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Technical Report Series

GROUNDWATER BROCHURE BANASKANTHA DISTRICT GUJARAT

Compiled
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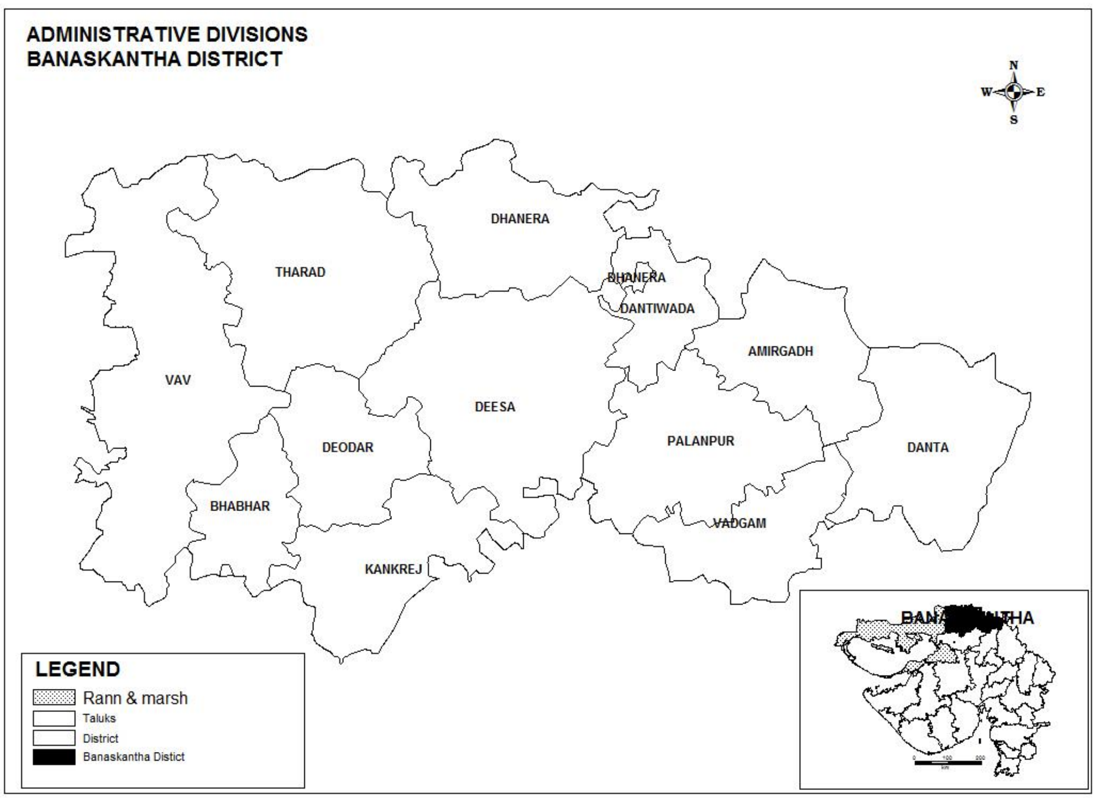
DISTRICT GROUND WATER BROCHURE
BANASKANTHA

1.0 Introduction

The Banaskantha district takes its name from the river Banas, which flows through it. The district is situated in the north western part of the state and lies between north latitudes 23°33’ & 24°25’, and east longitude 71°07’ & 73°02’. It has an area of 10,303 sq. km and is bounded by state of Rajasthan in north, Rann of Kachchh in west, by Sabarkantha, Mahesana and Patan districts in east, south and south west respectively.

The district with its headquarter at Palanpur is consists of 12 taluks and 1249 villages. The talukas are Palanpur, Danta, Vadgam, Amirgadh, Dantiwada, Deesa, Dhanera, Kankrej, Diyodar,, Bhabhar, Vav and Tharad. Total population of the district, as per 2001 census, is 2502843.

Fig-1 Administrative map of the District



The district has a diverse landscape, it is characterized by hilly upland in the northeast with intermountain valleys, followed by piedmont zone with alluvium and residual hills/inselbergs and gently sloping vast alluvial – aeolian plain. The Rann in the west forms a totally different landscape in which a few isolated islands (Bets) are inhabited. The elevation in the district ranges from less than 10 m in the western part to more than 800 m amsl in the northeastern part.

The district has semi arid climate. Extreme temperatures, erratic rainfall and high evaporation are the characteristic features of this type of climate. Since the district experiences a semi arid type of climate, the rivers flowing through it are of ephemeral nature i.e. have water during monsoon only and dry up after monsoon. The drainage network in the district is constituted mainly by the Banas and Sarashwati rivers and their tributaries. In the extreme east, Sabarmati river forms district boundary with Sabarkantha district and in part controls the drainage network of the hilly area east of Danta. The surface water resources of the district are very limited. Groundwater is the main source of irrigation. Important Irrigation schemes of the districts are Dantiwada, Mukteshvar Irrigation Project, Sipu Reservoir Project and Hadmatiya Irrigation Scheme.

In Banaskantha district major part of the soils are sandy in nature. In general the soils are poor to medium in fertility and water retention capacity.

Economy of the district is basically dependent on agriculture as about 65% of the workers are engaged in primary sector.

1.1 Studies/Activities by CGWB

Systematic hydrogeological surveys commenced by CGWB in the year 1967-68, and continued by S.A. Faruqui (67-68), R.C. Tyagi(1968-69), Arun Kumar (1982-83) and R.C. Jain (1981-82,1982-83,1987-88). Reappraisal hydrogeological surveys were carried out by CGWB during 1979-80, 1987-88, 1988-89 and during 2006-08, in parts of Banaskantha districts.

Ground water exploration studies by test drilling in the district commenced during 1961-62 by ETO (now CGWB) and continued by CGWB under UNDP and regular exploration programme of CGWB. CGWB also constructed tubewells under Production well programme in Bhabhar area under Desert Development scheme (DDS) under Crash programme and Economic area Development programme during early seventies for the Government of Gujarat. Apart from the exploratory wells and production wells Piezometers tapping aquifer at different depths are also constructed for periodic monitoring of the ground water regime and quality in the district and is continued till date. Total 143 wells are constructed in the district (upto march 2010). I.e. 42 EW, 14 OW, 47 PZ and 40 Deposit wells are constructed. Arun Kumar, 1996 prepared report titled “Hydrogeological Framework and Ground water Resources of Banaskantha District”

Hydrogeological studies and exploratory drilling carried out in the district broadly indicated multi-aquifer system in the area. A phreatic and confined/semi-confined aquifer system was deciphered down to the explored depth of 600m. In hard rock area, there are strong evidences indicating presence of potential fracture zones at the depth below 100 m.

2.0 Rainfall and climate

The district has semi arid climate. Climate in the district is characterised by the hot summer and dryness in the non-rainy seasons. The year is marked by four distinct seasons i.e cold from December to February followed by the hot season from March to May/(mid-June). The south-west monsoon season is from mid June to mid September and Post monsoon season is from mid September to end of October. May is the hottest month with mean daily maximum temperature of 41^0 C. January is the coldest month in which the mean daily minimum temperature of 9.8^0 C recorded in 1998. Annual rainfall of the district is 578.8 mm and is mostly received during the south-west monsoon season from June to September. Climatological data of Deesa IMD station (1951-1980) is given in the table 1a & district wise spread and range of rainfall is given in Table-1b. and fig 2.

Table 1a - Climatological data of Deesa IMD station (1951-1980)

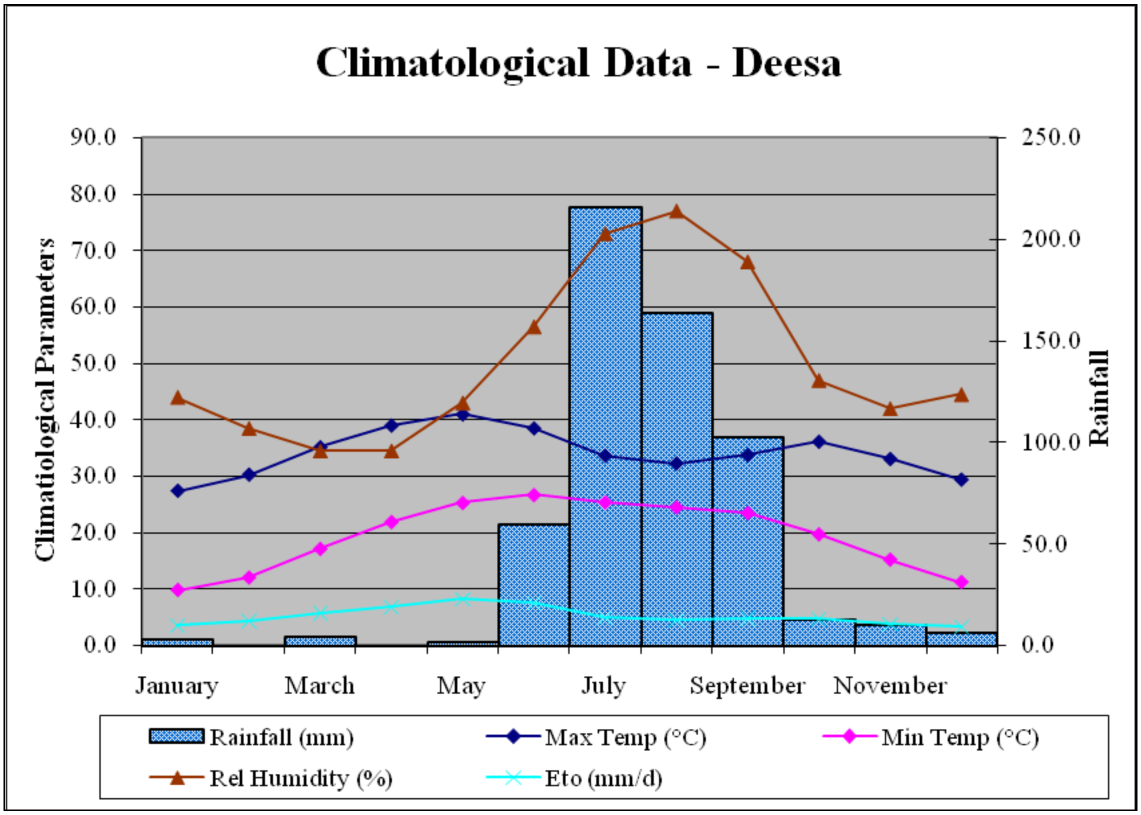
Month	Maximum Temp. (° C)	Minimum Temp. (° C)	Humidity (%)	Wind Speed (kmpd)	Sunshine (Hours)	Evapotran spiration (mm/Day)	Rainfall (mm)
January	27.3	9.8	44	129.4	8.9	3.5	2.7
February	30.2	12.0	38.5	127.7	9.5	4.3	0.9
March	35.1	17.1	34.5	136.3	10.1	5.7	4.3
April	39.0	21.9	34.5	134.6	10.8	6.8	0.1
May	41.0	25.3	43.0	184.6	11.4	8.2	1.4
June	38.5	26.7	56.5	246.7	8.7	7.5	59.2
July	33.6	25.4	73.0	201.8	5.3	5.0	215.7
August	32.2	24.5	77.0	162.2	5.4	4.4	163.2
September	33.7	23.5	68.0	122.5	7.9	4.8	102.2
October	36.1	19.7	47.0	100.1	9.6	4.7	12.6
November	33.0	15.2	42.0	103.5	9.3	3.8	10.2
December	29.3	11.2	44.5	115.6	8.9	3.3	6.3
Total							578.8
Average	34.1	19.4	50.2	147.1	8.8	5.2	

Table 1b. - District wise Summary

Banaskantha	Month ->	June	July	Aug	Sept	Oct	Total
District wise Monthly average rainfall	(in MM), 2007	44	520	217	63	0	844
Spread and range of rainfall	Spread of rainfall – 23rd June to 23rd Sept, 1990-2007	Maximum(Total) Rainfall(mm) in a year			Minimum(Total) Rainfall(mm) in a year		
		1578 (2006)			213 (1999)		

- *There was no rain during the months Jan to May, October to December. Source: Directorate of Relief, Gujarat State, Gandhinagar.*

Fig 2- Climatological Parameters of Deesa Observatory



3.0 Physiography, Drainage and Soil

3.1 Physiography

The district can be divided in three main parts – the hilly- mountainous region having high relief and rugged topography covering parts of Dhanera, Palanpur, Vadgaon and entire Danta taluka in the east, the piedmont zone all along the periphery of hilly area, and west and southwest of River Banas the area is flat plain with occasional undulations given rise to by sand dunes and mounds in the west. The western extension of this plain merges into the marshy area of Rann of Kutch.

Geomorphologically the district can be divided into six sub micro regions on the basis of physiogarphy, climate, geology, soils and natural vegetation.

a) **Vav Sandy Plain:** It is mostly sandy plain with an altitude of 100 m above mean sea level. There are a few small channels, which merge into little Rann of Katchchh. Geologically area is composed of Alluvium, blown sand etc.
b) **Sandy Plain:** The region mainly extends over the north and north western parts of the district bounded by the state of Rajasthan in the north, Banas

valley in the east and south and Vav sandy plain in west. The region has the sloppy gradient, towards the west in which the river Sukal flows. Geologically area is composed of Alluvium, blown sand etc.

c) **Banas Vally:** This region extends over the central and south-western part of the district, It is mainly formed by the Banas River which flows southwesterly direction and ultimately merges into Rann of Katchchh. Northern part of this region is high in elevation than the south and western portions. Geologically area is composed predominantly of Alluvium, blown sand etc.

d) **Banskantha Aravalli Range:** The region spreads over the eastern part of Banaskantha district, occupying Danta and part of Palanpur and small area of Vadgaon talukas. It is bounded by the state of Rajasthan from north, Banas Valley from west, Mehsana district from south and Sabarkantha district from east. This region is highly elevated ranging between 100 and 300 m above mean sea level. Saraswati River is the main river of the region. Geologically area is composed Alluvium, blown sand etc

e) **Jasor Chhotila Hills:** The region lies in Dhanera and Palanpur taluks and is enclosed by the state of Rajastahn from three sides while Banaskantha Aravalli range makes its limit in the south. It is actually disrupted part of Aravalli range by the Banas valley. It is an undulating terrain with an elevation of 300 m above mean sea level and is covered by forest. Geologically this region is mainly composed of Eranpura granite formation.

f) **Umardasi – Sarawati Plain:** This region mainly extends over the south – eastern part of Banskantha district covering the taluks of Palanpur and Vadgaon. It is bounded by Banas valley in the west and north, Banaskantha Aravalli range in the east and Mehsana district in the south. This region is formed by the Umardasi and Saraswati River and having an elevation of 100 m above mean sea level. Geologically area is composed of alluvium, blown sand etc

3.2 Drainage:

The drainage network in the district is constituted mainly by the Banas and Sarashwati rivers and their tributaries. In the extreme east, Sabarmati river forms district boundary with Sabarkantha district and in part controls the drainage network of the hilly area east of Danta. Other important rivers passing through or originating from the district are Arjuni, Sipu, Balaram, Khari, Khapra, Kalari, Gujudi, Dholka, Umardashi, Chekaria, Selvam, Rel, Ravi and Sirinala. Since the district experiences a semi arid type of climate, the rivers flowing through it are of ephemeral nature i.e. have water during monsoon only and dry up after monsoon. Some of the rivers like Banas and Saraswati, however carry fairly good amount of water during rainy season. Most of the rivers have south and south westerly flow directions.

There are few important lakes in the district i.e Ganga Saragar near Jethi Village in Palanpur taluka, Man Sarover near Chitrasani village and Dantiwala lake constructed near Dantiwada Dam. Various canals drawn from the lakes irrigate the land of the district.

3.3 Soil:

In Banaskantha district major part of the soils are sandy in nature. In general the soils are poor to medium in fertility and water retention capacity. Most soils have good aeration, porosity and permeability. The hydraulic conductivity of the soils ranges from as low as 0 for saline and alkali soils in the western part to more than 7cm/hr for calcareous sandy soils in the north and west. Soils of the district fall in five broad categories as below.

I) Saline and alkali soils: These are typically deep, grey calcareous sandy clay loams of low permeability.
II) Calcareous sandy loams: These are generally Deep, light grey or brown sandy loams of moderate to good permeability and drainage.
III) Calcareous sandy soils: These are mostly pale yellow and brown sands & loamy sands of good depth and high permeability.
IV) Non calcic brown soils: These are characterised by pale brown to brown deep loamy sands and sandy loams of adequate to good permeability.
V) Non calcic red brown soils: These are of mixed colluvial and alluvial derivations from rocks of the Aravali system. Mostly deep loamy sands to sandy loams with adequate to good hydraulic conductivity.

3.4 Surface Water Resources

The surface water resources of the district are very limited. Groundwater is the main source of irrigation. There are no perennial rivers flowing through the district. Important irrigation schemes (Table-2) of the district are as follows:

Table-2 Medium & Major Irrigation Schemes

(000 hectares)

Sr. No	Name of scheme	Ultimate Irrigation Potential	Potential created upto March '06	Balance Irrigation Potential
1	Mukteshvar Irri. Project	6.186	6.186	-
2	Sipu Reservoir Project	16.00	16.00	-
3	Hadmatiya Irri. Scheme	0.792	0.792	-
4	Dantiwada	44.52	44.52	-

Source: Irrigation Department, Palanpur

3.5 Irrigation - Area Irrigated by different Sources

The area irrigated by different sources in the district during 2006 – 07 are presented in Table-3, which indicate that tubewells are the main source of irrigation in the district The gross area irrigated for both the sources taken together was 47400 Hact. for the year 2006 – 07 (Table-3).

Table-3 Area irrigated by different sources

(00 hectares)

S No.	Source	Area irrigated	S No.	Source	Area irrigated
1	Govt.Canals	1950.36	6	Tubewells(Electrified)	240
2	Tanks	237	7	River Lift	
3	Wells		8	Other (Adbsnds Lift)	290
4	Wells (Electrified)	212	9	Net Irrigated Area	466
5	Tubewells		10	Gross Irrigated Area	474

Source: Irrigation Department Palanpur

The area irrigated by different sources during 2006 – 07 and presented above indicates that tubewells are the main source of irrigation in the district. The gross area irrigated for both the sources taken together was 47400 ha.. Estimated 75545 agriculture connections are there in district and equal Number of Pump Sets / Tubewells were energized

4.0 Ground Water Scenario

4.1 Hydrogeology

Precambrian hard rocks, semi-consolidated Mesozoic and tertiary formations and unconsolidated quaternary alluvial deposits form multi layer aquifer system in the district. Groundwater occurs both under phreatic and confined conditions, however its development is restricted depending upon the aquifer geometry and yield characteristic of individual aquifer and/or ground water quality of the formation water. The Hydrogeological framework of the district is presented in Fig.3.

Ground water in fissured formation (Hard rock):

The north-eastern part of the district is mainly occupied by metasediments and Post Delhi intrusives. The occurrence and movement of ground water is governed by secondary porosity i.e. thickness and extent of weathering and size & interconnections of fractures/joints.

These formations generally do not form very good aquifer system. The depth of dugwells ranges from 15-30 mbgl and of borewells ranges from 100-200 mbgl. Depth to water level in the dug wells varies from 5 -14 mbgl and in borewells from 15 to 60 mbgl. The successful borewells drilled so far, yielded in the range of 30-1036m^3/day with an average yield of 240m^3/day.

There is a strong evidence indicating presence of potential fracture zones at the depth below 100 m, however contribution of yield to the total yield from these zones is about 15-30% in general except at suitably identified locations i.e Karanpur in Danta taluka where contribution of yield from potential deeper zones is more than 75%.

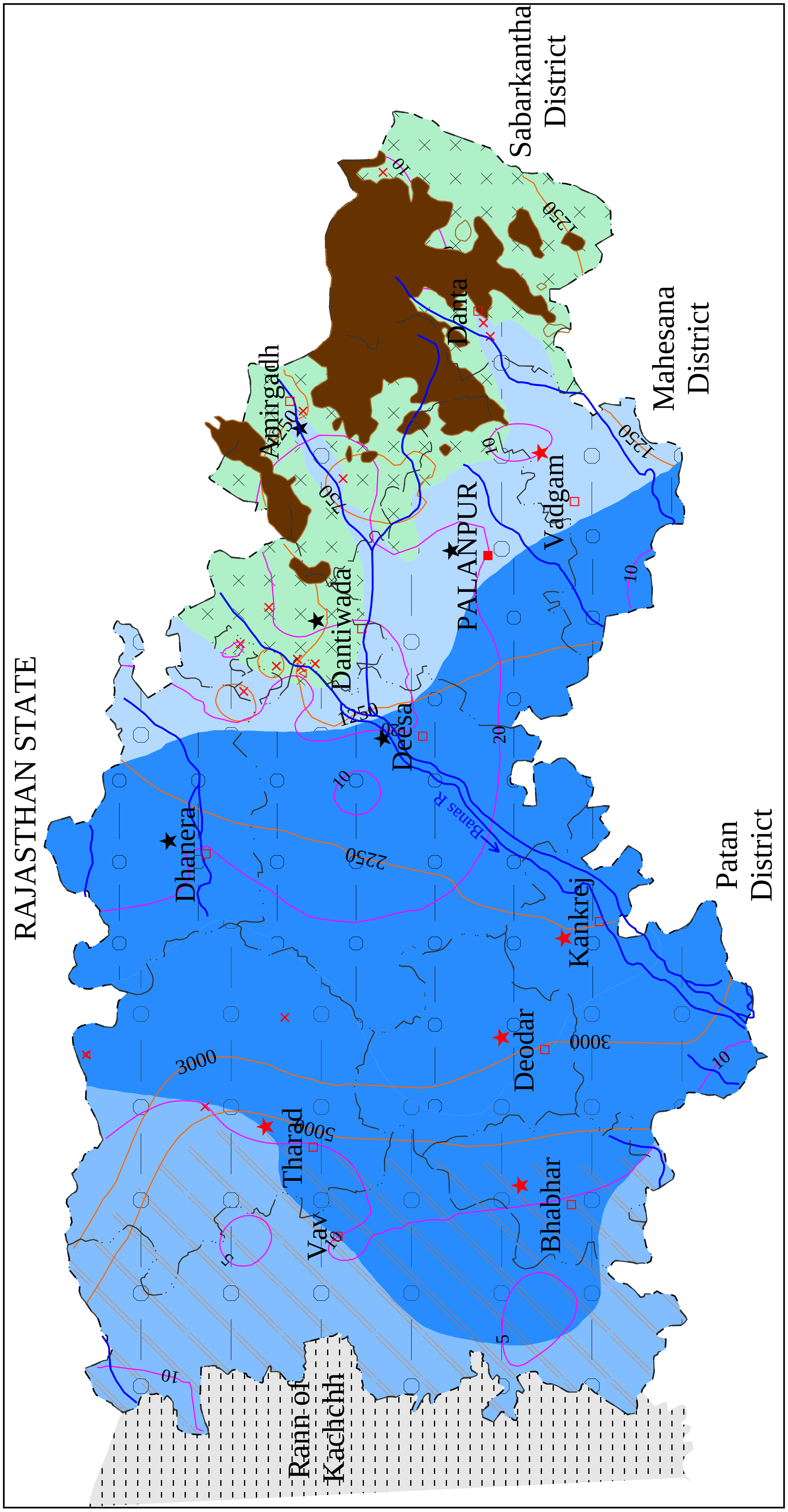


Fig:3-Hydrogeology and Groundwater user Map

Legend Hydrogeological Map

	Wells Feasible	Rigs Suitable	Depth of Well (m)	Discharge (lpm)	Artificial Recharge Structure Suitable
Soft Rock Aquifer	Dug Well Tubewell	Manual Direct Rotary, Reverse Rotary	10-25 50-100	200-300 600-1000	Percolation Tanks/ Ponds, Recharge Wells,
Soft Rock Aquifer	Dug Well Tubewell	Manual Direct Rotary Reverse Rotary	15-30 100-300	200-300 800-1000	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
Soft Rock Aquifer	Dug Well Tubewell	Manual Direct Rotary Reverse Rotary	15- 30 100-300	200-300 1000-1200	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
Hard Rock Aquifer	Dug Well Borewell	Manual Down the Hole Hammer (DTH)	10-25 100-200	60-150 100-300	Percolation Tanks/ Ponds, Recharge Wells, Check Dams, Nalla Bunds.
Hilly Areas	Not Suitable				Check Dam, Nalla Bund, Gully Plug
Saline Area	Not Suitable except localised fresh water pockets				

20	Pre-monsoon Decadal mean (1993-2000) Depth to Water Level (mbgl)	2000	Electrical Conductivity (µS/cm at 25° C)
✕	Fluoride > Maximum Permissible Limit (1.5 mg/l)	△	Nitrate > Maximum Permissible Limit (100 mg/l)
★	Over Exploited Taluka	★	Dark Taluka
	Drainage	■/□	District/Taluka HQS
	Rann/Marsh		

Groundwater in porous formations (Sedimentary):

Northern and central parts of the north Gujarat including major part of the Banaskantha district is underlain by post Miocene alluvium and older semi consolidated Mesozoic and Tertiary sedimentary formations. These sedimentary formations form the most prolific multi-aquifer system comprising several confined aquifers; these sediments are mainly consisted of Coarse sand, gravel, kankar, silt, clay and clay stones. Groundwater occurs both under phreatic and confined conditions in arenaceous horizons within sedimentaries. The occurrence and movement of groundwater is mainly controlled by intergranular pore spaces. Two major aquifer units have been identified the upper unit is mostly phreatic but becomes semi confined to confined in some parts. It is designated as aquifer A and consists of relatively coarse grained sediments. The lower units comprising a few hundred metres of alternating sand and clay beds form confine aquifer system. It is further subdivided into aquifers of post Miocene sediments and aquifers in the Miocene sediments. The post Miocene aquifers are generally coarse to fine grained sand with occasional gravel beds. Confined aquifers in this area have been broadly grouped into, first confined (shallow) aquifer ranging in depth from 80 to 160 m bgl and the second confined aquifer (deep) ranging in depth from 155 to 275 m bgl. These aquifers extend from the foothill of the Aravallis in the northeast to the little Rann of Kachchh in the west. The Miocene aquifers are mainly fine to medium grained sand, sandstone interbedded with clay, clay stone and siltstone. Himmatnagar sandstone is generally coarse grained and friable. A typical schematic Hydrogeological cross section is presented below in Fig 4.

Fig:4 - Schematic Section showing dual aquifer system Concept

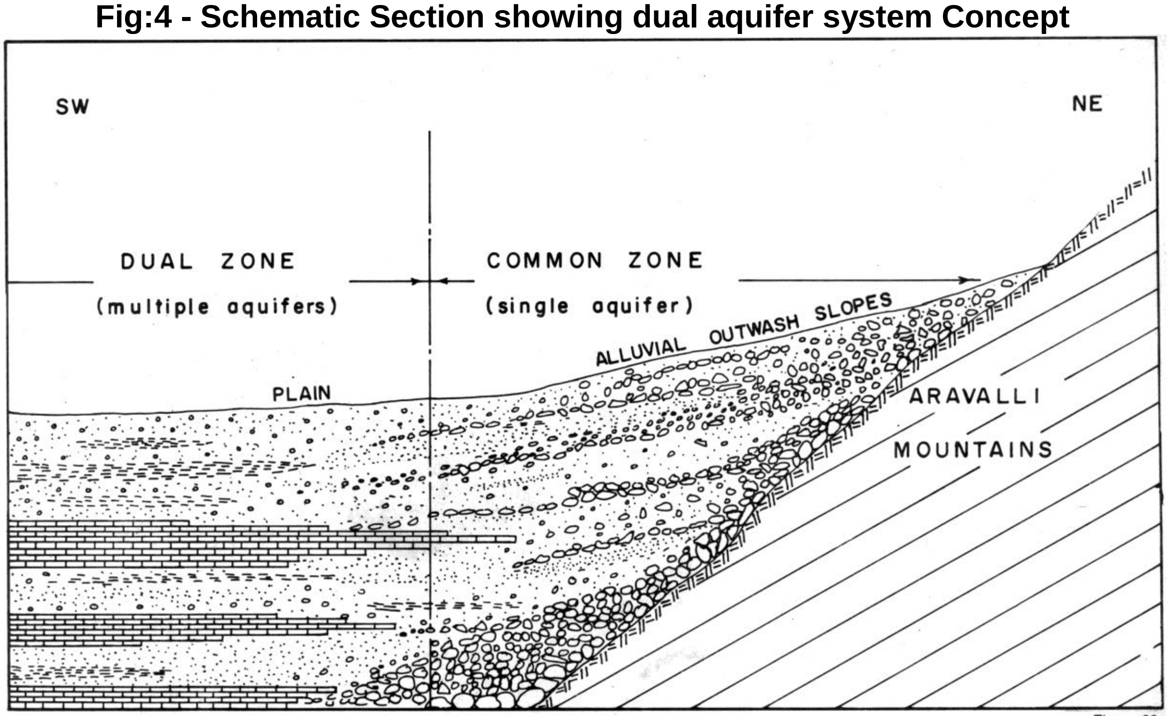


Figure 66

SCHEMATIC SECTION SHOWING DUAL-AQUIFER SYSTEM CONCEPT

4.2 Depth to Water Levels:

Since 1969, Central Ground Water Board, as a part of its national programme, has established a network of observation wells in the state of Gujarat and UT of Daman and Diu for periodic monitoring of water levels and the variation in quality of groundwater. At present 1039 (dugwells-655 & 384 piezometers) National Network monitoring Stations including 19 open wells and 42 Piezometers in Banaskantha district which form the important part of North Gujarat mainland are being monitored. Distribution of Hydrograph network stations in different units is presented below in table 4. The ground water scenario of the district is presented here.

Table-4. Distributions of Monitoring Stations in Banaskantha District (Nov, 2010)

	Rock Type	Dug Wells	Piezometers	Total
Area				
	Hard rock	6	1	7
	Soft rock	13	41	54
	Total	19	42	61
Basin	**Subbasin**	**Dug Wells**	**Piezometers**	**Total**
Draining into Gulf	Rupam			25
Luni & other draining into Great Rann of Kutch	Luni			6
	Draining into Great Rann of Kutch			26
Sabarmati	Laft bank upto Hatmati			1
	Right bank beyond Hatmati			1
Total				59

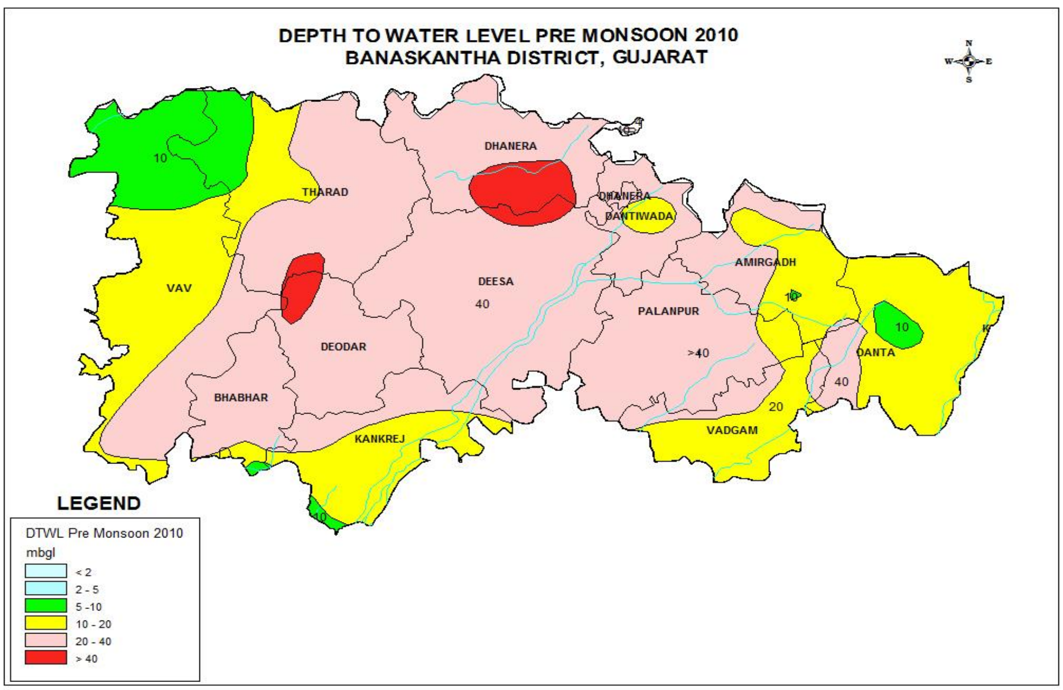
Talukas	Dug Wells	Piezometer	Total
Amirgadh	3		3
Bhabhar		1	1
Danta	3	2	5
Dantiwada	4	1	5
Deesa	2	12	14
Dhanera	1	6	7
Diyodar		2	2
Kankrej	1	1	2
Palanpur	1	2	3
Tharad	4	3	7
Vadgaon		7	7
Vav		5	5
Total	**19**	**42**	**61**

Unconfined Aquifer

Unconfined aquifer is the most extensive aquifer occurring in the different hydrogeological units in the district with thickness ranging from 20 m in the northeast, west and southern part to about 70 meters in the central part of the district.

Depth to Water Level during pre monsoon period (Fig.- 5) in 38% area falls in the range of 5 to 20 m bgl, mainly the western part of the district, 54% area in the range of 20 to 40 mbgl in central part and deeper water level of more than 40m bgl are observed in central part of the district in isolated patches in parts of Deesa – Dhanera – Thread - Deodar – Kankrej and Palanpur taluka of the district in about 8% of area. The shallowest water level 8.10 m bgl was observed in Tharad Taluka and the deepest water level 51.71 m bgl in Dhanera Taluka. Water level of less than 20 m bgl is also observed in the eastern part adjoining the hilly areas.

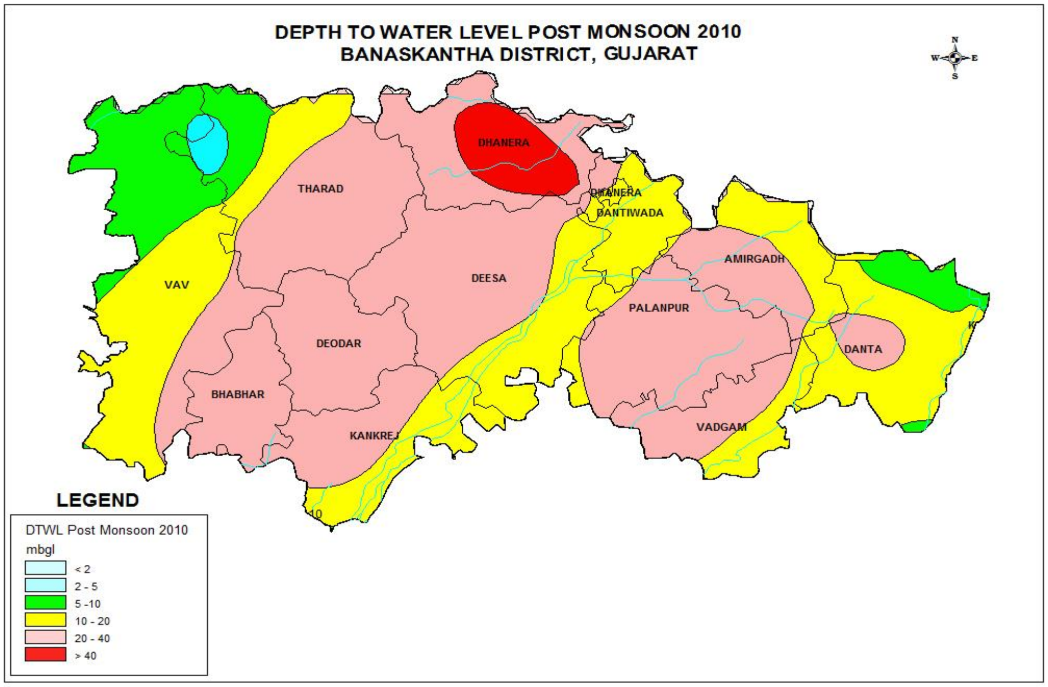
Figure 5



During post monsoon period (Fig.-6), 51% area falls in the water level range of 5 to 20 m bgl, 35% area in the range of 20 to 40 mbgl and deeper water level of more than 40m bgl are observed in parts of Deesa – Dhanera, Tharad - Deodar - Kankrej and Palanpur taluka of the district in isolated patches in about 14% of area. The shallowest water level 4.72 m bgl was observed in Tharad Taluka and the deepest water level 61.69 m bgl in Deesa Taluka.

Pre-monsoon to post monsoon fluctuation in the water level ranges from -0.5 m to more than 5 m in unconfined aquifers.

Figure 6



Confined Aquifer

Northern and central parts of the north Gujarat is underlain by the unconsolidated alluvial deposits of post Miocene age and semi consolidated Mesozoic and Tertiary sediments. These sedimentary formations form the most prolific multi-aquifer system comprising several confined aquifers. Confined aquifers in this area have been broadly grouped into, first confined (shallow) aquifer ranging in depth from 75 to 160 m bgl with an aerial extent up to Bharuch district and the second confined aquifer (deep) ranging in depth from 155 to 275 m bgl extended up to Anand district. These aquifers extend from the foothills of the Aravallis in the northeast to the little Rann of Kachchh in the west.

During the premonsoon, 2010, depth to water level recorded in the range of 18.12 mbgl in Vadgam talukas to 108.57 mbgl in Deesa Taluka in confined aquifers. In the postmonsoon, 2010, depth to water level in the range of 17.38 mbgl in Vadgam talukas to 199.15 mbgl in BhabharTaluka in confined aquifer was observed.

Pre-monsoon to post monsoon fluctuation in the water level ranges from 1 m (Rupal, Rah) to more than 10 m at Miyal in aquifers under semi confined and confined conditions with most frequent range being 5 to 8 m.

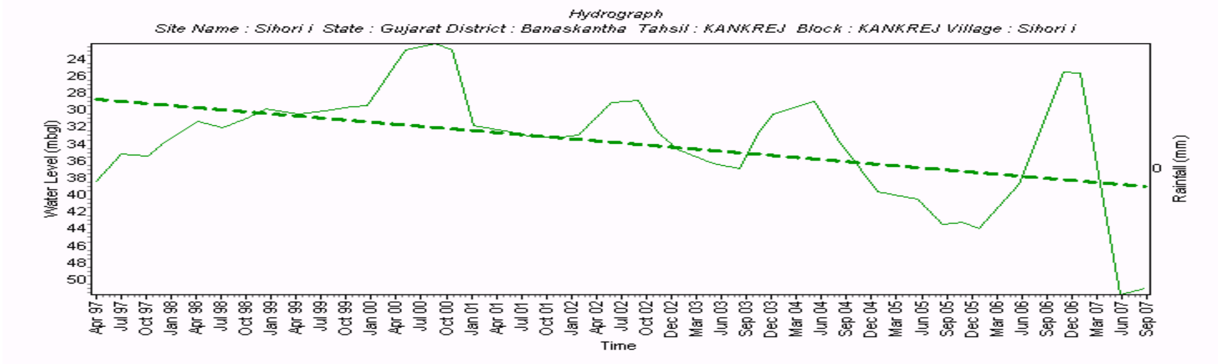
4.3 Long Term Water Level Trends: Rise and fall of water levels

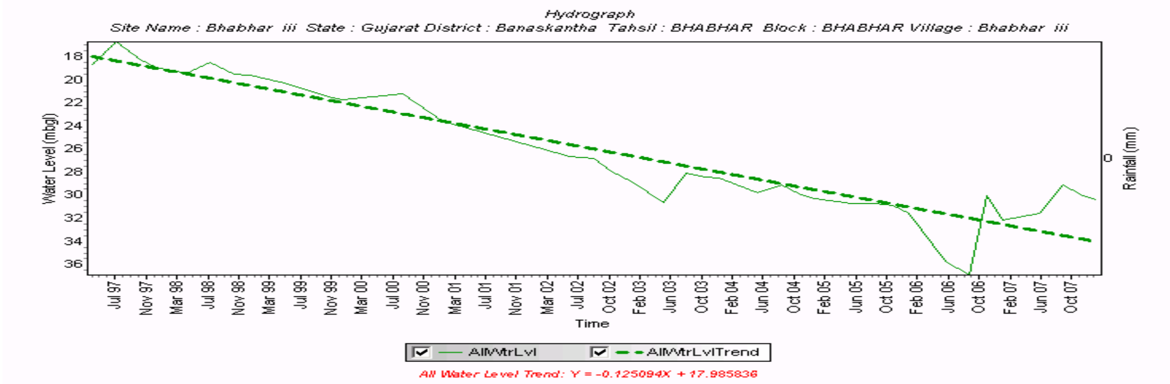
Behaviour of ground water regime over longer period (2001 -2010), the data of NHS was analysed and the same is presented in table 5. The hydrograph of few representative wells are given in Fig. 7.

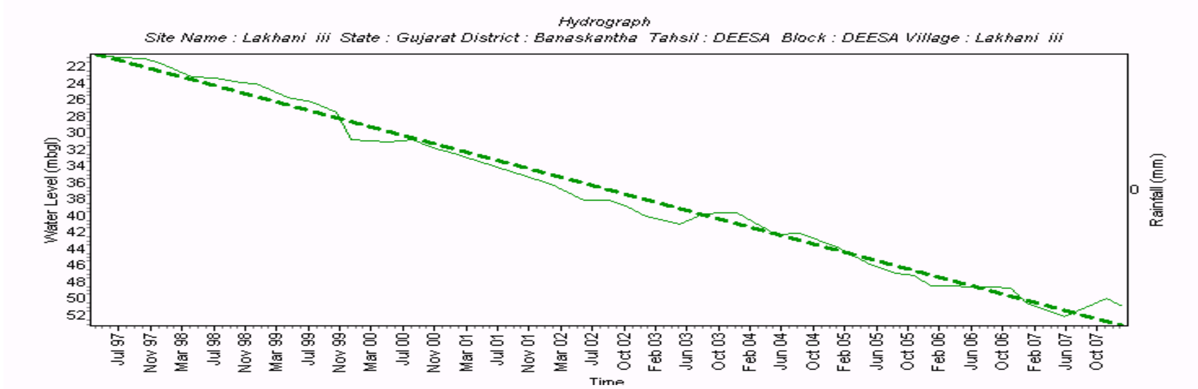
Table – 5 Long Term Premonsoon Water Level Trends (2001 -2010)

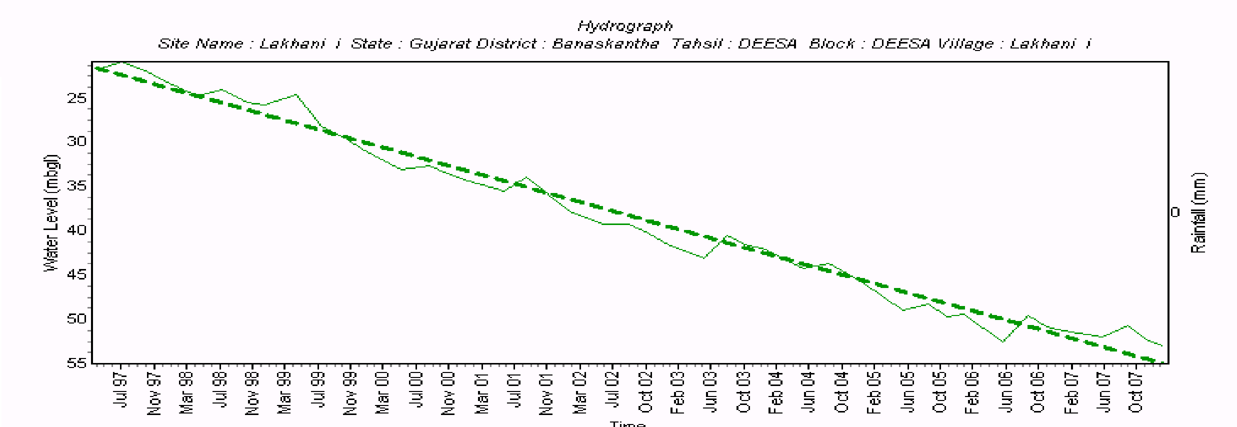
Location	Rise (m/year)	Fall (m/year)	Location	Rise (m/year)	Fall (m/year)
Ambaji_Pz	0.4772		Kuchwada		0.6445
Amirgadh	1.3990		Lakhani i		3.0627
Aserda_Pz		3.1540	Lakhani ii		2.8140
Asodar		0.1310	Lakhani iii		2.6239
Balodhar_Pz-I		6.2742	Mahi twi		3.7976
Balodhar_Pz-II		5.8461	Meda	1.2754	
Balodhar_Pz-III		3.5514	Miyal ii		0.3316
Bhabhar iii		0.7298	Miyal iii		0.2454
Bharol1	0.0090		Miyal pz-i		2.5320
Biyok_Pz-I	8.6435		Mohabbat gadh		0.0089
Biyok_Pz-II		1.3740	Moti mahudi	0.6203	
Danta	1.3616		Palanpur_Pz	1.8439	
Dantiwada		0.0840	Palanpur2	1.7450	
Dhanera Pz- II		2.2419	Panthawada	0.1181	
Dhanera Pz-I		1.9442	Rah Pz-III		1.5531
Dharnodhar_Pz-I		3.7908	Rah_Pz I		1.6575
Ganapipli	0.0230		Rah_Pz II		1.5239
Gangodra	0.5003		Rasna(Repl)_Pz_I		0.3604
Iqbalgarh	1.7040		Ratanpur2	1.2126	
Jalotra Pz-I		0.5188	Rupal_Pz_I		0.4959
Jalotra Pz-II		0.2515	Rupal_Pz_II		0.3567
Jerda Pz-I		5.1198	Sankad		1.8584
Jerda Pz-II		8.6965	Sihori i		1.4425
Jhat	0.5801		Sodapur	0.2742	
Jorapura	0.8975		Vav ii		1.1373
Khoda		0.8266	Vav i		0.1921
Kidotar	0.5962				

Fig – 7 Hydrographs of selected Ground water monitoring stations in Banaslantha District









4.2 Ground Water Resources

The ground water resources of the district as per GWRE are presented in Table no - . Out of 12 talukas, 6 talukas are categorised as over exploited, 1 taluka is categorised as semi-Critical, 1 as critical, 1 as Safe and 2 as Saline (Fig. - 8)

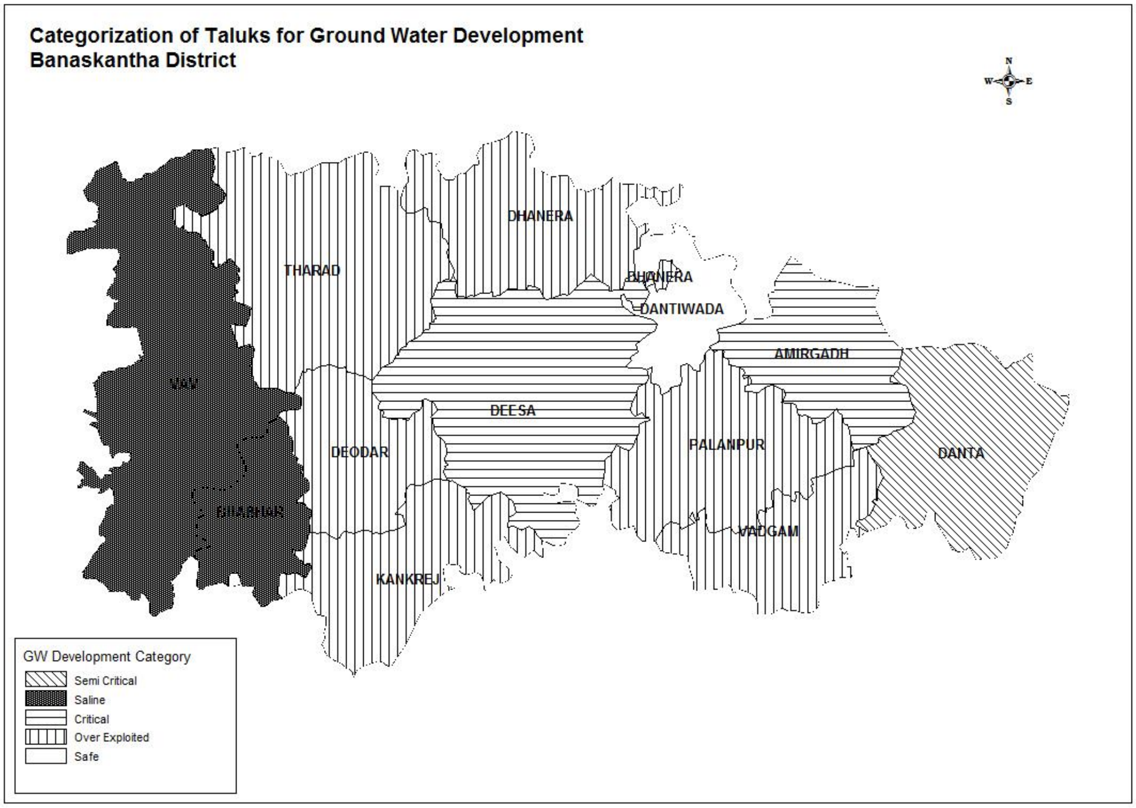
Table-6a Ground Water Development Potential of Banaskantha as on 31st March, 2004

Sr. No.	Assessment Unit/ Taluka	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses (4+5)	Allocation for domestic and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development (3-4-7)	Stage of Ground Water Development {(6/3)*100} (%)
1	2	3	4	5	6	7	8	9
1	Amirgadh	3330	2863	275	3138	410	-218	94.24
2	Bhabhar	SALINE						
3	Danta	4421	3159	473	3632	703	87	82.14
4	Dantiwada	7802	4687	240	4927	356	2519	63.15
5	Deesa	19993	17273	1248	18521	1857	-386	92.64
6	Deodar	4585	7418	250	7667	371	-3453	167.22
7	Dhanera	7657	12496	494	12990	735	-6068	169.64
8	Kankrej	8682	8766	385	9151	572	-1041	105.40
9	Palanpur	12988	12749	1052	13801	1542	-2355	106.26
10	Tharad	6039	10348	173	10520	257	-4738	174.21
11	Vadgam	10451	16905	561	17466	835	-7850	167.13
12	Wav	SALINE						
	TOTAL	85949	96663	5150	101813	7638	-23502	118.46

Table – 6b Categorization of talukas for Ground Water Development (2004)

District					Saline
	Over exploited	Critical	Semi critical	Safe	
Banaskantha	Tharad	Amirgadh	Danta	Dantiwada	Bhabhar
	Vadgam	Deesa			Vav
	Palanpur				
	Kankrej				
	Dhanera				
	Deodar				

Figure 8 Categorization of Taluks for Ground Water Development



4.3 Ground Water Quality

Hydrochemistry:

In general the ground water quality is good in eastern part. The ground water quality deteriorates towards west, in the western part along the Rann the ground water quality is poor. High concentration of Fluoride is observed in parts of the district.
Quality of ground water gradually deteriorates from east (recharge zone) to west and south west (discharge zone). Ground Water is Saline in Vav, Bhabhar talukas and in most part of Tharad taluka. Higher EC value (3000 to more than 5000 µs/cm) in most parts of Bhabar, Diyodar and Kankrej talukais observed. High concentration of fluoride inparts of Danta, Vadgam, Amirgarh, Dhanera talukas. Nitrate beyond permissible lmt is found in some wells of Vadgam, Palanpur, Deesa, Dhanera in most of the talukas. General ground water quality of the district is presented in Fig 9 to 12.

Fig. 9 ISO Electrical conductivity Map of Banaskantha District

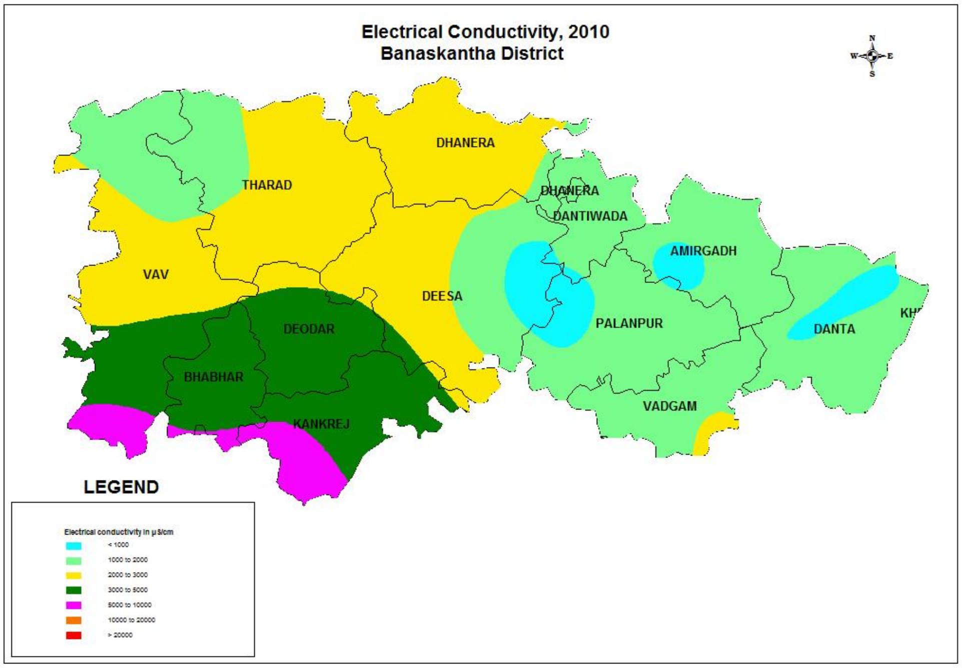


Fig. 10 ISO Chloride Map of Banaskantha District

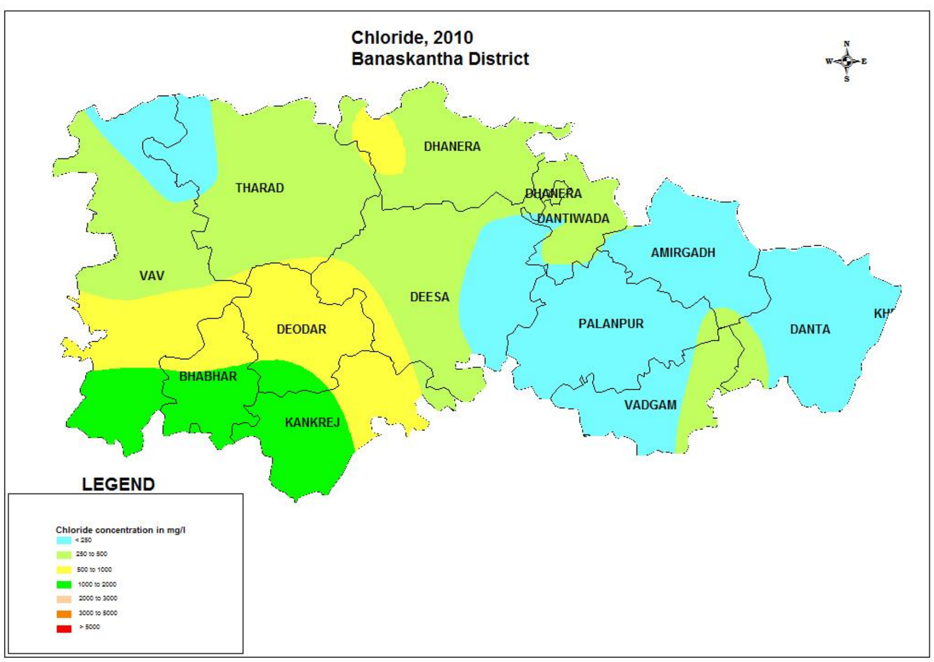


Fig. 11 Fluoride Map of Banaskantha District

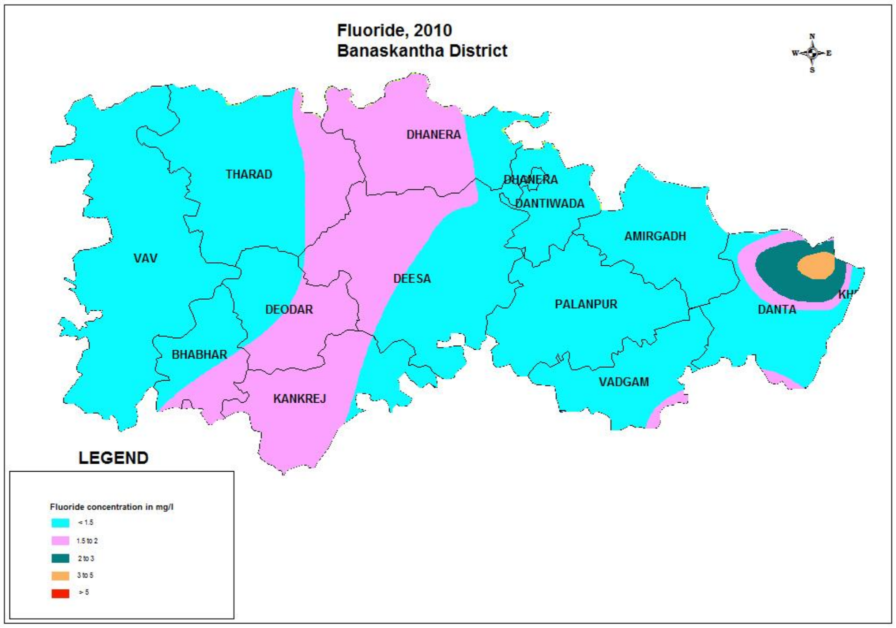
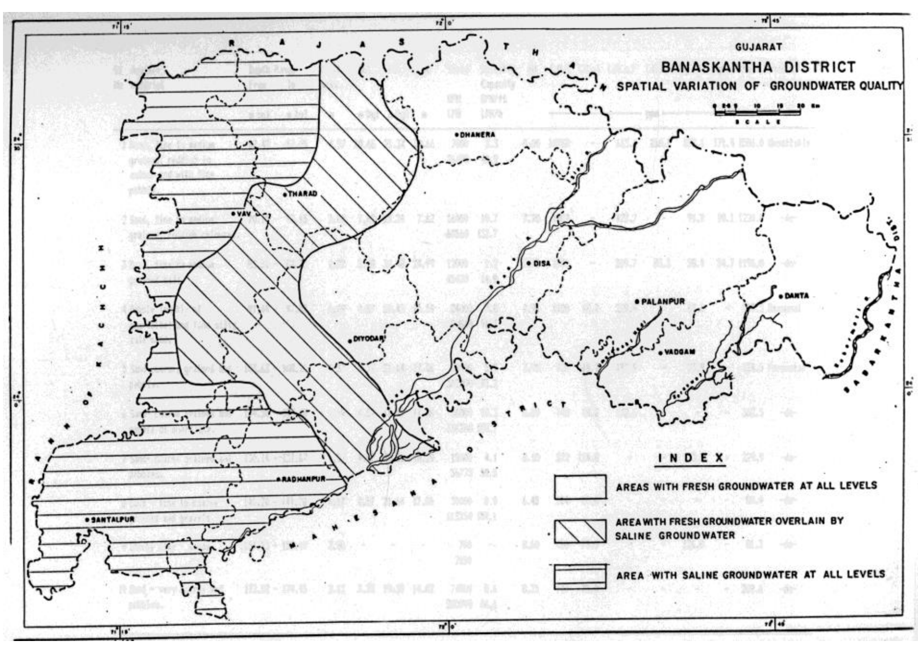


Fig. 12 Spatial Variation in Ground Water Quality in Banaskantha District



As per available information about drinking water sources about 16% of the wells are non potable due to salinity and 21% are due to fluoride beyond permissible limit.

4.4 Status of Ground Water Development (Block wise)

Groundwater development in the district is by dug wells, dug-cum-bored and shallow tubewells. Existing Irrigation scenario from ground water sources as per MI census 2000-01 there are 50941 dugwells out of which 42820 are in use. Irrigation potential created through these dugwells is 223009 Ha. and potential utilized is 217633 Ha. area. Tthere are 4950 shallow tubewells out which 4636 are in use. The irrigation potential created is 25768 Ha. and utilized is 25116 Ha. There are 21143 deep tubewells in the district out of which 20431 are in use. The irrigation potential created is 183940 Ha. and potential utilized is 180069. Taluka wise potential created by dug wells shallow tube wells and deep tube wells (M I Census 2000-01) is tabulated in table-7.

Table-:7 Potential Created by Groundwater abstraction structures

S. No.	Name of Taluka	Dug wells		Shallow Tube wells		Deep Tube wells		Total	
		No.s in use	Potential Created	No.s in use	Potential Created	No.s in use	Potential Created	No.s in use	Potential Created
			Ha.		Ha.		Ha.		Ha.
1	Amirgadh	2698	1236	0	0	0	0	2698	12346
2	Bhabhar	393	2541	2	20	1577	17693	1972	20524
3	Danta	5188	14289	26	88	13	53	5227	14430
4	Dantiwada	1561	9170	336	1887	494	2990	2391	14047
5	Deesa	8570	58152	924	7089	4291	29611	13785	94852
6	Deodar	91	434	214	1597	4820	35269	5125	37300
7	Dhanera	7532	49400	16	177	203	3431	7751	53008
8	Kankrej	601	2740	142	1000	3991	42927	4734	46667
9	Palanpur	5001	17522	635	3187	1151	13241	6787	33980
10	Tharad	5592	31047	1305	6193	2353	19099	9250	56339
11	Vadgam	5299	23328	983	4288	1088	11420	7370	39036
12	Wav	294	2010	53	242	450	8207	797	10459
	Total	42820	223009	4636	25768	20431	183941	67887	432718

(Source M.I. Census 2000 – 2001)

Apart from Irrigation Ground water is extensively used for drinking water in most parts of the district through Tube wells and also through Hand pumps in isolated tribal pockets of Hard rock area. Summarized details of user aquifers for drinking water from the user point of view is given in table-8.

Table – 8 Summary of Drinking water structures and Groundwater situation in Banaskantha district

Sr No.	Taluka	Area (sq.Km.)	Hard Rock Area suitable for GWD (sq.Km.)	Geological Formations	Normal Depth Range of wells (m)	Pumping Water level (m)	Quality (TDS) (mg/l)	Cl (mg/l)	No of Drinking water wells	GW Resource Category (GWRE 2004)
1	Amingarh	609.7	547	Alluvium Granite, Schist	60-90	35-40	500-1000	1.0-2.5	69	Critical
2	Bhabar	429.3		Alluvium	150-300	120-150	1500-2000	1.0-2.5	53	Saline
3	Danta	860.7	690	Granite, Quartzite, Schist, Phyllite	60-70	35-40	500-1000	1.0-2.5	185	Semi Critical
4	Dantiwada	414.7	318	Alluvium Granite Gneiss Schist Phyllites	90-120	30-100	700-900	0.7-1.5	49	Safe
5	Deesa	1460.2	46.82	Alluvium	120-250	90-120	500-800	0.5-1.5	151	Critical
6	Deodar	582.2		Alluvium	120-300	100-150	1000-1500	1.0-2.5	71	OE
7	Dhanera	842.9	98	Alluvium Granite	90-200	50-120	800-1000	0.5-3.0	81	OE
8	Kankrej	795.5		Alluvium					106	OE
9	Palanpur	791.5	178	Alluvium Granite Gneiss	90-120	30-100	700-900	0.7-1.5	119	OE
10	Tharad	1358		Alluvium	150-300.	120	800-1800	0.5-2.5	135	OE
11	Vadgam	565.9	162	Alluvium Granite Gneiss	45-220	45-90 100-120	800-1200	1.5-4.5	110	OE
12	Vav	1694.7		Alluvium	120-130	100-150	2000	1.0-2.5	121	Saline
	Bans Kantha Total	**10405.3**							**1250**	

5.0 Ground Water Management Strategy

Judicious and cautious approach for developing ground water resources is to be adopted as there is an urgent need for management of resources for sustainable development. Suitable recharge structures are to be practiced in the area along with the withdrawal of ground water to minimize the effect of heavy withdrawal of ground water. Status of availability of agriculture land and source of irrigation is summarised in table-9.

Table - 9 Agricultural land and source of irrigation

(area in hac.)

Sl. No.	Name of taluka	Geographical area	Cultvable area	Net area sown	Net area irrigated through			
					Major/ medium scheme	Groundwater	Surface water	Total
1	Amirgadh	52217	16805	13054	40	10120	0	10160
2	Bhabhar	47680	39212	30521	0	13156	212	13668
3	Danta	83521	25520	20144	76	12986	12	13074
4	Dantiwada	40985	34831	30776	0	26444	0	26444
5	Deesa	165984	123827	106032	363	84450	0	84813
6	Deodar	60233	51557	41633	0	21807	0	21807
7	Dhanera	81582	60715	50961	3	29485	0	29488
8	Kankrej	84734	66522	53434	120	26242	0	26362
9	Palanpur	82467	56739	42496	12	31808	0	31820
10	Tharad	164019	140090	107635	0	59035	37	59072
11	Vadgam	57698	38146	31933	0	16554	0	16554
12	Wav	264051	172754	140102	0	5671	0	5671
	TOTAL	1185161	826718	66870	614	337768	261	338633

(Source: M I Census 2000-01)

Percolation tanks/ponds, Recharge wells, Recharge shaft, check dams, nalla bunds and gully plugs are the recharge structures feasible in the district depending on the terrain conditions. In the phreatic aquifers with deep water levels and de-saturated zones, spreading channels, recharge pits, recharge ponds etc are suitable to utilize surplus runoff and tail end releases from the canals.

Large number of Rainwater harvesting schemes depending on the suitable hydrogeological conditions have been constructed in the district viz. Check dams, Recharge tube wells, deepening the of the village ponds etc and the Recharge structures have shown good impact on the groundwater scenario n the vicinity of the recharge structures. Such rain water harvesting and water conservation schemes should be encouraged in future also.

6.0 Ground Water Related Issues and Problems

Distribution of source of water supply to the 1249 villages of the district is mostly dependent on groundwater or wherever the ground water quality is saline villages are dependent on the regional water supply schemes. Summary of the source of drinking water supply and potability of groundwater in the district as a whole indicated that about 16% of the sources are non potable due to salinity and about 21% due to excess fluoride in ground water and 63% source are potable.

- Steady decline in water level due to **- h**eavy withdrawal of ground water owing to intensive irrigation which demands unhindered development of fresh water resources.

- Severe depletion in water level has lead to a large number of failures of tube wells in many parts of the district. Farmers who invested heavily in newer technology and deeper wells were severely affected economically. In the quest of more water deeper wells are drilled which resulted in further monetary loss.

- Ever increasing population as well as industrialization has led to a great demand and thus immense pressure on the fresh water resources.

- Deterioration in quality of ground water.
  - Quality of ground water gradually deteriorates from east (recharge zone) to west and south west (discharge zone).
  - Saline water in Vav, Bhabhar talukas and most part of Tharad taluka. Higher EC value (3000 to more than 5000 µs/cm) in most parts of Bhabar, Diyodar and kankrej taluka.
  - High concentration of fluoride in Danta, Vadgam, Amirgarh, Dhanera talukas and excess nitrate (Vadgam, Palanpur, Deesa, Dhanera) in most of the talukas.

- Tharad taluka: Except for 34 villages rest of the villages are dependent on the regional water supply scheme as the quality is saline. Over withdrawal of ground water resources for irrigation leads to continuous decline in water level in the taluka.

- Bhabar , Diyodar Taluka -The quality of water is saline upto depth of 130-150 mbgl. Aquifer below this depth is under huge stress as ground water development is more. Excessive withdrawal of ground water resources for irrigation leads to continuous decline in water level in the taluka.

- Vav Taluka: Quality of ground water is saline because of marshy land, salt/ mud flats devoid of vegetation (Rann). The villages are dependent on the regional water supply scheme as the quality is saline.

- The farmers have no control over power supply, therefore they irrigate the crops by groundwater when power supply is available rather than waiting for the wilting to start.

- Flood irrigation technique which is practised in the area is also the major cause of wastage of ground water as there is no control on the watering depth.

7.0 Awareness and Training Activity

In order to increase awareness among farmers, other ground water users and custodians as well as the stakeholders, Central Ground Water Board conducted Mass awareness programs at Deesa in Dec 2004 & at Shiya in Kankrej Taluk during Febuary, 2007. In addition a Training program was also oranised at Palanpur during January,2007.

8.0 Recommendations

- Judicious and cautious approach for developing ground water resources should be adopted together with creating awareness among the farmers in general and other ground water users regarding Rain water harvesting, water conservation and adoption of efficient irrigation techniques and about minimizing the effect of pumping on ground water resources in terms of quality and quantity.

- Artificial recharge should be taken up on large scale through appropriate techniques on a regional scale with active community participation. Institutional finance and appropriate technology should be freely made available to any individual or cooperative group of farmers that undertake resource augmentation and management measures.

- Artificial recharge practices should be encouraged by diverting surplus run-off during monsoon into ponds, percolation tanks, Spreading basins, abandoned dugwells etc.

- Augmentation of ground water resource with artificial recharge and roof top rain water harvesting and Construction of water conservation structures like check dams etc. should be done at suitable locations for storage of water

- Adopt method s and practices for reduction in wastage of irrigation water like use of drip irrigation system, sprinklers, plastic agriculture. Use of furrow irrigation method, mixed farming in order to use fresh water resources efficiently with more yields. Optimized irrigation agriculture in areas of intensive irrigation is required for sustainable development.

- Farmers may be encouraged and made aware towards shifting to innovative, intensive and high valued crops.

- In order to reduce the concentration of nitrate in ground water to some extent, use of bio pesticides, organic farming, bio fertilizers etc (Vadgam, Palanpur, Deesa, Dhanera) should be encouraged.

- Schemes involving effective management for judicious distribution from existing surface reservoirs and extensive recharge of ground water through different methods for dilution of fluoride in subsurface reservoir. (Danta, Vadgam, Amirgarh, Dhanera talukas)

- The land holding of the group of farmers under public tubewell irrigation should be brought under the provision of the change in crops, irrigation practices and installation of drip/sprinkler irrigation technique. Soft term institutional finances to the farmers and liberal subsidies in equipments are suggested.

- Decreasing the stress on the ground water by using surface water in place of ground water for irrigation. This would prevent the upconing/mixing of inferior quality groundwater from the deeper aquifers. Alternatively, the existing cropping preference may be replaced with crops that require lesser irrigations or by replacing the crops by water quality tolerant crops, which can use low quality water.

- Suitable ground water legislation may be enforced and all future ground water exploitation by deep tube wells be restricted followed by periodic monitoring of water level through closely knit monitoring system to appraise the condition more precisely from time to time.