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HIGHLIGHT

Role of Decentralized Rainwater Harvesting and Artificial Recharge in Reversal of Groundwater Depletion in the Arid and Semi-arid Regions of Gujarat, India

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The assessment of groundwater resources of Gujarat for the year 2007 reveals a noteworthy shift in a large number of assessment units from Critical to Semi-critical/safe category in the semi-arid Saurashtra region, when compared with 2002. This is significant against the backdrop of decline of groundwater levels and groundwater depletion in large parts of the arid and semi-arid regions of the country. The Saurashtra region was facing problems of declining groundwater levels and ground water depletion prior to 2002 but in the post 2002 scenario, there has been an overall steady rise and stabilization in post monsoon ground water levels. Although, Saurashtra experienced above average rainfall during the period, the limited period available for infiltration of rainfall during the monsoon does not allow significantly enhanced recharge due to the limited storage of the underlying aquifers. The analysis of the drivers indicate that the intervention of decentralized rain water harvesting and artificial recharge to ground water taken up on a mass scale in the Saurashtra and Kachchh regions have prolonged the period of recharge to the aquifers during post monsoon season resulting into this miracle of stabilizing the ground water levels and even reversing the trend of ground water depletion.

Role of Decentralized Rainwater Harvesting and Artificial Recharge in Reversal of Groundwater Depletion in the Arid and Semi-Arid Regions of Gujarat, India[1,2]

Research highlight based on based on paper with the same title[3]

Introduction

The Gujarat government has undertaken some unconventional initiatives in managing the groundwater economy, the mainstay of its irrigated agriculture. For one, the government has enthusiastically made common cause with farming communities in undertaking decentralized rainwater harvesting and groundwater recharge work. By adopting an aggressive recharge strategy that has contributed significantly to stabilizing the ground water levels and even reversing the trend of groundwater depletion, the Saurashtra region of Gujarat has become a role model for other states to follow.

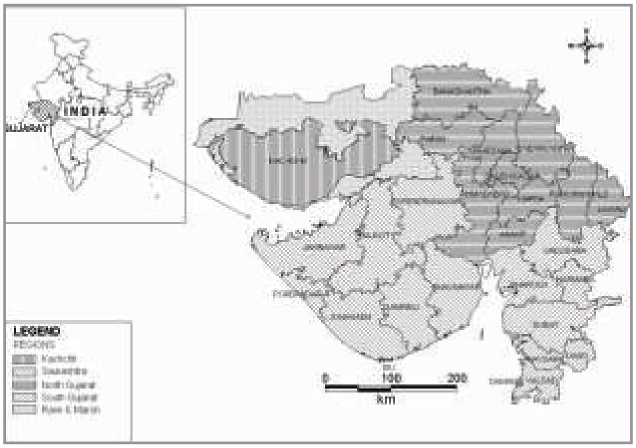
This movement had started as a mass movement in late 1980s. Subsequently the Gujarat government lent strong support to communities and NGOs to expand this work in a participatory mode under the *Sardar Patel Sahakari Jal Sanchaya Yojana*. The scheme performed best in Saurashtra region; but for the state as a whole, by December 2008, nearly 5 lakhs structures were created — 113738 check dams, 55917 *bori bandhs*, 240199 farm ponds, besides 62532 large and small check dams constructed under the oversight of the Water Resources Department of the Government of Gujarat all in a campaign mode.

What is the driving force behind this miracle of stabilizing the groundwater levels and even reversing the trend of groundwater depletion in the semi-arid Saurashtra region of Gujarat? Is it a succession of good monsoons? Or the Sardar Sarovar Irrigation project? Or because of things the farmers and the Government of Gujarat have done? This Highlight attempts to unlock the secret of Saurashtra's groundwater miracle during the recent years. If the miracle is caused by acts of God — like favorable monsoons — it is of relatively little policy interest. However, if government policy drivers are behind the miracle, the Saurashtra story acquires great significance for the lessons it offers to other States in the country about how to kick-start rapid buildup of ground water resources in arid and semi-arid regions.

The Gujarat State is situated in western part of India, between North latitudes 20° 06' 00” to 24° 42' 00”and East longitudes 68° 10' 00” to 74° 28' 00” (Figure 1). Gujarat has nearly 1600 km long coastline, which is the longest as compared to any other state in the country. The State has common boundaries with the states of Rajasthan, Madhya Pradesh and Maharashtra and shares international border with Pakistan in northwest. Droughts are frequent in North Gujarat, Saurashtra and Kachchh regions due to poor and erratic rainfall.

The climate varies from humid in the south through sub-humid in the central part to semi-arid and arid in the northern and western parts. The state receives rainfall mainly during southwest monsoon period. The normal rainfall shows steep reduction from 1843 mm in the extreme south in Dangs district to 405 mm in Kachchh district. The distribution of normal rainfall in the state is depicted in Figure 2. The year 2007– 2008 was a good rainfall year in general. Above average rainfall with respect to decadal average was recorded in all the districts. Departure (positive) from the average varies from 0.11percent to 92.10 percent whereas negative departure varies from 0.15 percent to 30.46 percent. The topography and rainfall virtually control the runoff and groundwater recharge.

Figure 1 Location map of Gujarat with four distinct regions

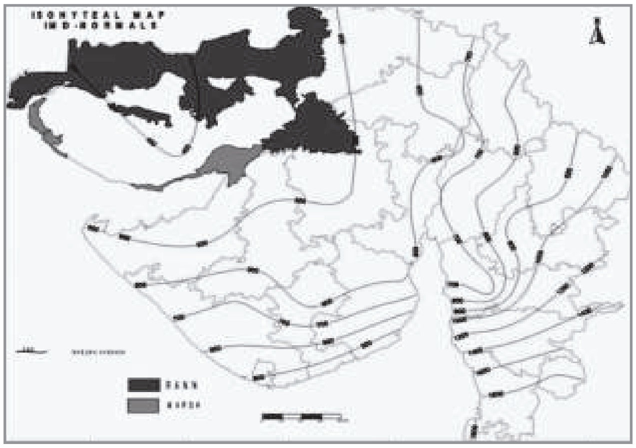


[1]This IWMI-Tata Highlight is based on research carried out under the IWMI-Tata Program (ITP). It is not externally peer-reviewed and the views expressed are of the authors alone and not of ITP or its funding partner Sir Ratan Tata Trust (SRTT), Mumbai.

[2]A selection of case studies by Sneha Lamba, Nidhi Tewari and others for the IWMI-Tata Program can be obtained from p.reghu@cgiar.org

[3]One lakh = 0.1 million

Figure 2 Distribution of normal rainfall in Gujarat



HYDROGEOLOGY

The high relief areas in the eastern and north-eastern parts of the state occupied by the Deccan Traps and the Achaeans respectively have steep topographic gradients resulting in high run-off, and therefore, provide little scope for groundwater recharge. The groundwater potential in this terrain is limited. The large alluvial tract extending from Banaskantha district in the north to Surat and Valsad districts in the south constitutes the largest most potential groundwater reservoir in the state. The aquifers are extensive, thick, hydraulically connected and are moderate to high yielding. Almost the entire Saurashtra and Kachchh regions are occupied by a variety of hard and fissured formations including basalt and consolidated sedimentary formations with semi-consolidated sediments along the low-lying coastal areas. The compact and fissured nature of rocks gives rise to discontinuous aquifers with moderate yield potential. The friable semi-consolidated sandstone forms an aquifer with moderate yield potential. The coastal and deltaic areas in the state form a narrow linear strip and are underlain by Tertiary sediments and Alluvium. Though highly potential aquifers occur in these areas, salinity is a constraint for groundwater development. Groundwater withdrawal requires to be strictly regulated so that it does not exceed the annual recharge and also that it does not disturb the hydrochemical balance leading to seawater ingress. The quality of groundwater in both hard rock and alluvial terrain is, by and large, suitable except in the coastal areas, estuarine tract and the Rann where the degree of mineralisation in groundwater is rather high and salinity is common. Salinity in groundwater is also noticed in the arid and semi-arid tract.

GROUNDWATER RECHARGE ASSESSMENT

The methodology published by the Groundwater Estimation Committee (GoI 1997) has been utilized by the Narmada, Water Resources and Water Supply Department, Government of Gujarat, for assessment groundwater recharge in the state of Gujarat for computations for the years 2002 and 2007. As per this methodology total annual groundwater recharge is obtained as the sum of recharge in the monsoon season and recharge in the non-monsoon season, where in each season, the recharge comprises of recharge from rainfall and recharge from other sources .The assessment is carried out at the level of "*taluka"* which is smallest administrative unit in the state.

The groundwater recharge due to rainfall in the monsoon season has been estimated by groundwater level fluctuation method .The water level fluctuation method is based on the application of groundwater balance equation, which is stated in general terms as follows for any specified period,

Input - Output = Storage increase

In the above equation, the terms input and output are used in the general sense, referring to all components of ground water balance, which are either input to the unit, or output from the unit of groundwater system taken up for resource assessment (*Taluka*). Hence input refers to recharge from rainfall and other sources and subsurface inflow into the unit. Output refers to groundwater draft, groundwater evapo-transpiration, and base flow to streams and subsurface outflow from the unit. Recharge in the monsoon season and non-monsoon season is estimated separately.

For purposes of monsoon recharge assessment in Gujarat receiving the main rainfall from South West monsoon water level fluctuation method has been used. The monsoon season has been taken as May/June to October/November for all areas. Generally, a well hydrograph follows a definite trend like stream flow hydrograph with a peak followed by a recession limb. The recession limb in the post monsoon period, particularly in hard rock areas, is categorized by two slopes: a steep limb from September-October to October-November and other gentle limb from October-November to May-June. The steeper limb indicates that whatever rise has taken place during the monsoon period, of the total, a significant part is lost soon after the end of rainfall. The rate of recession of the water level is relatively rapid in the beginning, for a period of 1-1.5 months immediately after the water level rises to maximum. Due to less demand for groundwater in view of adequate moisture in soils, the resource available during this period is not fully utilized.

Recharge during the monsoon season

The recharge during monsoon season has been computed as follows:

$$R = Rrf_{rf} + Rsc_{sc} + Rt_{f} + Rrif_{wc} + Rwc_{t}\text{, where}$$

Rrf_{rf} = Recharge from monsoon rainfall

Rsc_{sc} = Recharge due to seepage from canals

Rt_t = Recharge due to seepage from storage tanks and ponds

Rrif= Recharge due to return flow from irrigation in the area

Rwc_w= Recharge from water conservation structures (check dams and percolation tanks)

The estimation of recharge due rainfall is based on water level fluctuation/rainfall infiltration method, while the estimates of recharge due to irrigation return flows (Rrf), recharge from water conservation structures (Rwc), recharge due to seepage from canals (Rsc)and recharge from storage tanks and ponds (Rt) has been made based on the norms given by the GEC 97 (GoI 1997).

Recharge in non-monsoon season

As the normal rainfall in the non-monsoon season in Gujarat is less than 10 percent of the normal annual rainfall, the recharge due to rainfall in the non-monsoon season has been taken as zero. The total recharge in the non-monsoon season is obtained as the sum of recharge from rainfall in the non-monsoon season and recharge from other sources in the non-monsoon season.

GEC 97 Norms for recharge: Various components are described hereunder.

Recharge from other sources

Recharge from other sources, namely return flow from irrigation ($Rrif_f$), tanks (Rt_t) and from water conservation structures (Rwc_c) have been estimated as follows.

Return flow from irrigation

The recharge due to return flow from irrigation may be estimated, based on the source of irrigation (groundwater or surface water), the type of crop (paddy, non-paddy) and the depth of water table below ground level, using the norms provided below (Table 1).

Recharge from storage tanks and ponds

1.4 mm/day for the period in which the tank has water, based on the average area of water spread. If data on the average area of water spread is not available, 60 percent of the maximum water spread area has been used instead of average area of the water spread.

Recharge from water conservation structures (percolation tanks and check dams)

50 percent of gross storage, considering the number of fillings, with half of this recharge occurring in the monsoon season, and the balance in the non-monsoon season.

Analysis of the Drivers of ground water recharge

To explore what has been the role of each of the drivers contributing to groundwater recharge, a regional level analysis of estimates of groundwater recharge for the periods 2002 and 2007 has been carried out. To this end, Gujarat has been divided into four distinct regions as outlined in Figure 1 and the salient features of these regions in terms of hydrology, groundwater occurrence, agricultural practices and socio-economy are presented in Table 2.

For gaining an understanding of the role various sources which contribute to groundwater recharge in the state, it is important to look at the contribution of each of them in making up the total recharge. The Table 3 gives a region wise disaggregation of the estimated contribution of rainfall and other sources to the ground water recharge for 2002 and 2007 scenario. The same is graphically presented in Figure 3 for the sake of easy comprehension.

HYPOTHESIS

While some of the drivers for recharge to groundwater work state-wide while others are region specific. Thus rainfall is the most important contributor to groundwater recharge throughout the state during the monsoon season. As a result, the impacts could be felt everywhere. Besides, in the South Gujarat region having large number of reservoirs and a large network of irrigation canals, the seepage from reservoirs and return flows from surface irrigation are major contributors to groundwater recharge. The contribution from seepage from reservoirs and flow

Table 1 Recharge as percentage of application

Source of Irrigation	Type of crop	Water table below ground level		
		<10m	10-25 m	>25m
Ground water	Non-paddy	25	15	5
Surface water	Non-paddy	30	20	10
Ground water	Paddy	45	35	20
Surface water	Paddy	50	40	25

Table 2 Salient Features of the Four Distinct Regions of Gujarat

Regions	Districts	Features
North Gujarat	Ahmedabad, Gandhinagar, Patan, Mehsana, Dahod, Banaskantha, Panchmahals and Sabarkantha.	Arid to semi-arid climate; groundwater is the main source of irrigation; deep, alluvial aquifer system that is over-exploited; enterprising farmers; highly developed dairying and dairy co-operatives.
South Gujarat	Anand, Kheda, Vadodara, Bharuch, Surat, Narmada, Navsari, Valsad and Dangs.	Humid and water-abundant part of Gujarat; large areas under canal irrigation systems such as Mahi, Ukai-Kakarapar, Karjan, Damanganga and Sardar Sarovar; conjunctive use of groundwater and canal surface water through farmer initiative; enterprising farmers; strong Dairy cooperatives.
Saurashtra	Amreli, Bhavnagar, Junagadh, Jamnagar, Porbandar, Rajkot and Surendranagar,	Arid to semi-arid climate; groundwater the main source of irrigation; hard rock aquifers have poor storativity; open dug wells are the main source of irrigation; Agriculture dependent mostly on monsoon; early withdrawal of monsoon is a curse for *kharif* crop.
Kachchh	Kachchh	Arid to semi-arid climate; groundwater the main source of irrigation; limited area with tube wells in productive aquifers and large area with hard rock aquifers having poor storativity with open dug wells are the main source of irrigation; agriculture dependent mostly on monsoon; early withdrawal of monsoon the curse of *kharif* crop.

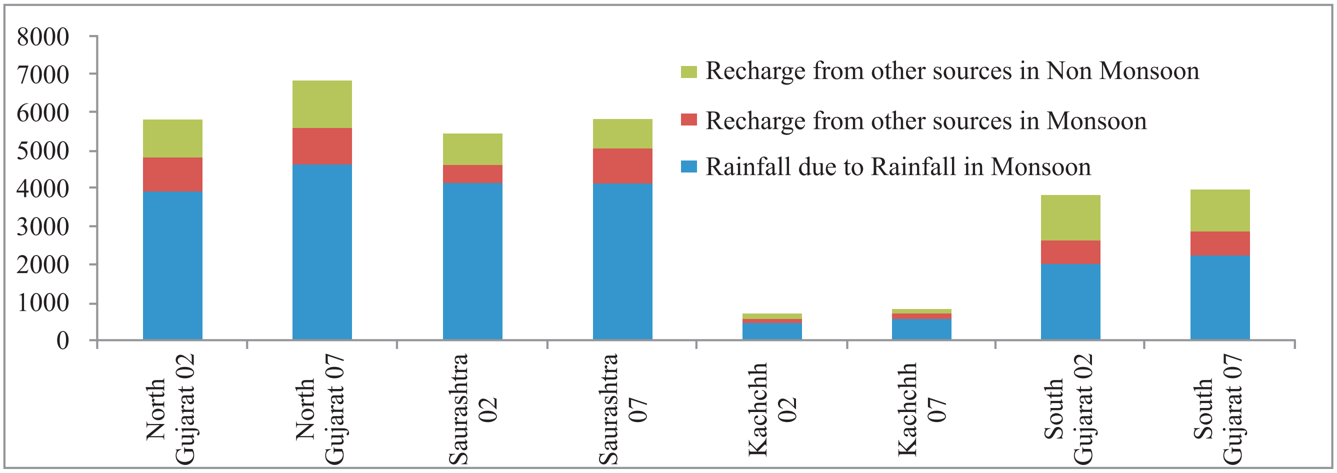
Table 3 Region wise Groundwater recharge in Gujarat during 2002 and 2007

Si. No.	Region/State	Monsoon	Non Monsoon		Total annual groundwater recharge (MCM/yr.)
		Recharge from rainfall (MCM/yr.)	Recharge from other sources (MCM/yr.)	Recharge from other sources (MCM/yr.)	
1	North Gujarat 2002	3939.31	895.81	1001.26	5836.40
2	North Gujarat 2007	4613.80	995.92	1247.87	6857.59
3	Saurashtra 2002	4166.56	459.90	801.78	5428.24
4	Saurashtra 2007	4490.03	911.69	829.41	6231.13
5	Kachchh 2002	449.34	131.61	142.15	723.11
6	Kachchh 2007	570.38	146.27	108.68	825.33
7	South Gujarat 2002	2034.60	587.78	1200.82	3823.20
8	South Gujarat 2007	2238.97	628.87	1079.97	3947.81
9	Gujarat State 2002	10589.81	2075.10	3146.01	15810.92
10	Gujarat State 2007	11913.18	2682.75	3265.93	17862.17

Source: CGWB 2002; 2007

irrigation to recharge is comparatively less important in other regions of the state. Whereas in Saurashtra, North Gujarat and Kachchh regions in the state which have relatively large areas under groundwater irrigation the seepage from groundwater irrigation forms the second most important driver to groundwater recharge. However, some other interventions are by their nature confined to one or more of the four regions. For example, if canal irrigation underwent major changes, its impact will be strongly felt in southern Gujarat where much of canal irrigation is located. Contrary to this, if the increased availability of water through canal irrigation system has

Figure 3 Region wise contribution of different sources to the ground water recharge in Gujarat during 2002 and 2007



Source: CGWB 2002; 2007

been a major driver for building up of groundwater resources in Gujarat, we should not expect to see large impacts in North Gujarat, Saurashtra and Kachchh which have only a small share in canal irrigated area in the state. "Decentralized Groundwater Recharge" activities are concentrated in Saurashtra and Kachchh; hence its impact is more likely to be visible in these regions. This implies that groundwater recharge activities which are concentrated mostly in Saurashtra, North Gujarat and Kachchh regions would reflect region specific impact on groundwater recharge if they form a dominant driver for recharge. The expected influence of various drivers on groundwater recharge in different regions of Gujarat is given in Table 4.

It is against this background that a disaggregated analysis of drivers of recharge to groundwater in Gujarat was taken up to isolate the policy drivers most responsible for the build up in groundwater resources in Saurashtra region in particular.

Disaggregated Analysis

The contribution of various drivers for groundwater recharge in the state of Gujarat has been subjected to district wise analysis for different regions. These data are given in Table 3 and the graphical presentation in Figure 3. A careful study reveals the following.

Recharge during Monsoon Period

Much of Gujarat - especially the drought-prone regions of Saurashtra, Kachchh and North Gujarat have received above normal rainfall during the years post 1999-2000. During 2002, when almost all of India experienced shortfall in rainfall precipitation, Gujarat too faced an overall shortfall. However, drought hit was only southern part which is well-covered by canal irrigation. The drought-prone regions mentioned above all had above or near normal rainfall as shown in Figure 4 below.

The total recharge from rainfall has been of the order of 10590 MCM/year in 2002 and 11914 MCM/year in 2007

Table 4 Expected Influence of different drivers on recharge to groundwater in Gujarat.

	Drivers responsible for ground water recharge	Regions likely to be affected			
		South Gujarat	Kachchh District	North Gujarat	Saurashtra
1	Rainfall	↑↑↑↑	↑↑↑↑	↑↑↑↑	↑↑↑↑
2.	Canals	↑↑↑↑	↑	↑↑	↑↑
3.	Storage tanks and Ponds	↑↑↑↑	↑↑	↑↑↑	↑↑↑
4.	Irrigation return flows	↑↑↑↑	↑	↑↑	↑↑↑
5.	Check dams and percolationtanks	↑	↑	↑↑	↑↑↑↑

reflecting an overall rise in groundwater recharge to the extent of 12 percent in the state as a whole. But the increased contribution towards recharge varies from nearly 8 percent in Saurashtra to about 27 percent in Kachchh. The North Gujarat and South Gujarat regions have recorded an increase in recharge due to rainfall to the extent of 17 percent and 10 percent respectively. Groundwater recharge in the monsoon from other sources has increased from 2075 MCM/year in the year 2002 to about 2683 MCM/year in the year 2007 recording an increase in contribution by nearly 30 percent when considered with respect to the year 2002. This increase is of the order of about 7 percent in South Gujarat, 11 percent in North Gujarat and Kachchh regions and 98 percent in Saurashtra region. After the 2002-03 drought, monsoons have been kind to most parts of India except in 2009. Yet, it was only Saurashtra region of Gujarat which experienced rapid buildup of ground water resources during these years.

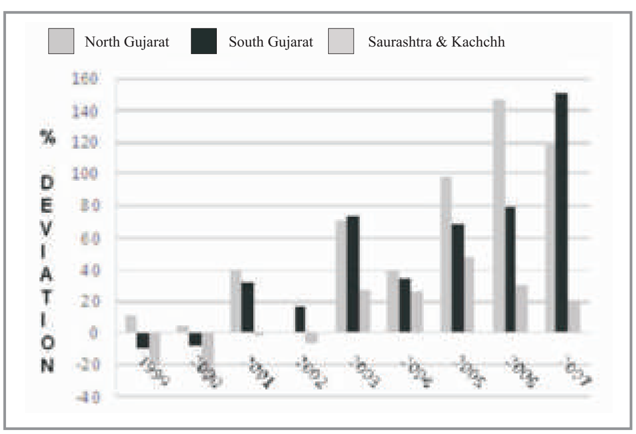
Recharge during Non-Monsoon Period

In the non-monsoon season there is no contribution from the rainfall in 2002 as well as in 2007 to groundwater recharge. However, recharge from other sources during the non-monsoon season in the state has increased from 3146 MCM/year to about 3266 MCM/year recording an increase of nearly 4 percent. While North Gujarat has recorded a maximum increment in this component to the extent of 25 percent as compared to 2002. In the Kachchh region, the contribution has in fact decreased by nearly 24 percent. In Saurashtra region, there has been a nominal increase by about 3percent as compared to 2002. However, in South Gujarat region dominated by the canal irrigation, the contribution of recharge from other sources decreased by nearly 10 percent as compared to 2002.

Annual Recharge

If we look at the overall position of change in the groundwater recharge, it is seen that in the state as a whole there has been an increase in recharge to the extent of nearly 2050 MCM/year. Across the regions, the increase in groundwater recharge varies from nearly 3 percent in the South Gujarat to about 14 percent to 15 percent respectively in Kachchh and Saurashtra regions. In North Gujarat region, the total groundwater recharge has increased by about 18 percent.

Figure 4 Deviation from normal rainfall in different regions of Gujarat



Assessment

An analysis of the various drivers of recharge reveal that maximum increment in the groundwater recharge to the extent of 607 MCM /year has taken place in the monsoon season from recharge through other sources. This include recharge from canals, seepage from storage tanks and ponds, surface water irrigation and from check dams and percolation tanks. With a view to demystify the increase in groundwater recharge in the Saurashtra region, component wise analysis of recharge in respect of the above said drivers has been carried out ,which is given in Table 5. It can be seen from a perusal of this table that recharge from check dams and percolation tanks, the singular and most important component of increase in groundwater recharge in the Saurashtra region which has contributed about 480 MCM/year is an important driver for the miracle of stabilization of Groundwater levels in the post monsoon season. This effect of decentralized rainwater harvesting and artificial recharge to ground water is vivid in Figure 5.

INCREMENTAL RISE IN POST MONSOON WATER LEVELS

When groundwater levels are dropping in large parts of the country, Gujarat is the only state whose groundwater balance has turned positive during the recent years. This is amply demonstrated by increased incremental rise in post monsoon water levels in Saurashtra and North Gujarat regions between 2001 (CGWB[1]) and 2006 (CGWB[2]).

A comparison of the water level fluctuation maps showing incremental rise in post monsoon for the years 2001 (Figure 6) and 2006 (Figure 7) shows that during 2001, the groundwater levels recorded decline in about 27600 sq.km area .Whereas, in 2006, the situation was reversed and the area recording decline in post monsoon ground water levels was drastically reduced to only about 4400 sq.km. This means that in an area of nearly 23200 sq. km, the post-monsoon declines were reversed. This improvement in the situation is mostly confined to Saurashtra and parts of North Gujarat which witnessed decentralized construction of check dams/percolation tanks on a massive scale.

IMPACT ON GROUNDWATER RESOURCES

The assessment of groundwater resources is carried out periodically in the state of Gujarat for planning the development and management of groundwater resources

Table 5 Saurashtra region: Ground Water Recharge in MCM/Year (2007)

District	Monsoon Recharge	Recharge from canal	Recharge from surface water irrigation	Recharge due to Seepage from Reservoirs & Tanks	Recharge from Check Dam & Percolation Tanks	Recharge from GW irrigation (Monsoon)	Recharge from GW irrigation (Non monsoon)	Potential Recharge	Annual replenishable ground water resource
Amreli	533.51	13.16	41.24	7.26	67.8	28.23	62.31	5.01	758.51
Bhavnagar	594.75	4.74	50.03	20.94	125.95	29.21	58.46	8.48	892.56
Jamnagar	691.33	21.85	59.11	36.67	63.41	33.07	66.14	10.79	982.37
Junagadh	1083.73	20.48	47.66	22.66	81.35	51.55	89.88	8.89	1406.20
Porbandar	136.71	3.18	7.42	1.09	4.45	8.23	8.54	5.41	175.03
Rajkot	956.88	27.76	81.4	81.87	126.09	51.27	85.21	12.94	1423.42
Surendranagar	493.12	14.55	14.35	4.67	10.33	20.21	30.65	5.14	593.02
Total	4490.03	105.72	301.21	175.16	479.38	221.77	401.19	56.66	6231.12

in a scientific manner. This helps in taking timely measures to notify the areas for regulation of groundwater development as well as to take measures for improvement of groundwater situation in the areas, where it has become critical or approaching criticality. The assessment of groundwater resources for the years 2002 and 2007 has been carried out based on the groundwater resources estimation methodolgy-1997 recommended in the Report of the Ground Water Estimation Committee, published by the Ministry of Water Resources, Govt. of India in 1997.

As per the groundwater resource estimation completed recently for the Gujarat state for the year 2007 a noteworthy shift is seen in a large number of assessment units *(Taluka*) from the critical to semi-critical/safe category in the semi-arid Saurashtra region, when compared with 2002 (Table 6).The salient features of shift in the status of assessment units from a given category to a different category has been compiled from the Report on Estimation of Ground water resources and irrigation potential in Gujarat State(2002) and the Report on Assessment of Ground water resources and irrigation potential of Gujarat State (2007) prepared by the Narmada ,Water Resources and Water Supply Department, Government of Gujarat.

A perusal of the Table 6 reveals that the total number of over exploited (OE), critical and semi-critical *talukas* in the state has reduced from 105 in 2002 to 54 in 2007. Region wise comparison across the state shows that Saurashtra has the largest share of 33 *talukas* which have witnessed increased availability of ground water and shifted to safe category of development. The North Gujarat region follows the tally where increased water availability in 17 *talukas*, have led to a shift from higher category of ground water development to safe category. While Kachchh and South Gujarat regions do not reflect any significant change in the number of *talukas* in different categories.

CONCLUSIONS

Well known for aggressive adoption of decentralized rain water harvesting and artificial recharge to groundwater, the semi-arid region of Saurashtra in Gujarat has charted out a new course for building up of its groundwater resources. It is stage of groundwater development and rise in post monsoon water table, which has posted an impressive growth since 2002. This Highlight analyzed the drivers of groundwater build up through disaggregated analyses of performance of four distinct regions of Gujarat, viz., South Gujarat, North Gujarat, Saurashtra and

Figure 5 Saurashtra: Contribution of different drivers to ground water recharge (2007)

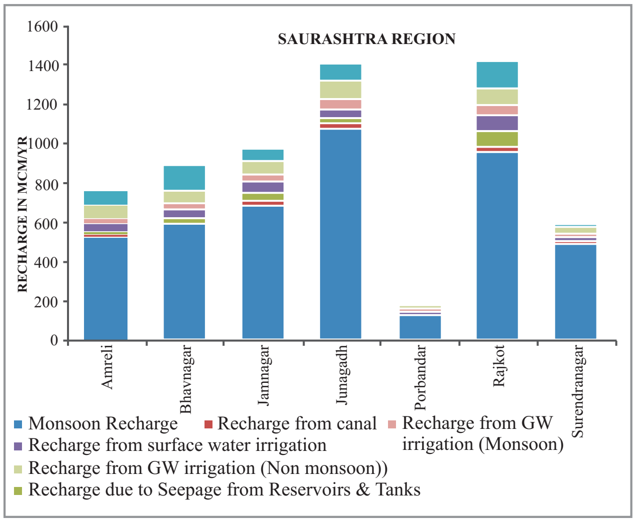


Figure 6 Water level fluctuation between Pre-and Post-Monsoon Water levels in Gujarat, 2001

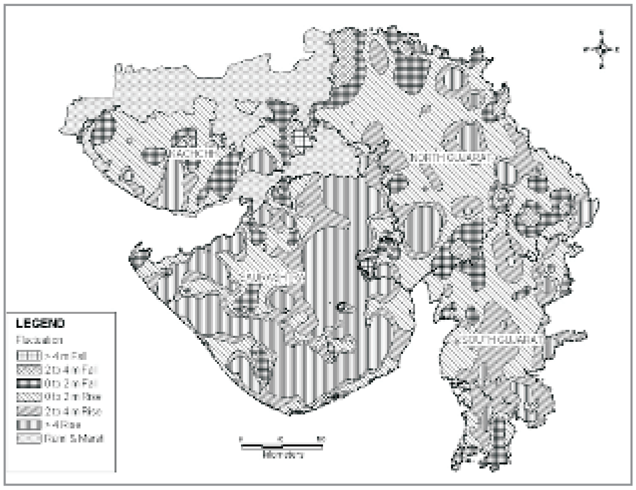
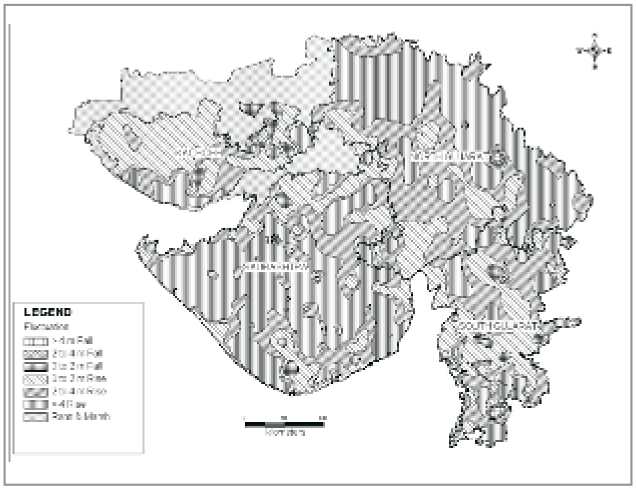


Figure 7 Water level fluctuation between Pre- And Post-Monsoon Water levels in Gujarat, 2006



Kachchh. The rapid strides made in augmentation of groundwater resources in Saurashtra region of Gujarat deserves replication in the semi-arid and arid hard rock regions of the country suffering from secular decline in water levels and groundwater depletion, in spite of reasonably good rainfall.

In interpreting these regional trends vis-à-vis the recent groundwater resources assessment, it emerges that if Saurashtra, and to lesser extent, North Gujarat, would not have benefitted as much as they have in the absence of the mass-based water harvesting and groundwater recharge movement. During the relatively good monsoons of 2003 to 2006, the vast corpus of check dams and, percolation ponds increased the availability of groundwater that made it possible to see the visible large scale impact possible on the ground water scenario and a noteworthy shift in a large number of assessment units from the critical and semi-critical to safe category in the semi-arid Saurashtra region and to a lesser extent in north Gujarat, when compared with 2002.

Table 6 Status of Groundwater development in Gujarat State (2002 - 2007)

Region	Year-2002	Year 2007								
	No. of OE *taluka*	No. of critical *taluka*	No. of semi-critical *taluka*	No. of safe *taluka*	No. of saline *taluka*	No. of OE *taluka*	No. of critical *taluka*	No. of semi-critical *taluka*	No.of safe *taluka*	No. of saline *taluka*
North Gujarat Region	24	8	23	**29**	7	22	5	10	**46**	7
Kachchh Region	3	1	4	1	1	3	2	2	2	1
Saurashtra Region	2	3	32	**32**	2	1	0	4	**65**	2
South Gujarat Region	1	0	4	42	4	0	0	5	42	4
TOTAL	30	12	63	**104**	14	26	7	21	**155**	14

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About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

Water Policy Highlights are pre-publication discussion papers developed primarily as the basis for discussion during ITP's Annual Partners' Meet. The research underlying these Highlights was funded with support from IWMI, Colombo and SRTT, Mumbai. However, the Highlights are not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or either of its funding partners.

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