Assessing ground water resources and their sustainability

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Introduction

Judicious management of any natural resource requires precise assessment of availability and exploitability of the resource. Sustainable management of ground water also involves scientific assessment of the exploitable quantity of the resource which can be harnessed without any environmental degradation. National Water Policy, 2002 has defined that the ground water exploitation should be limited to ground water recharge. Hence attempts at regular interval are being made to assess the replenishable ground water resources of the country.

Ground water resources were assessed since 1976. Initial attempts are mostly on adhoc basis. In 1979, the Over-exploitation committee on ground water for the first time brought out a systematic methodology for assessing the ground water resources of the entire in a scientific manner. Based on the norms suggested by the committee, the country's Gross Ground Water Recharge was assessed as 47 M.ham. and the Net Recharge as 32 M.ham (Central Ground Water Board, 1995). The methodology for assessment of ground water resources was modified in 1984 and revised assessment was brought in 1995 (Central Ground Water Board, 1995). As per 1995 report, the total Replenishable Ground Water Resources in India was about 432 billion cubic meter and ground water resource available for irrigation purpose was about 361 billion cubic meter. The Net Ground Water Draft from Irrigation uses was around 115 billion cubic meters and the level of ground water development was 32%. The ground water resources assessment methodology was further revised considering the increasing thrust on ground water usage by various sectors and changed scenario of data acquisition. The new methodology is known as Ground Water Resources Assessment Methodology (1997), popularly as GEC'97. Based on GEC-1997, the dynamic ground water resources of India were estimated for 2004 as base year. The annual replenishable ground water resources was 433 billion cubic meter (bcm). Keeping an allocation for Natural Discharge during non-monsoon season of 34 bcm, the Net Annual Ground Water Availability has been estimated as 399 bcm. The annual ground water draft for all uses is of the order of 231 bcm and the overall Stage of ground water development for the entire country is 58%.

The 2004 assessment indicated that dependency on ground water for meeting the water requirement by various sectors is accelerating at fast pace. A World Bank report (World Bank, 2010) indicated that there are about 20 million wells in the country extracting ground water. Various management initiatives were taken through Govt. and private institutions with the objective towards sustainable management of ground water resources. Reassessment of ground water resources of the country was therefore became necessary to review the prevailing ground water scenario and studying the impact of the on-going management practices on ground water regime and take corrective measures if necessary. The reassessment of ground water resources was therefore carried out for 2009.

Methodology

The ground water resources assessments for 2009 were carried out broadly following the methodology recommended by Ground Water Resources Estimation Committee, 1997 with additional inputs from Ground Water Estimation Methodology in Hard Rock Terrain (2003), Report of the Group for Suggesting New and Alternate Methods of Ground Water Resources Assessment (2009), Status report on review of ground water resources estimation methodology (2009).

The methodology broadly involves assessment of season-wise (monsoon and non-monsoon) ground water recharge from rainfall and other sources including seepage from canals, irrigation return flow, recharge from water bodies, water conservation measures. The 'annual replenishable ground water resources' are the sum-

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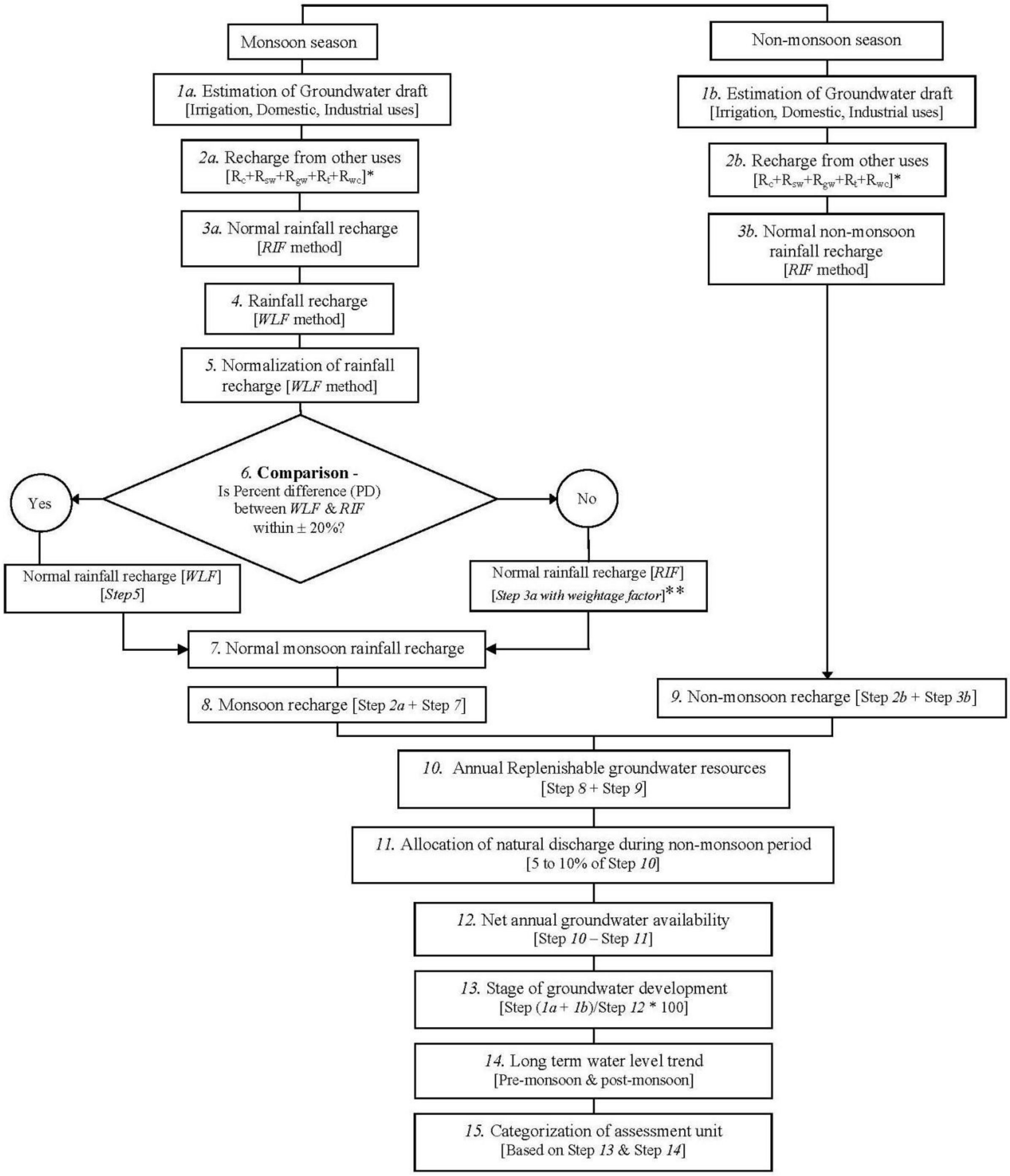
total of monsoon and non-monsoon recharge. Keeping an allocation for natural discharge, 'net ground water availability' is arrived at. Estimation of 'ground water draft' (withdrawal) for irrigation, domestic and industrial purposes is carried out. 'Stage of ground water development' is computed as a ratio of net annual ground water availability and annual ground water draft. Finally, the assessment unit is categorized based on stage of ground water development and long term water level trend.
The details of the methodology are indicated in the following diagram (Fig 1) and equations.
Fig. 1. Steps for estimation of annual replenishable groundwater resource and categorization of assessment units/ sub-units



*Note: * Recharge from other sources in non-command areas would exclude recharge from canal seepage and surface water irrigation.*
(*from* Chatterjee and Purohit, 2009)

Governing equations for recharge estimations

- *Recharge estimation during monsoon season –*
  - Water level fluctuation approach (WLF)

  Possible recharge during monsoon season after deducting natural discharges is the sum total of change in storage and gross draft during monsoon season.

$$R = S + DG = h * Sy * A + DG \quad \text{..................(i)}$$

Where,

R = Recharge during monsoon
S = Change in storage (S = h * Sy * A)
DG = Gross draft during monsoon season
h = water level fluctuation between pre-monsoon and post monsoon
Sy = Specific yield
A = Area of assessment

$$Rrfi = R - Rc - Rsw - Rgw - Rwc - Rt \quad \text{..................(ii)}$$

$$= h * Sy * A + DG - Rc - Rsw - Rgw - Rwc - Rt \quad \text{..................(iii)}$$

Where,

Rrfi = Rainfall Recharge during monsoon season for ith particular year
Rc = Recharge from canal seepage during monsoon season (in command areas) for ith particular year
Rsw = Recharge from surface water irrigation during monsoon season (in command areas) for ith particular year
Rgw = Recharge from groundwater irrigation during monsoon season for ith particular year
Rwc = Recharge from water conservation structures during monsoon season for ith particular year
Rt = Recharge from tanks during monsoon season for ith particular year

  - Rainfall Infiltration Factor approach (RIF)

$$Rrf = F * A * \text{Normal rainfall during monsoon season} \quad \text{..................(iv)}$$

Where, Rrf = Rainfall recharge during monsoon

F = rainfall infiltration factor

A = area of assessment unit

$$R\ (\text{normal}) = Rrf\ (\text{normal}) + Rc + Rsw + Rgw + Rwc + Rt \quad \text{..................(v)}$$

- *Recharge estimation during non-monsoon season*

  Rainfall recharge – Using RIF approach

  Recharge from other sources – Using norms recommended in GEC-1997 or values obtained through field studies.

  Total recharge is the sum of rainfall recharge and recharge from other sources

- *Annual recharge* = recharge during monsoon + recharge during non-monsoon
- *Categorization of assessment units*

The assessment units are categorized according to the status of ground water utilization and water level trend (Table 1).

Table 1. Criteria for categorization of assessment units

Stage of Ground Water Development	Significant Long Term Water level Decline trend		Category
	Pre-Monsoon	Post-Monsoon	
<=90%	No	No	Safe
>70% and <=100%	No	Yes	Semi-Critical
>70% and <=100%	Yes	No	Semi-Critical
>90% and <=100%	Yes	Yes	Critical
>100%	No	Yes	Over-Exploited
>100%	Yes	No	Over-Exploited
>100%	Yes	Yes	Over-Exploited

Protocol for assessment

Ministry of Water Resources suggested a uniform procedure for assessment of ground water resources to be followed by all the states. The protocol involves compilation of data and estimation of parameters through field study wherever necessary. Computation of ground water resources and categorization following the prescribed guidelines. Field validation of computed results wherever necessary.

The State level assessment was jointly carried out by State Ground Water Department and Central Ground Water Board under the overall supervision and approval of the State Level Committee (SLC) on Ground Water Resources Assessment. SLC is headed by the State Secretary In-charge of Water Resources and comprises representatives from various Central and State nodal agencies on ground water resources. Technical guidance, coordination, monitoring and compilation at the national level was carried out by the Central Level Expert Group (CLEG) constituted by Ministry of Water Resources for over-all supervision of the re-assessment of ground water resources in the entire country. CLEG is headed by Chairman, Central Ground Water Board and comprises representatives from various nodal Government agencies in the field of water and premier academic and research institutes.

Rainfall

Rainfall is the most important source of ground water recharge. India receives about 120 cm of rain in a year. However distribution of rainfall has a wide variation both in space and time (Fig 2). Most of rainfall (about 76%) occurs during the Monsoon months resulting into eight relatively dry months. Similarly the meteorological Subdivisions like Coastal Karnataka, Konkan and Goa, North east India receive more than 250 cm of rainfall annually whereas the major part of country including Northern, Central and Eastern India receives rainfall between 75 and 150 cm. A portion of Peninsular India including parts of Western Maharashtra and Karnataka receives less rainfall up to 75 cm. Western part of the country including Rajasthan and Gujarat receives the lowest rainfall in the country, at places even less than 15 cm in an year.

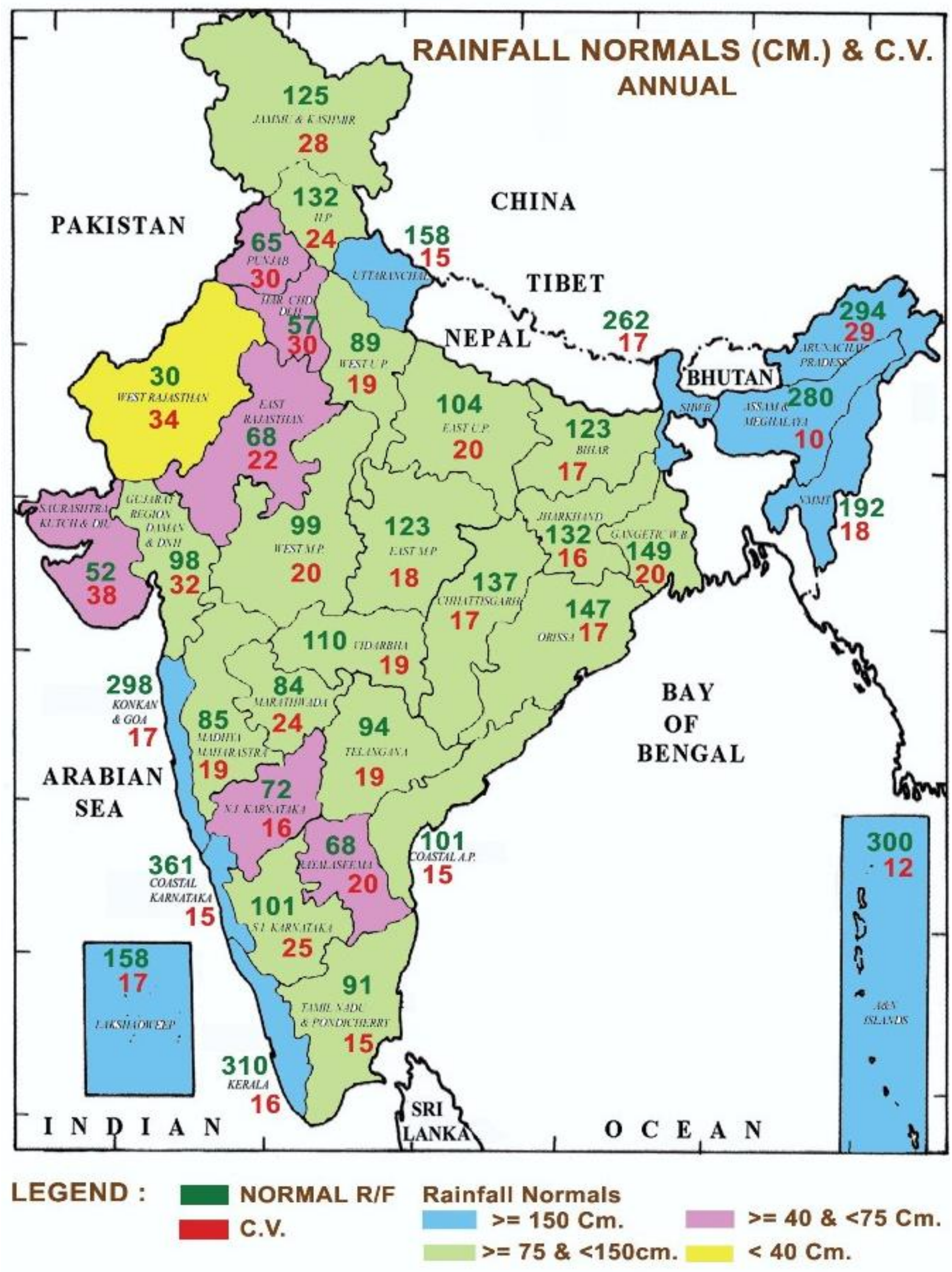


Fig. 2. Normal Annual Rainfall (Source: India Meteorological Department)

Rainfall pattern during intervening period between two successive ground water assessment viz. 2004 and 2009 indicate that overall rainfall pattern has been normal during 2005 to 2008 (Fig. 3). In 2005, major part of the country received normal rainfall. In the Western part including parts of Gujarat, Maharashtra, Karnataka and Rayalaseema and Telengana regions of Andhra Pradesh received excess rainfall. Only in Bihar, Jharkhand and Assam-Meghalaya-Tripura regions of North Eastern sector, monsoon rainfall was scanty. In 2006, the states of Jammu & Kashmir, western Rajasthan, Gujarat, Madhya Maharashtra and Orissa recorded excess rainfall, while Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and parts of North Eastern States recorded deficient rainfall. In rest part of the country, monsoon rainfall was normal. In 2007, Uttarakhand, Gujarat, Madhya Maharashtra, Karnataka, Andhra Pradesh, Orissa, Bihar and West Bengal received excess rainfall. The parts of Punjab, Haryana, Western U.P. and Eastern M.P. received deficient rainfall. In 2008, major part of the country received normal monsoon rainfall, except for Punjab and Orissa, where excess monsoon rainfall was recorded and Western Madhya Pradesh, Vidharbha and Kerala which received deficient monsoon rainfall.

Consecutive normal to excess rainfall in parts of west coast, east coast and peninsular India helped in improving the ground water situations in the area.

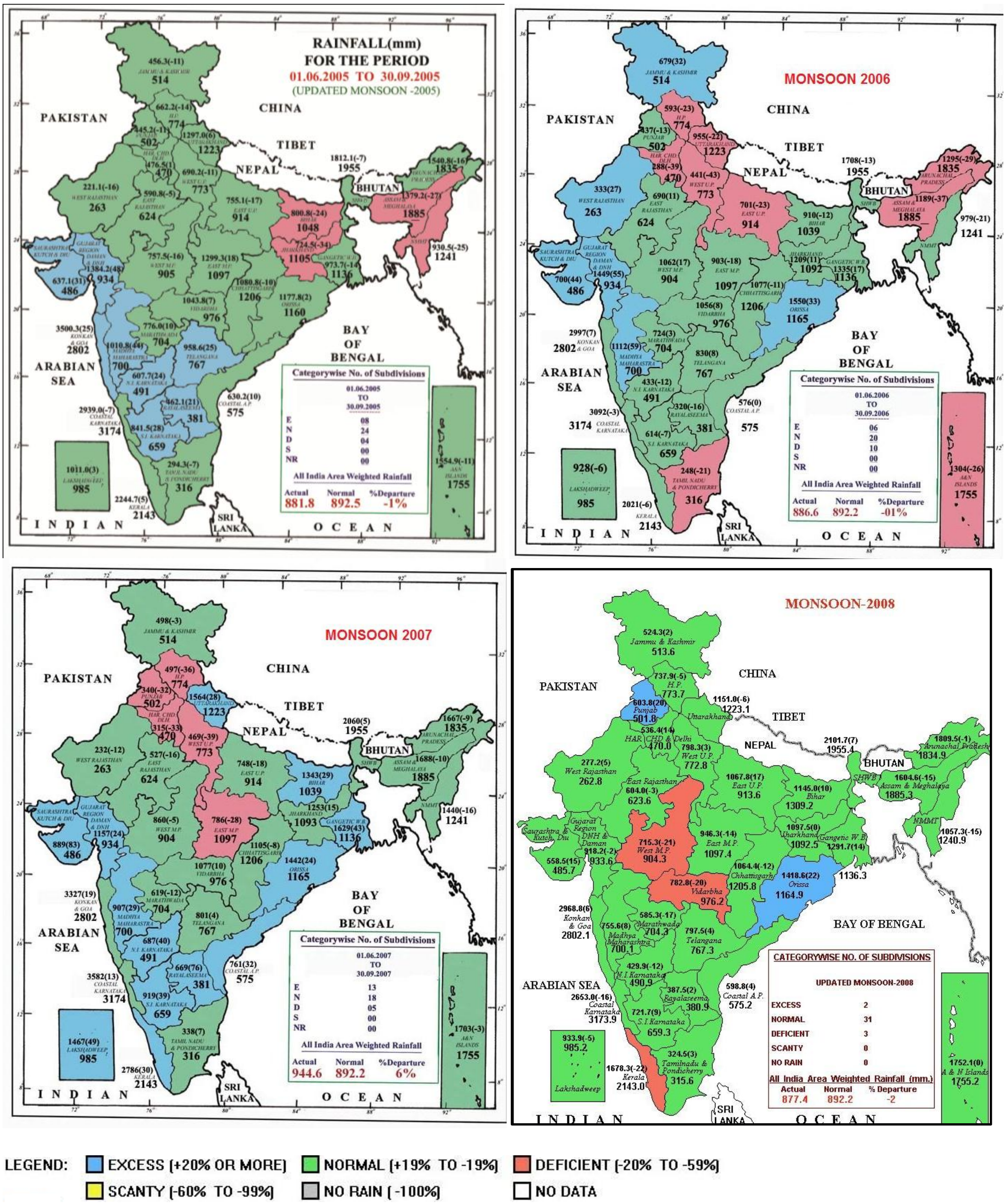


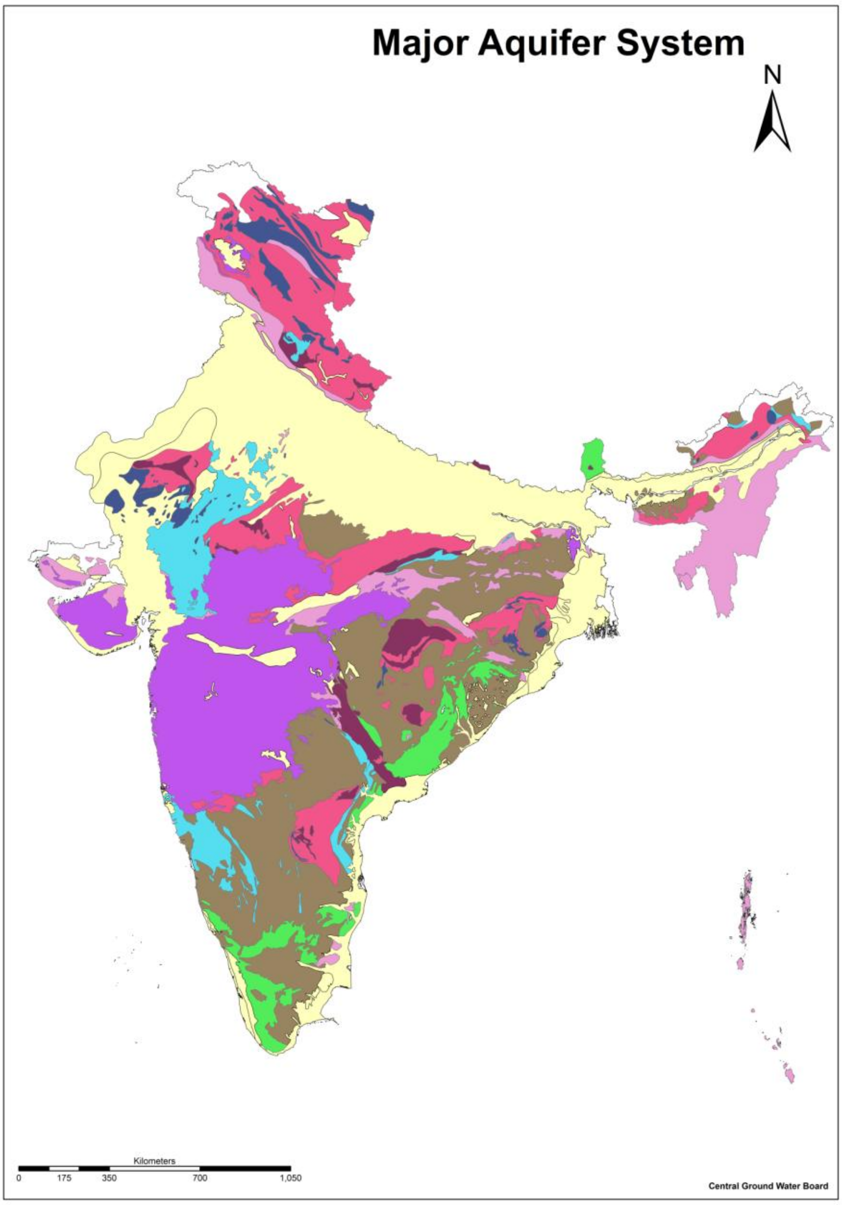
Fig. 3. Year-wise monsoon rainfall distribution (2005-2008) [Source: India Meteorological Department]

Hydrogeology

The occurrence of ground water is governed by the transmission and storage properties of the aquifer. In India, broadly two groups of rock formations have been identified depending on characteristically different hydraulic properties of these formations viz. Porous Formation and Fissured Formation. Porous formations have been further subdivided into Unconsolidated and Semi – consolidated formations. The unconsolidated formations consisting of alluvial sediments exist extensively in the Indo-Ganga-Brahmaputra basin and forms the most important repository of ground water resources of the country. Coastal aquifers are also characterized by unconsolidated formations and constitute an important ground water source. These aquifers are generally tapped by dug (open) wells and tubewells of varying depth. There are however quality problems like salinity, arsenic, iron and pollution in these aquifers. Extensive ground water withdrawal in coastal aquifer results in sea water ingress and consequent contamination of the aquifer (Dhiman & Thambi, 2009). The semi-consolidated formations normally occur in narrow valleys or structurally faulted basins. The Gondwanas, Lathis, Tipams, Cuddalore sandstones and their equivalents are the most extensive productive aquifers. The fissured or consolidated formations, commonly called as hard rock formations occupy almost two-third part of the country. The consolidated formations except vesicular volcanic rocks have negligible primary porosity. Ground water occurs mainly in the weathered portion and bedding, fractures and jointed planes. Ground water is tapped through dug (open) wells and borewells. Aquifer map of India is depicted in Fig 4.

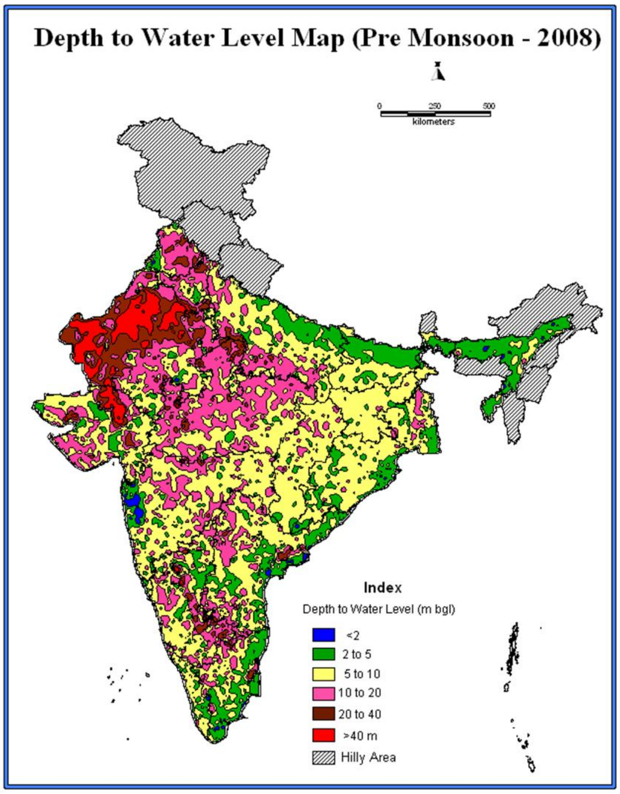
Ground water level

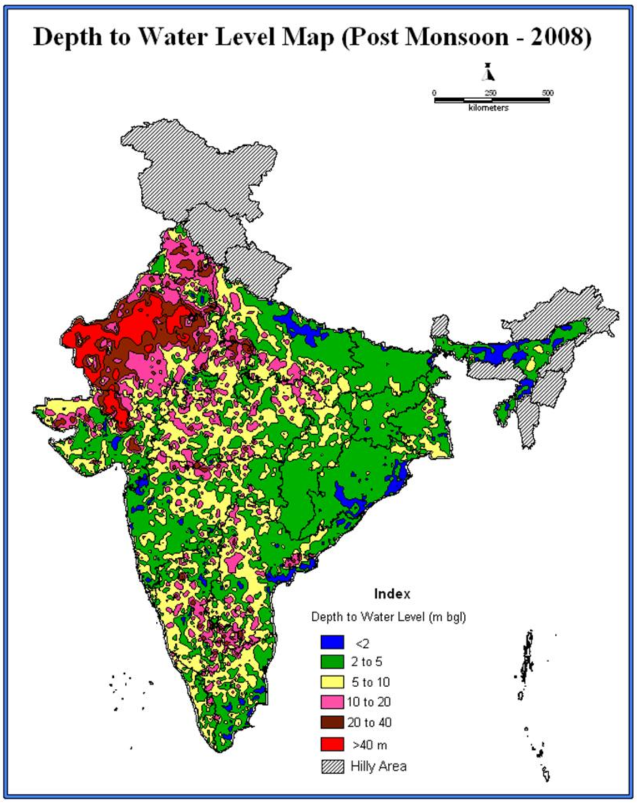
The ground water level in the country general varies between 5 and 40 m below ground level (bgl). Shallow water levels less than 5 m bgl are observed in pockets in eastern part of the country, canal command areas, river banks etc. Deeper water level of more than 40 m bgl are mostly observed in the western arid part of the country, north western India where ground water exploitation is very high and in some pockets of peninsular India. Ground water level maps are presented in Fig 5. Ground water fluctuation with respect to the mean water level indicate that the water level in general mimics the rainfall pattern. Thus ground water level scenario show slight improved situation during 2006, 2007, 2009 in parts of coastal peninsular India and western India whereas in the North western India the water level show decline during this period.

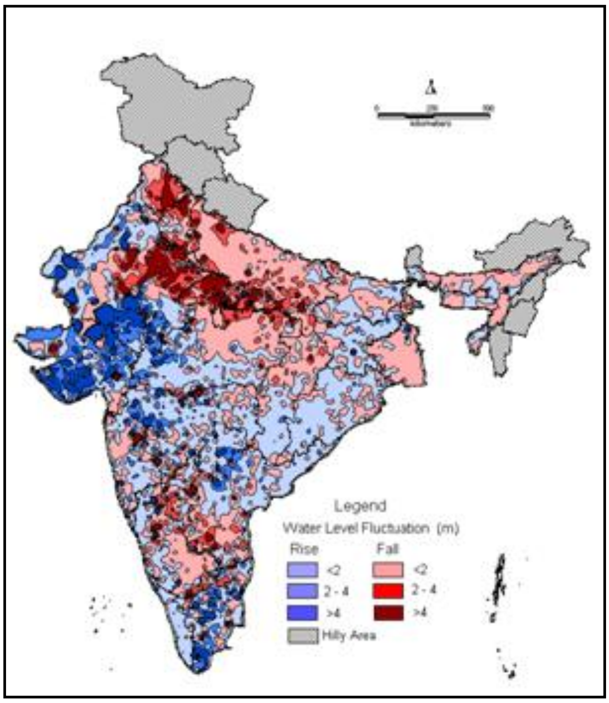


Age	Formation	Lithology	Color Code
Quaternary	Unconsolidated	RECENT & OLD AEOLIAN ALLUVIUM, CLAY, SILT, SAND, PEBBLE, GRAVEL, CALCAREOUS OLDER ALLUVIUM, LATERITE, FERRUGINOUS CONCRETIONS, LITHOMARGIC CLAY, SILT, SAND, GRAVEL	
Cenozoic , Mesozoic	Consolidated -Effusive	BASALT WITH OR WITHOUTINTERTRAPPEAN	
Cenozoic , Mesozoic, Upper Palaeozoic	Semi-Consolidated	SANDSTONE, SHALE, LIMESTONE INCLUDING CONGLOMORATE	
Cenozoic , Proterozoic	Consolidated -Intrusive	GRANITE, BASALT, DOLERITE	
Cenozoic , Proterozoic	Sedimentries and Meta Sedimentaries	SHALE, QUARTZITE, SLATE, SANDSTONE, PHYLLITE, SCHIST	
Proterozoic	Sedimentries and Meta Sedimentaries	LIMESTONE, DOLOMITE	
Proterozoic, Azoic	Meta Sedimentaries	SCHIST, PHYLLITE, SLATE, GNEISS, MARBLE	
Proterozoic, Azoic		CHARNOCKITE, KHONDALITE	
Azoic	Basal Cystalline	GRANITE-GNEISS COMPLEX	

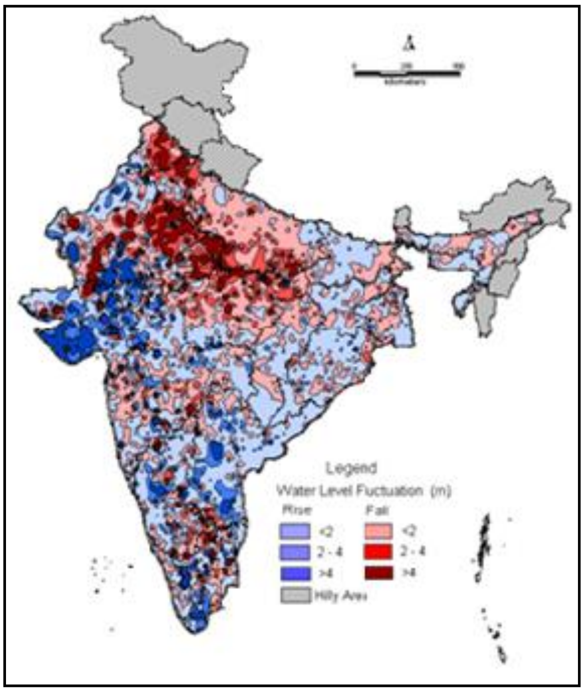
Fig 4. Aquifer Map of India



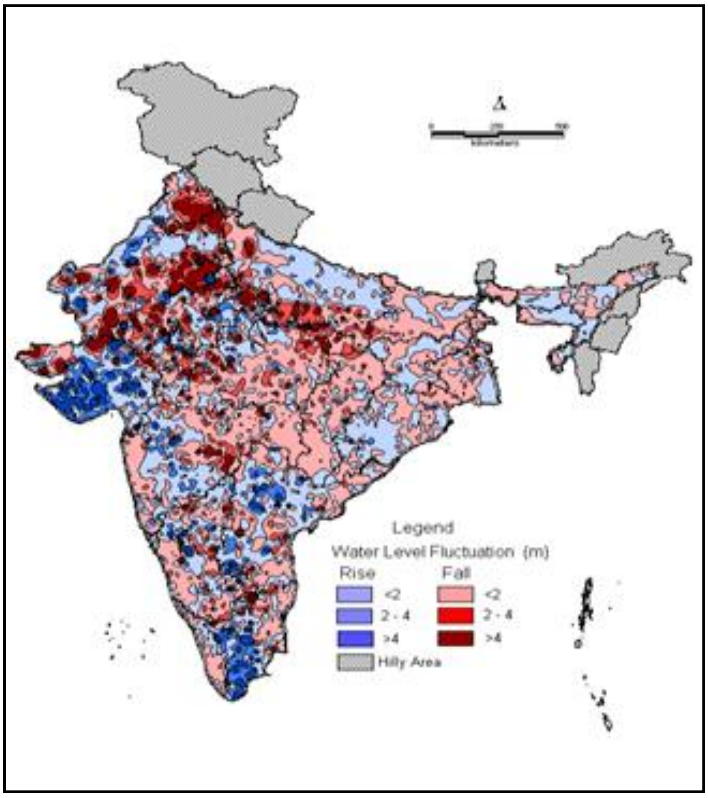




Post-monsoon 2006 vs. Decadal Mean (1996-2005)



Post-monsoon 2007 vs. Decadal Mean (1997-2006)



Post-monsoon 2008 vs. Decadal Mean (1998-2007)

Fig 5. Maps showing Water level (2008) and fluctuation with respect to Decadal Mean for the years 2006 to 2008.

Ground Water Resources Assessment

Database and parameters used in assessment

Database used in ground water resources assessment are mainly collected from various Central and State agencies. Rainfall data are provided by IMD, State Revenue departments and other state agencies. Water level data of around 45000 monitoring wells of State Ground Water Departments and Central Ground Water Board are used. Details of canal morphology and flow are given by State Irrigation Departments and Irrigation and Flood Control Department. State agriculture departments provided cropping pattern data which were used in computation of ground water draft and return flow from irrigation in many places. Minor Irrigation census also provided cropping pattern data and well census data. Number of ground water abstraction structure is also available with certain State Revenue departments and statistical handbooks. Data on tanks and ponds are available with State Minor Irrigation Department and water conservation structure with various nodal agencies engaged in water conservation measures.

Parameters pertaining to the characteristics of aquifer like specific yield, recharge factors like rainfall infiltration factor, canal seepage factor, return flow from irrigation and ground water draft i.e. unit draft of ground water abstraction structures play significant role in the assessment of ground water resources. Precise estimations of these parameters are key to realist assessment of ground water resources. Specific yield at some assessment units were determined through field studies including long duration pump tests and dry season water balance studies (in hard rock areas). In other cases, specific yield values were adopted from norms recommended in GEC-97. These norms of parameters were formulated based on experimental studies carried out in various water balance studies by Central Ground Water Board in collaboration with international agencies, state ground water agencies, academic and research institutes. Parameters like rainfall infiltration factor, canal seepage factor, return flow factor, recharge factor from tanks and ponds etc. are also adopted from GEC-97 norms. Unit drafts are either estimated through sample survey carried out at field or adopted from norms. The various parameters used in the 2009 assessment are as follows.

Table 2. Parameters used in the 2009 assessment

<table>
<tr><th colspan="2">Specific Yield</th><th>Rainfall Infiltration factor</th><th colspan="2">Canal Seepage factor</th><th colspan="2">Return flow from Irrigation</th><th>Seepage from Tanks & Ponds</th></tr>
<tr><td>Alluvium</td><td>0.04 to 0.22</td><td>0.08 to 0.25</td><td>Unlined canals</td><td>15 to 30 ham/day/million sq.m. of wetted area</td><td>Surface water Irrigation</td><td>0.10 to 0.50</td><td rowspan="3">1.4 mm/ day over the average water spread area</td></tr>
<tr><td>Sedimentary rocks</td><td>0.01 to 0.15</td><td>0.03 to 0.14</td><td rowspan="2">Lined canals & canals in hard rock terrain</td><td rowspan="2">20% of above value suggested for unlined canals</td><td rowspan="2">Ground water irrigation</td><td rowspan="2">0.05 to 0.45</td></tr>
<tr><td>Crystalline and other hard rocks</td><td>0.002 to 0.04</td><td>0.01 to 0.12</td></tr>
</table>

Replenishable Ground Water Resource

The Annual Replenishable Ground Water Resource for the entire country has been assessed as 431 billion cubic meter (bcm) of which 57% is contributed by monsoon rainfall alone. The overall contribution of rainfall to country's Annual Replenishable Ground Water Resource is 68%. The contribution from other sources such as canal seepage, return flow from irrigation, seepage from water bodies etc in Annual Replenishable Ground Water Resource is more than of 33% in the states of Andhra Pradesh, Delhi, Haryana, Gujarat, Goa, Jammu & Kashmir, Karnataka, Punjab, Tamil Nadu, Uttar Pradesh, and UT of Puducherry. The Net Annual Ground Water Availability for the entire country is computed after keeping an allocation for natural discharge. Thus out of 431 bcm of annual replenishable ground water resource, 35 bcm is the natural discharge and 396 bcm is Net annual ground water availability (Table 3).

The alluvial belt of Indus–Ganga–Bramhputra basin covering the states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and valley areas of North Eastern States and coastal alluvial belt particularly eastern coast have significantly high annual replenishable Groundwater resource varying between 0.25 to more than 0.5 m. In western India, particularly Rajasthan and parts of northern Gujarat which have arid climate, the annual replenishable ground water resources are scanty, mostly up to 0.025 m. Similarly, in major parts of the southern peninsular India covered with hard rock terrains, annual replenishable ground water recharge is less, only up to 0.10 m. This is primarily because of comparatively low infiltration and storage capacity of the rock formations prevailing in the region. The remaining part of Central India is mostly characterized by moderate recharge in the range of 0.10–0.25 m (Fig 6).

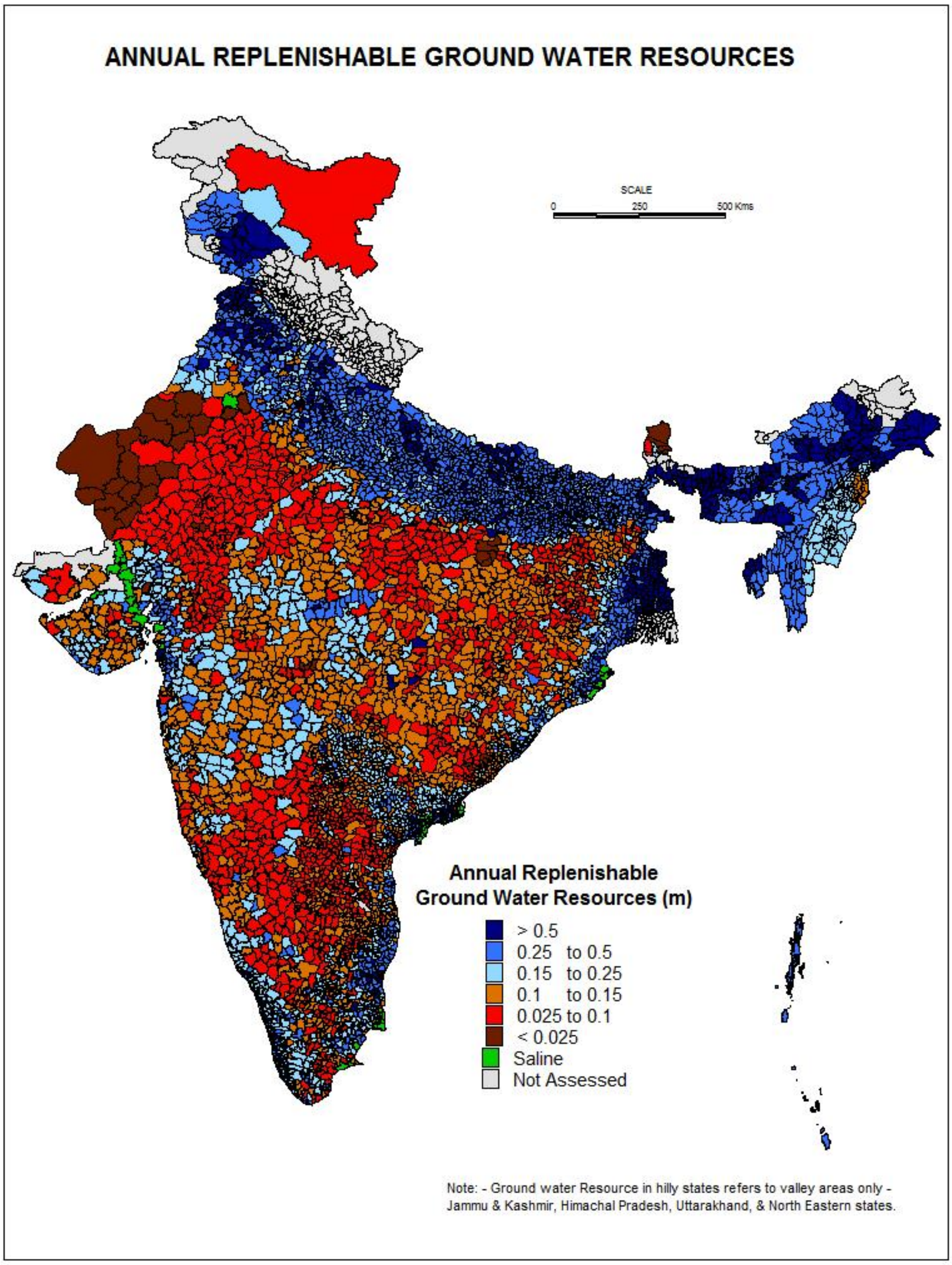


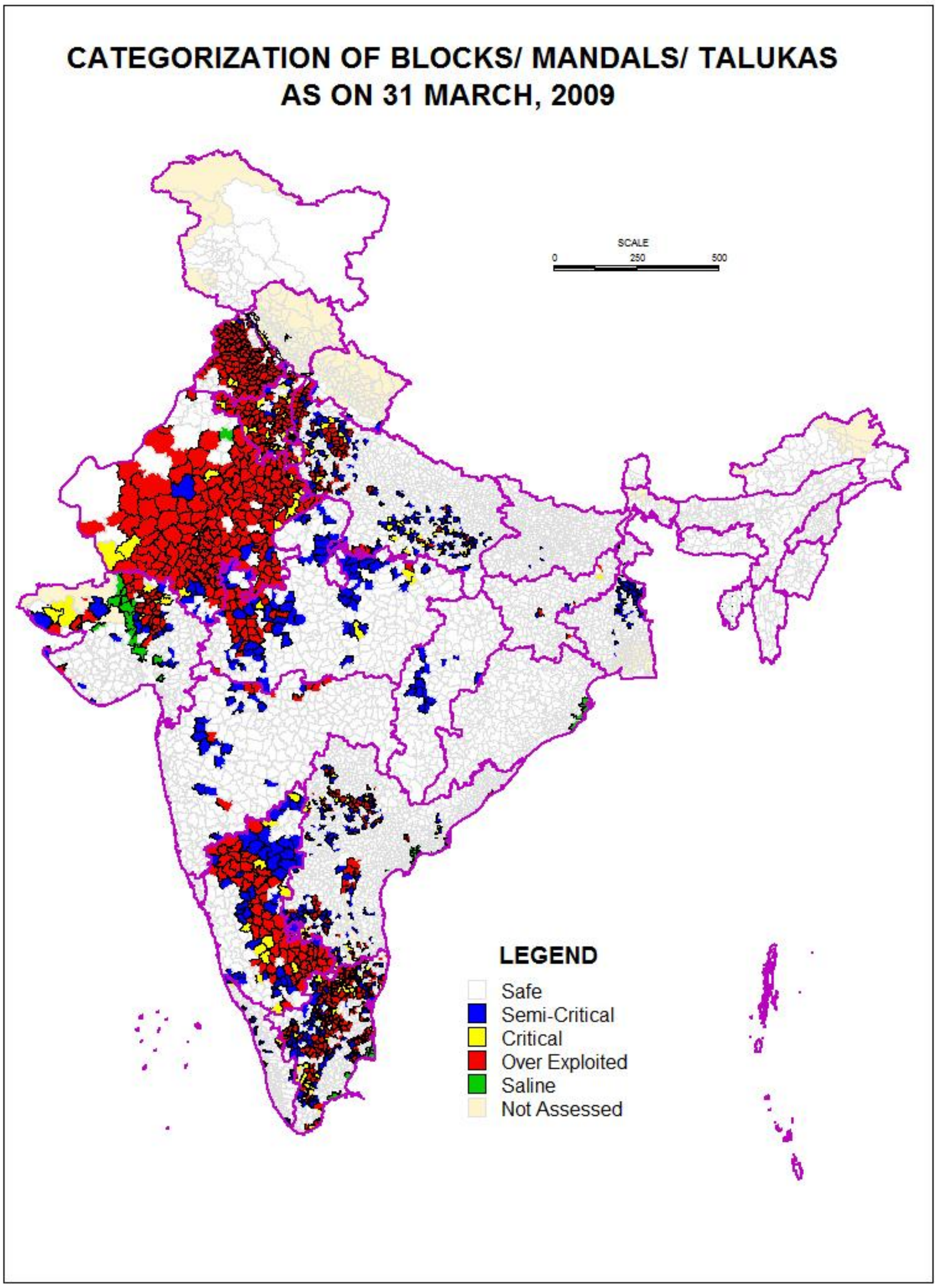
Fig 6. Annual Replenishable Ground Water Resources

Ground water utilization

The Annual Ground Water Draft of the entire country has been estimated as 243 bcm, out of which 91% i.e. 221 bcm is for irrigation purpose. The stage of ground water development in the country is 61%. The status of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where the Stage of Ground Water Development is more than 100%, which implies that in the states the annual ground water consumption is more than annual ground water recharge. In the states of Gujarat, Tamil Nadu and Uttar Pradesh and UTs of and UT of Daman & Diu, Lakshadweep and Puducherry, the stage of ground water development is 70% and above.

Categorization of assessment units

Out of 5842 numbers of assessed administrative units (Blocks/ Taluks/ Mandals/ Districts), 802 units are categorized as Over-exploited, 169 units are Critical, 523 units are Semi-critical, and 4277 units are Safe. Apart from these, there are 71 assessment units which are completely Saline. Number of Over-exploited and Critical administrative units are significantly higher (more than 15% of the total assessed units) in Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Punjab, Rajasthan and Tamil Nadu and also the UTs of Daman & Diu and Puducherry. Over-exploited blocks are concentrated in the North Western, Western and Southern Peninsular part of the country. The state-wise ground water resources, utilization and categorization is presented in table 1.



The reason for over-exploitation in the North Western part i.e. Punjab and Haryana is indiscriminate extraction of ground water mainly for irrigation purpose. In the Western part of the country viz. Rajasthan and Gujarat, over-exploitation is caused by arid climate resulting scanty and irregular rainfall and consequent less recharge. In the southern part of the country i.e. Karnataka, and Tamil Nadu, large number of over-exploited blocks are caused because of hard rock terrain which permits less recharge and thus result in water stressed conditions.

Comparison with 2004 assessment

The overall estimate of annual replenishable ground water resources of the entire country do not indicate any significant change since there is no major country-wide change in rainfall pattern during the period of 2004 to 2009 (Fig 7). However localized changes in the replenishable resources have been observed mainly because of consecutive years of normal or excess rainfall in the area, widespread implementation of rain water harvesting and water conservation measures, adoption of revised values of parameters like specific yield based on subsequent field studies and availability of improved database.

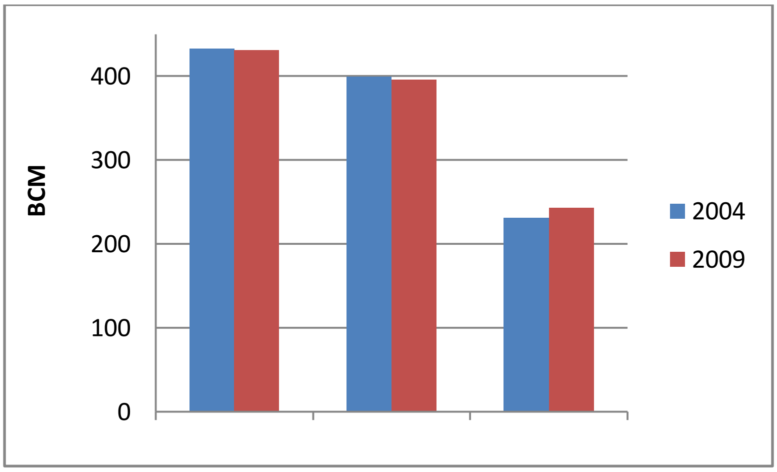


Fig 7. Overall comparison between 2004 and 2009 Assessment

There has been about 5% increase in the overall estimate of the annual ground water draft of the country in 2009 as compared to 2004. However, in some States, decrease in ground water draft estimates has also been recorded which have been attributed to lower yield of bore wells in Over-exploited blocks in hard rock terrain, good rainfall and provision for alternate source of water resulting in lesser stress on ground water resources etc.

In general increase in ground water draft led to change in assessment category from Safe/Semi-critical/Critical to Semi-critical/Critical/Over-exploited in many places. Reverse trends have also been observed in 249 assessment units (Fig 8). The reasons are mainly because of enhanced recharge as mentioned above and also partly because of management interventions like efficient water use practices with community participation, increased awareness etc. which helped in controlling the utilization of ground water resources in stressed areas.

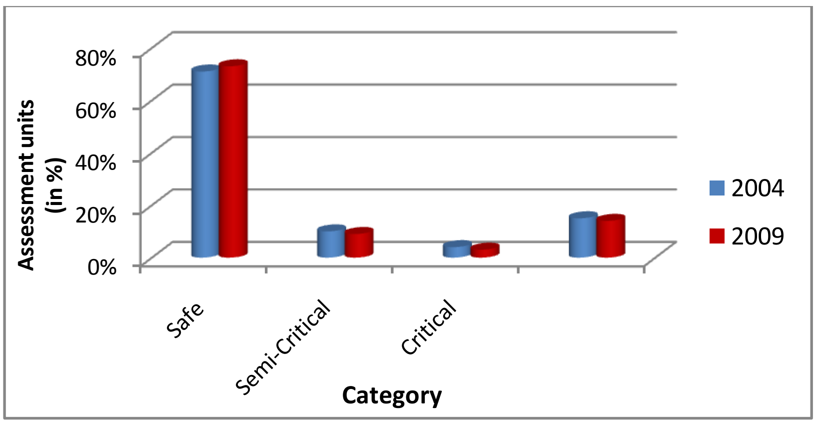


Fig 8. Overall comparison between 2004 and 2009 Categorization

Conclusion & recommendation

The occurrence and utilization of ground water resources in the country have been uneven. In the north western part of the country in the states of Punjab, Haryana, Western Uttar Pradesh, there is abundant ground water resources. However, the withdrawal of ground water is also excessive in these areas resulting in over-exploitation and continuous decline in water level. In the western part of the country in Rajasthan due to arid climate, recharge is less and the meagre ground water resources are being utilized resulting in over-exploitation. Similarly, in the peninsular India due to comparatively poor aquifer characteristics, the ground water recharge is less whereas stress on ground water resources is high. This situation is also resulting in over-exploitation. On the other hand, in the eastern part of the country in Ganga basin including eastern Uttar Pradesh, Bihar, West Bengal and Brahmaputra valley of Assam, ground water resources are yet to be tapped upto its optimum level.

Proactive management interventions like water conservation and rainwater harvesting measures, awareness campaign regarding controlled use of water and water use efficiency practices have resulted in improvement in the assessment category of blocks at few regions. Future ground water management practices should be upscaled in similar directions viz. augmentation and conservation measures in ground water stressed areas. Alongwith conservation measures, the development of ground water resources is also necessary as sustainable source of water supply for irrigation to meet the food security programme of the country. The eastern part of the country is suitable for planned development of ground water resources.

Effective management of ground water requires accurate assessment of the resources. One of the most crucial factors determining the accuracy of assessment is the database used for the exercise. Continuous strengthening of the database is required to bring in refinements in the assessment. Benchmarking of the data elements used for assessment is essential in this regard. The quality and intensity of spatial and measured data needs to be improved upon by the Central and State Govt. agencies. The refinements of norms of parameters need to be taken up through R&D support in the form of Project based studies. There is an urgent need to setup Groundwater Resources Assessment Cell in each State Ground Water Department with dedicated manpower for continuous updation of database, refinements of norms for various parameters, periodical groundwater resources assessment and field validations of the estimates. Ground water quality has emerged as an important consideration in determination of utilizable resource. Therefore the methodology for ground water assessment needs to be refined taking into consideration both quantity and quality issues. Ground water resources assessment is the crucial step towards sustainable management of the resource. A continuous endeavour is therefore required towards realistic assessment of ground water resources of the country.

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Table 3. Dynamic Ground Water Resources, Utilization and Categorization (As on 2009)

Sl. No.	States / Union Territories	Annual Replenishable Ground Water Resource (bcm)	Natural Discharge (bcm)	Net Annual Ground Water Availability (bcm)	Annual Ground Water Draft (bcm)	Stage of Ground Water Development (%)	Percentage of Over-exploited / Critical blocks (%)	
							Critical	Over-exploited
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	Andhra Pradesh	33.83	3.07	30.76	14.15	46	2	8
2	Arunachal Pradesh	4.45	0.45	4.01	0.003	0.07	0	0
3	Assam	30.35	2.537	27.81	6.026	22	0	0
4	Bihar	28.63	2.42	26.21	11.36	43	0	0
5	Chhattisgarh	12.22	0.64	11.58	3.60	31	0	0
6	Delhi	0.31	0.02	0.29	0.40	138	0	74
7	Goa	0.221	0.088	0.133	0.044	33	0	0
8	Gujarat	18.43	1.08	17.35	12.99	75	3	12
9	Haryana	10.48	0.68	9.80	12.43	127	18	59
10	Himachal Pradesh	0.59	0.06	0.53	0.31	58	13	13
11	Jammu & Kashmir	3.70	0.37	3.33	0.73	22	0	0
12	Jharkhand	5.96	0.55	5.41	1.61	30	1	2
13	Karnataka	16.81	2.00	14.81	10.01	68	4	26
14	Kerala	6.62	0.59	6.03	2.81	47	2	1
15	Madhya Pradesh	33.95	1.70	32.25	17.99	56	1	8
16	Maharashtra	35.73	1.93	33.81	16.95	50	0	3
17	Manipur	0.44	0.04	0.40	0.0040	1	0	0
18	Meghalaya	1.2343	0.1234	1.1109	0.0017	0.15	0	0
19	Mizoram	0.044	0.004	0.039	0.0004	1	0	0
20	Nagaland	0.42	0.04	0.38	0.008	2.14	0	0
21	Orissa	17.78	1.09	16.69	4.36	26	0	0
22	Punjab	22.56	2.21	20.35	34.66	170	2	80
23	Rajasthan	11.86	1.07	10.79	14.52	135	10	69
24	Sikkim	-	-	0.046	0.010	21	0	0
25	Tamil Nadu	22.94	2.29	20.65	16.56	80	9	36
26	Tripura	2.97	0.23	2.74	0.16	6	0	0
27	Uttar Pradesh	75.25	6.68	68.57	49.48	72	4	9
28	Uttarakhand	2.17	0.10	2.07	1.05	51	6	0
29	West Bengal	30.50	2.92	27.58	10.91	40	0	0
30	Andaman & Nicobar	0.310	0.012	0.298	0.011	4	0	0
31	Chandigarh	0.022	0.002	0.020	0.000	0.000	0	0
32	Dadara & Nagar Haveli	0.059	0.003	0.056	0.009	15	-	-
33	Daman & Diu	0.012	0.001	0.011	0.011	99	0	50
34	Lakshdweep	0.0105	0.0070	0.0035	0.0026	74	0	0
35	Puducherry	0.171	0.017	0.154	0.150	98	0	25
	Total	**431.03**	**35.03**	**396.06**	**243.32**	**61**	**3**	**14**