48
17	Manipur	0.20	0.005	0.16	0.01	0.38	0.04	0.34	0.002	0.0005	0.002	0.02	0.31	0.65
18	Meghalaya	0.79	0.03	0.33	0.005	1.15	0.12	1.04	0.00	0.002	0.002	0.10	0.94	0.18
19	Mizoram	0.03	0.00	0.02	0.00	0.04	0.004	0.04	0.00	0.0004	0.0004	0.0008	0.04	0.90
20	Nagaland	0.28	0.00	0.08	0.00	0.36	0.04	0.32	0.00	0.009	0.009	0.03	0.30	3
21	Orissa	12.81	3.56	3.58	3.14	23.09	2.08	21.01	3.01	0.84	3.85	1.22	16.78	18
22	Punjab	5.98	10.91	1.36	5.54	23.78	2.33	21.44	30.34	0.83	31.16	1.00	-9.89	145
23	Rajasthan	8.76	0.62	0.26	1.92	11.56	1.18	10.38	11.60	1.39	12.99	2.72	-3.94	125
24	Sikkim	-	-	-	-	0.08	0.00	0.08	0.00	0.01	0.01	0.02	0.05	16
25	Tamil Nadu	4.91	11.96	4.53	1.67	23.07	2.31	20.76	16.77	0.88	17.65	0.91	3.08	85
26	Tripura	1.10	0.00	0.92	0.17	2.19	0.22	1.97	0.08	0.09	0.17	0.20	1.69	9
27	Uttar Pradesh	38.63	11.95	5.64	20.14	76.35	6.17	70.18	45.36	3.42	48.78	5.30	19.52	70
28	Uttaranchal	1.37	0.27	0.12	0.51	2.27	0.17	2.10	1.34	0.05	1.39	0.08	0.68	66
29	West Bengal	17.87	2.19	5.44	4.86	30.36	2.90	27.46	10.84	0.81	11.65	1.24	15.32	42
	Total States	**247.88**	**69.51**	**41.83**	**73.15**	**432.42**	**33.73**	**398.70**	**212.38**	**18.04**	**230.44**	**29.12**	**161.92**	**58**
	Union Territories													
1	Andaman & Nicobar	-	-	-	-	0.330	0.005	0.320	0.000	0.010	0.010	0.008	0.303	4
2	Chandigarh	0.016	0.001	0.005	0.001	0.023	0.002	0.020	0.000	0.000	0.000	0.000	0.020	0
3	Dadara & Nagar Haveli	0.059	0.005			0.063	0.003	0.060	0.001	0.007	0.009	0.008	0.051	14
4	Daman & Diu	0.006	0.002	0.000	0.001	0.009	0.0004	0.008	0.007	0.002	0.009	0.003	-0.002	107
5	Lakshdweep	-	-	-	-	0.012	0.009	0.004	0.000	0.002	0.002	-	-	63
6	Pondicherry	0.057	0.067	0.007	0.029	0.160	0.016	0.144	0.121	0.030	0.151	0.031	-0.008	105
	Total Uts	**0.138**	**0.075**	**0.012**	**0.031**	**0.597**	**0.036**	**0.556**	**0.129**	**0.051**	**0.181**	**0.050**	**0.365**	**33**
	Grand Total	**248.01**	**69.59**	**41.85**	**73.19**	**433.02**	**33.77**	**399.25**	**212.51**	**18.09**	**230.62**	**29.17**	**162.29**	**58**

Source: Dynamic ground water resources of India (as on march 2004), Central Ground Water Board, Ministry of Water Resources, 2006

Annexure 2.2

BASIN-WISE MONSOON RUNOFF AND AVAILABLE SURPLUS WATER

S. No.	BASIN	Drainage area	Average Monsoon rainfall	Average monsoon runoff	Committed storage of surface water projects	Surface water available for recharge
		km^2	cm	mcm	mcm	mcm
1	Indus	321289	32	58640	16992	29837
2	Ganga-Brahmputra-Barak & others	1097540	111	878800	150963	587120
3	Godavari	312812	94	107080	36248	47437
4	Krishna	258948	60	61010	37230	4649
5	Cauvery	87900	75	18860	8017	6151
6	Pennar	55123	48	6170	2519	2152
7	East flowing rivers between Mahanadi & Godavari and Krishna & Pennar	74350	66	15250	3824	8563
8	East flowing rivers between Pennar & Kanyakumari	100140	90	15950	1441	12410
9	Mahanadi	141590	148	60190	25274	20051
10	Brahmani-Baitarni	51822	140	32600	13129	11616
11	Subarana Rekha	29200	120	9680	3806	3574
12	Sabarmati	21674	76	3430	1445	1136
13	Mahi	34842	88	10650	4534	3464
14	West flowing rivers of Kachchh and Kathaiawar including Luni	321874	48	13590	5838	4350
15	Narmada	98796	100	36860	23202	1851
16	Tapi	65145	70	16200	11093	0
17	West flowing rivers Tapi to Tadri	54120	216	97760	10277	74110
18	West flowing rivers Tadri to Kanyakumari	58000	187	80320	14271	53022
19	Areas of inland drainage of Rajasthan	26900	22	-	-	-
20	Minor river basins draining to Bangladesh & Burma	-	114	24800	-	-
	GRAND TOTAL	**3212065**		**1547840**	**370103**	**871493**

Source: After 'National perspective plan for recharge to ground water by utilizing surplus monsoon runoff, Central Ground Water Board, Ministry of Water Resources, 1996

ANNEXURE 2.3

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA

Sl. No.	States /Union Territories	Total No. of Assessed Units	Safe		Semi-critical		Critical		Over-exploited		Remarks
			Nos.	%	Nos.	%	Nos.	%	Nos.	%	
	States										
1	Andhra Pradesh	1231	760	62	175	14	77	6	219	18	-
2	Arunachal Pradesh	13	13	100	0	0	0	0	0	0	.
3	Assam	23	23	100	0	0	0	0	0	0	-
4	Bihar	515	515	100	0	0	0	0	0	0	-
5	Chattisgarh	146	138	95	8	5	0	0	0	0	-
6	Delhi	9	2	22	0	0	0	0	7	78	-
7	Goa	11	11	100	0	0	0	0	0	0	-
8	Guiarat	223	97	43	69	31	12	5	31	14	Rest 14 talukas-Saline
9	Haryana	113	42	37	5	4	11	10	55	49	-
10	Himachal Pradesh	5	5	100	0	0	0	0	0	0	-
11	Jammu & Kashmir	8	8	100	0	0	0	0	0	0	-
12	Jharkhand	208	208	100	0	0	0	0	0	0	-
13	Kamataka	175	93	53	14	8	3	2	65	37	-
14	Kerala	151	101	67	30	20	15	10	5	3	-
15	Madhva Pradesh	312	264	85	19	6	5	2	24	8	-
16	Maharashtra	318	287	90	23	7	1	0	7	2	-
17	Manipur	7	7	100	0	0	0	0	0	0	-
18	Meghalaya	7	7	100	0	0	0	0	0	0	-
19	Mizoram	22	22	100	0	0	0	0	0	0	-
20	Nagaland	7	7	100	0	0	0	0	0	0	-
21	Orissa	314	308	98	0	0	0	0	0	0	Rest 6 blocks-Saline
22	Punjab	137	25	18	4	3	5	4	103	75	-
23	Rajasthan .	237	32	14	14	6	50	21	140	59	Rest 1 block-Saline
24	Sikkim	1	1	100	0	0	0	0	0	0	-
25	Tamil Nadu	385	145	38	57	15	33	9	142	37	Rest 8 blocks-Saline
26	Tripura	38	38	100	0	0	0	0	0	0	-
27	Uttar Pradesh	803	665	83	88	11	13	2	37	5	-
28	Uttaranchal	17	12	71	3	18	0	0	2	12	-
29	West Bengal	269	231	86	37	14	1	0	0	0	-
	Total States	5705	4067	71	546	10	226	4	837	15	-
	Union Territories										
1	Andaman & Nicobar	1	1	100	0	0	0	0	0	0	-
2	Chandiqarh	1	1	100	0	0	0	0	0	0	-
3	Dadra & Naqar Haveli	1	1	100	0	0	0	0	0	0	-
4	Daman & Diu	2	0	0	1	50	0	0	1	50	.
5	Lakshdweep	9	6	67	3	33	0	0	0	0	-
6	Pondicherry	4	2	50	0	0	0	0	1	25	Rest 1 Region-Saline
	Total Uts	18	11	61	4	22	0	0	2	11	-
	Grand Total	**5723**	**4078**	**71**	**550**	**10**	**226**	**4**	**839**	**15**	**-**

Note:
Blocks- Bihar, Chhattisgarh. Haryana, Jharkhand. Kerala, Madhya Pradesh. Manipur, Mizoram, Orissa, Punjab, Rajasthan, Tamilnadu. Tripura, Uttar Pradesh, Uttaranchal, West Bengal
Mandals (command/ non-command) - Andhra Pradesh
Talukas - Goa, Gujarat, Karnataka, Maharashtra
Districts - Arunachal Pradesh. Assam, Delhi, Meghalaya, Nagaiand
Districts (Valley) - Himachal Pradesh. Jammu & Kashmir" **
State - Sikkim
Islands - Lakshdweep
UT-Andaman & Nicobar. Chandigarh. Dadra & Nagar Haveli,Daman & Diu, Pondicherry
Source: Dynamic ground water resources of India (As on March, 2004), Central Ground Water Board, 2006

Statewise Energy Consumption(2003-04),Tariff and Subsidy for Agriculture(2001-02) and Semi critical, Critical and Over exploited blocks(2004)

Sl No	State	Gross Generation Gwh	Population (in million)	Per capita consumption for Agriculture Kwh	Total Agriculture Consumption Gwh	Percentage consumption of Agriculture to total generation	Total Blocks in the State assessed	Critical Semi Critical and Over exploited Blocks	Percentage of critical and semi critical blocks to total blocks	Average tariff for the Agri Sector (Rs/Kwh)	Subsidy for agriculture Rs crore
1	Haryana	19533.790	22.136	249.090	5513.856	28.2	113	71	63	0.48	2010.00
2	Himachal Pradesh	4917.340	6.265	3.120	19.547	0.4	5	-	-	0.5	4.00
3	Jammu Kashmir	6997.250	10.808	10.720	115.862	1.7	8	-	-	2.2	33.00
4	Punjab	31424.050	25.197	247.760	6242.809	19.9	137	112	82	No tariff	2339.00
5	Rajasthan	29175.550	59.629	71.680	4274.207	14.6	237	204	86	0.46	2341.00
6	UttarPradesh	45274.710	175.271	28.250	4951.406	10.9	803	138	17	1.19	1326.00
7	Uttranchal	6910.770	8.863	35.920	318.359	4.6	17	5	29	-	-
8	Chandigarh	1436.780	0.960	2.450	2.352	0.2	1	-	-	-	-
9	Delhi	23036.300	14.940	6.080	90.835	0.4	9	7	78	0.5	54.00
10	Gujarat	50367.450	52.847	271.740	14360.644	28.5	223	112	50	0.62	4555.00
11	MadhyaPradesh	27965.150	63.692	87.660	5583.241	20.0	312	48	15	0.07	3361.00
12	Chhattisgarh	11151.540	21.830	28.900	630.887	5.7	146	8	5	-	-
13	Maharashtra	83672.260	100.670	105.020	10572.363	12.6	318	31	10	0.82	3279.00
14	Goa	2964.520	1.435	12.730	18.268	0.6	11	-	-	-	-
15	AndhraPradesh	49096.100	78.118	172.150	13448.014	27.4	1231	471	38	0.14	4176.00
16	Karnataka	31330.470	54.540	164.880	8992.555	28.7	175	82	47	0.39	2629.00
17	Kerala	12182.040	32.711	5.750	188.088	1.5	151	50	33	0.67	146.00
18	Tamilnadu	49801.460	63.749	147.170	9381.940	18.8	385	232	60	0.01	3139.00
19	Pondicherry	1858.910	1.008	116.800	117.734	6.3	4	1	25	-	-
20	Bihar	6376.400	87.161	11.800	1028.500	16.1	515	-	-	0.13	649.00
21	Jharkhand	11959.090	28.114	4.790	134.666	1.1	208	-	-	-	-
22	Orissa	17187.580	37.940	4.760	180.594	1.1	314	-	-	-	Not available
23	WestBengal	31994.340	83.115	9.450	785.437	2.5	269	38	14	0.92	405.00
24	Sikkim	431.080	0.563	0.000	0.000	0.0	1	-	-	-	-
25	Assam	3358.900	27.846	1.810	50.401	1.5	23	-	-	2.87	16.00
26	Manipur	542.860	2.486	0.250	0.622	0.1	7	-	-	-	-
27	Meghayala	997.600	2.398	0.200	0.480	0.0	7	-	-	0.52	0.00
28	Nagaland	324.450	2.081	0.000	0.000	0.0	7	-	-	-	-
29	Tripura	871.350	3.305	23.820	78.725	9.0	38	-	-	-	-
30	ArunachalPradesh	254.520	1.133	0.000	0.000	0.0	13	-	-	-	-
31	Mizoram	278.500	0.926	0.000	0.000	0.0	22	-	-	-	-
	All India Total	**563673.110**	**1071.737**	**1824.750**	**87082.391**	**15.4**	**5710**	**1610**	**28**	**0.69**	**30462.00**

Note: Gross Annual Consumption of Electricity in 2003-04 excluding the self generation by the industries in the state

Report of the Expert Group on **Ground Water Management and Ownership**

Designed by: Charts & Maps Unit Planning Commission

Printed at Dee Kay Printers, New Delhi.