For official use

Technical Report Series

DISTRICT GROUNDWATER BROCHURE
PATAN DISTRICT
GUJARAT

Compiled By
A. K. Sinha
Assistant Hydrogeologist

Government of India
Ministry of Water Resources
CENTRAL GROUND WATER BOARD
West Central Region
Ahmedabad

March 2014

PATAN DISTRICT AT A GLANCE

SL No.	Items	Statistics	
1	**General Information**		
	i) Geographical area (Sq. Km)	**5,740**	
	ii) Administrative Divisions (As on 2011) Number of Talukas Number of Villages	 **7** **517**	
	iii) Populations (As on 2011 census)	**13,42,746**	
	iv) Average Annual Rainfall (mm)	**664.87**	
2.	**GEOMORPHOLOGY**		
	Major Physiographic Units: Alluvial plain & Rann		
	Major Drainages: Non-perenial rivers-Banas, Khari & Umardasi		
3.	**LAND USE (Sq. Km)**		
	a) Forest area b) Net area sown c) Cultivable area	**465** **3,819** **4,979**	
4.	**MAJOR SOIL TYPES : Sandy soil,Saline and Alkali soil**		
5.	**AREA UNDER PRINCIPAL CROPS (Sq. Km)**		
	Bajra-980, Wheat-270, Total Cereals-1280, Gram-160, Other Pulses-340, Total Pulses-500, Total Food Grains-1780, Seasemum-70, Rapes and Mustard-540, Total Oil Seeds-820.		
6.	**IRRIGATION BY DIFFERENT SOURCES**		
	(Areas and numbers of structures)	**No.**	**Area (Sq. Km.)**
	Dugwells	**4660**	**78**
	Tube wells/Borewells	**5271**	**1017**
	Tanks/Ponds/Water conservation structures		**6**
	Canals		**97**
	Other Sources		**262**
	Net Irrigated area	**1287**	
	Gross Irrigated area	**1535**	
7.	NUMBERS OF GROUND WATER MONITORING WELLS OF		
	CGWB (As on 31-3-2012) No of Dug Wells No of Piezometers	**36** **12** **24**	

8. **PREDOMINANT GEOLOGICAL FORMATIONS:** Alluvium

9. **HYDROGEOLOGY**

- Major Water Bearing Formation: Quaternary alluvium

Depth to water Level during 2011-12		
Period	**Phreatic Aquifer (DTW)**	
	Minimum	**Maximum**
Pre Monsoon	1.70 (Radhanpur)	32.01 (Nedra)
Post Monsoon	1.00 (Radhanpur)	20.98 (Nedra)

Long Term (10 Years) Water Level Trend (2003 to 2012)		
Trend	**Pre-Monsoon**	**Post- Monsoon**
Rise (m/Yr)	0.0438 (Radhanpur) to 0.7321 (Shankhari)	0.1681 (Dharmoda) to 0.7926 (Shankhari)
Fall (m/Yr)	0.0375 (Varahi) to 6.3079 (Bhutia Wasna II)	0.0079 (Radhanpur 2) to 0.1055 (Shankheshwar)

10. **GROUND WATER EXPLORATION BY CGWB (As on 31-03-2012)**

No of wells drilled (EW, OW, Pz, SH, Total)
EW 12,OW 9, PZ 15, SH 1, Total:.37

Depth Range(m)	40 – 618.9
Discharge (Litres per minute)	6 - 2616

11 **GROUND WATER QUALITY**

Presence of chemical constituents more than permissible limit)	Fluoride:126Villages Salinity :110 Villages
Type of water	Predominant bicarbonate-Chloride type

12. **DYNAMIC GROUND WATER RESOURCES (2011)**

Annual Replenishable Ground Water Resources (MCM)	280.64
Net Ground water Availability (MCM)	252.58
Projected Demand for Domestic and industrial Uses upto 2025 (MCM)	24.95
Stage of Ground Water Development (%)	122.33

13 **AWARENESS AND TRAINING ACTIVITY- Nil**

Mass Awareness Programmes organized (3/2012) No of Participants- (Tier-III Training)	NIL

<table>
<tr><td></td><td colspan="2">Water Management Training Programmes organized (3/12)</td><td>NIL</td></tr>
<tr><td rowspan="3">14</td><td colspan="3">EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING (31/3/2012)</td></tr>
<tr><td colspan="2">Projects completed by CGWB (No & Amount spent)</td><td>NIL</td></tr>
<tr><td colspan="2">Projects under technical guidance of CGWB (Numbers)</td><td>NIL</td></tr>
<tr><td>15</td><td colspan="3">GROUND WATER CONTROL AND REGULATION (2012)
<table>
<tr><td>Number of OE Talukas</td><td>03
(Chanasma, Patan, Sidhpur)</td></tr>
<tr><td>Number of Critical Talukas</td><td>Nil</td></tr>
<tr><td>Number of Semi Critical Talukas</td><td>Nil</td></tr>
<tr><td>Number of Safe Talukas</td><td>Nil</td></tr>
<tr><td>Number of Saline Talukas</td><td>04
(Harij, Sami, Radhanpur, Santalpur)</td></tr>
<tr><td>No. Of Talukas Notified</td><td>Nil</td></tr>
</table></td></tr>
<tr><td>16</td><td colspan="3">MAJOR GROUND WATER PROBLEMS AND ISSUES</td></tr>
<tr><td></td><td colspan="3">i) Declining Groundwater levels/ Piezometric heads in user aquifers
ii) Increasing depth of tubewells
iii) Inherent salinity of the aquifers in the western part of the district
iv) Increasing instances of high fluoride
v) Groundwater contamination due to unplanned construction and poor technical design of tube wells
vi) Awareness amongst villagers on water conservation techniques
vii) Demand supply management</td></tr>
</table>

DISTRICT GROUND WATER BROCHURE
PATAN

1.0 Introduction

Patan district is situated in the northern part of Gujarat state. The district is carved from Banaskantha and Mahesana district. The district occupies 5740 sq. km. area between 23°24' and 24°09' north latitudes and 71°01' and 72°30' east longitudes. It falls in the survey of India degree sheet numbers 41M, 46A, 40P & 45D. It is bounded by Banaskantha in north, Little Rann of Kachchh in west, Mahesana district in the east and by Surendranagar and Ahmedabad districts in the south. It has seven talukas, having 517 villages. Total population of the district as per 2011 census is 13, 42,746**.**

Rivers Banas, Khari and Umardasi drain part of the district. All these rivers are ephemeral in nature and flow only during good monsoon years. Major part of the area in the district is devoid of any drainage network and does not fall in any catchment.

The surface water resources of the district are very limited. Groundwater is the main source of irrigation.

Studies/Activities by CGWB

Before central Ground Water Board came to existence, Heron & Ghosh, 1938 (GSI) carried out geological mapping in the north eastern part of the district. Auden, 1938 carried short term investigation of the subsoil water in the district. The first Hydrogeological investigation was carried out by B. K. Baweja during 1953-55. V. V. Rane, 1962-63 (GSI), investigated the causes of decline of water level and discharge of tubewells. M.M. Oza, 1963-67 (GSI), continued hydrogeological studies and broadly identified three aquifer systems in the district.

CGWB under UNDP assisted phase II programme carried out extensive hydrogeological studies including exploratory drilling in the area. A phreatic and confined aquifer system was deciphered down to the explored depth of 600m.

Arun Kumar (1979-80), CGWB, carried out reappraisal hydrogeological study, covering parts of Patan and Banaskantha districts. P. N. Phadtare (1981), CGWB, compiled "hydrogeology of Gujarat State" and discussed groundwater resource potential of the district based on earlier studies.

During 1980-85, CGWB with UNDP assistance carried out pilot project for artificial recharge of groundwater to figure out technical feasibility and economic viability of the various artificial recharge techniques/experiments in the alluvial area of the district.

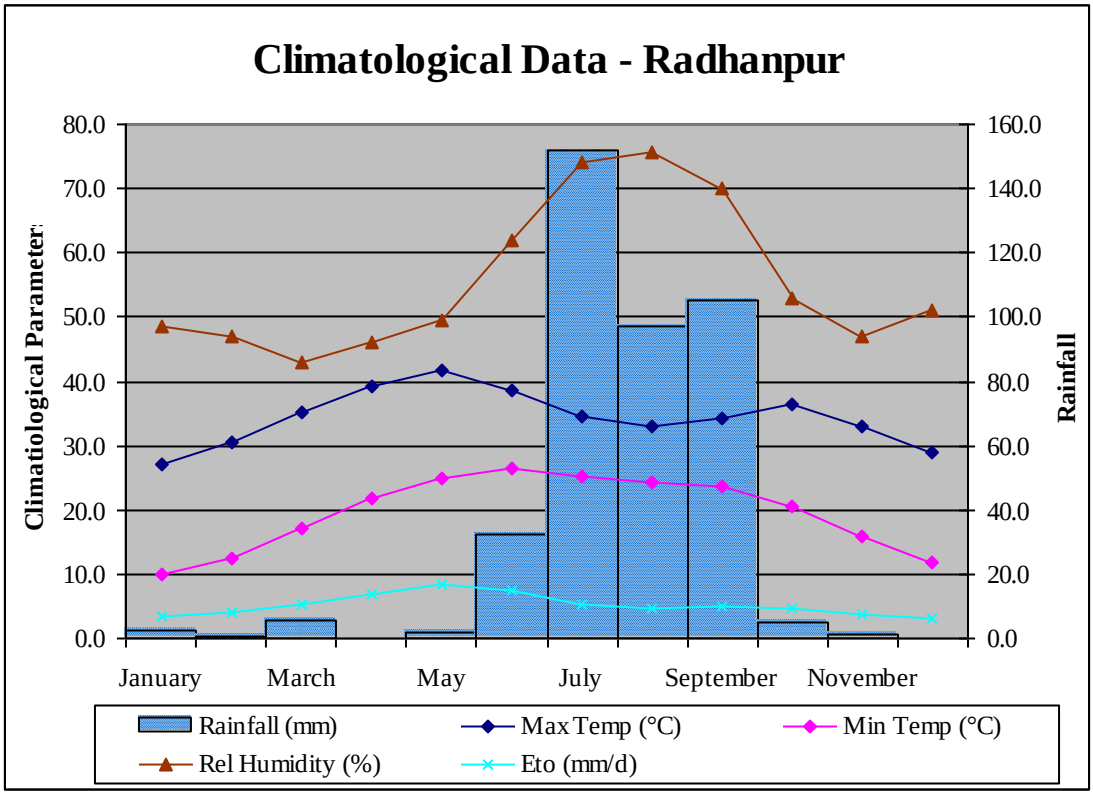
Groundwater exploration by test drilling in the district commenced in fifties and was continued till 2002-2003. Apart from the exploratory wells Piezometer of various depths are also constructed in the district for periodic monitoring of the ground water regime in the district and is continued till date.

2.0 Rainfall and climate

The district has semi arid climate. Extreme temperatures, erratic rainfall and high evaporation are the characteristic features of this type of climate. Climatological data of Radhanpur IMD station (1951-1980) which falls in the district is given in the table 1.

Table 1

Month	Max Temp (Deg.C)	Min Temp (Deg.C)	Humidity (%)	Wind Spd. Kmpd	Sunshine (Hours)	Solar Rad. (MJ/m2/d)	Eto (mm/d)	Rainfall (mm)
January	27.2	10.0	48.5	113.5	8.9	16.6	3.3	2.3
February	30.4	12.5	47.0	110.0	9.5	19.4	4.1	0.7
March	35.2	17.0	43.0	115.2	10.1	22.8	5.4	5.3
April	39.3	21.9	46.0	129.2	10.8	25.6	6.7	0.1
May	41.6	24.8	49.5	204.3	11.4	27.1	8.4	1.7
June	38.6	26.6	62.0	267.1	8.7	23.1	7.4	32.3
July	34.4	25.3	74.0	235.7	5.3	17.9	5.2	152.0
August	33.1	24.2	75.5	188.6	5.4	17.6	4.6	97.2
September	34.3	23.6	70.0	130.9	7.9	20.2	4.9	105.1
October	36.3	20.7	53.0	87.3	9.6	20.3	4.6	4.7
November	32.9	15.9	47.0	92.5	9.3	17.5	3.7	1.2
December	29.1	11.7	51.0	106.5	8.9	15.8	3.2	0.1
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**402.7**
Average	**34.4**	**19.5**	**55.5**	**148.4**	**8.8**	**20.3**	**5.1**	**-**



3.0 Geomorphology and Soil Type

3.1 Geomorphologically the district can be divided into three major zones

a) **Alluvial plain:** It is a vast sandy tract characterised by gently sloping, slightly rolling to undulatory topography owing to presence of sand dunes.. it is the most prominent unit and covers the most part of the district.
b) **Sedimentary Pedeplain:** It is a featureless, gently sloping sedimentary pedeplain bordering the alluvial plain which merges with the Rann of Kachchh. It consists of marine sedimentary formations of Jurassic and tertiary period. It falls in the western part of the district in Santhalpur Taluka.
c) **Rann and Bets:** These are small isolated and continuous patches of marshy land which are contiguous to the Rann of Kachchh. The terrain is monotonously flat and low lying with elevations less than 8 mamsl with or without salt encrustations. Bets are the small island in the Rann. These are found in the western part of the district.

3.2 Soil Type

Soils of the district can be classified broadly into two major types

3.2.1 Eolian and Alluvial Soils: These constitute the major part of the district. These are coarse to medium textured, deep to very deep with negligible to low organic content. These are sandy, loamy sand and sandy loam. Alluvial soils in general are restricted along rivers and streams whereas eolian soils are found away from these. These soils have very high basic infiltration rates(60 to 215 mm/hour)(RCJain and A Kumar)

3.2.2 Saline Soils These are found in the western part of the district. These are charged with salt content are basically saline-alkali type.

4.0 Ground Water Scenario

4.1 Hydrogeology

The geological setup with vast areas affected by salinity present a complex hydrogeological pattern in the district. The 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.

4.1.1 Occurrence of Ground water

Major part of the district is underlain by post Miocene alluvium and older sedimentary formations. These sediments are mainly consisted by 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.

4.1.2 Nature and depth of aquifer system

Two major aquifer units have been identified in the district. 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 unit comprising a few hundred metres of alternating sand and clay beds form confines aquifer system. It is subdivided into **B, C D and E** in post Miocene sediments and aquifer **F and G** in the Miocene sediments.Himmatnagar sandstone (Cretaceous) forms local aquifer in the north eastern part and has been designated as aquifer **H**. The post Miocene aquifers are generally coarse to fine grained sand with occasional gravel beds. 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.

4.1.3 Aquifer parameters:

Unconfined aquifer: Aquifer A: Specific capacity of phreatic aquifer in the district ranges from 31m^3/hr/m to less than 1 m^3/hr/m and transmissivity from 30m^2/day to 1000m^2/day.

Confined Aquifers

Aquifer B: Specific capacity ranges from 1.8m^3/hr/m to 49m^3/hr hr/m. Transmissivity ranges between 47 and 3400 m^2/day, however it is mostly between 200-600m^2/day. Storativity ranges from 0.6 -12.3x10^{-4}.

Aquifer C: Specific capacity calculated for wells at Saola and Charasan ranges from 21.3 and 2.8m^2/day/m respectively. Transmissivity was 94m^2/day at Charasan EW.

Aquifer D: Specific capacity calculated for EW at Dhinoj was found to be 1.3 m^3/hr/day, the transmissivity being 69m^2/day.

Aquifer E: No pumping test carried in this aquifer.

Aquifer F & G: Specific capacity calculated for wells at Charasan and Pilwai was 1.1 m^3/hr/m and 1.7m^3/hr/m respectively. Transmissivity was 59m^2/day and 70m^2/day.

SUBSURFACE GEOLOGY OF PATAN DISTRICT WITH DESCRIPTION OF AQUIFER PROPERTIES

Table 2

Stratigraphy	Formation group	Lithology	Depth to top of aquifer (m)	Thickness		Remarks
				Range (m)	Average (m)	
Recent to post Miocene	Aquifer A	Coarse sand, gravel, pebbles and fine and clayey sand	5-71	35-125	62	Variable water quality
	Aquitard I	Clay interbedded with sand and sandy clay	78-162	13-88	39	-
	Aquifer B	Medium to coarse sand and gravel interbedded with sandy clay	78-162	10-80	45	Generally good water quality
	Aquitard II	Clay interbedded with sand and sandy clay		13-80	37	-
	Aquifer C	Medium to coarse sand in north east and fine to medium in central part interbedded with sandy clay and clay	154-274	13-62	34	Generally good water quality
	Aquitard III	Clay interbedded with sand and sandy clay		19-172	73	-
	Aquifer D	Medium sand	229-402	11-105	52	Variable water

		interbedded with sandy clay				quality
	Aquitard IV	Clay interbedded with sandy clay		11-76	44	-
	Aquifer E	Fine to medium sand and sandy clay	300-542	15-57	24	Developed in central part . water quality good
Miocene	Aquiclude V	Grey clay and claystone		13-148	41	-
	Aquifer F	Fine to medium sand , sandstone interbedded with siltstone	200-574	7-68	39	Variable water quality
	Aquiclude VI	Clay and clay stone		34-49	40	-
	Aquifer G	Fine to medium sand , sandstone interbedded with siltstone	264-513	9-124	48	Water generally saline
Paleocene	-	Basalt			267	
Cretaceous	Aquifer H	Himatnagar sandstone	214-547	98-145	121	Variable water quality

Source : CGWB/UNDP Phase II

4.2 Ground Water Regime Monitoring

Groundwater regime monitoring are being carried out four times in a year during May, August, November & January. In all 36 hydrograph stations (12 Open wells & 24 purpose build Piezometers) spread over the entire district were monitored during the 2012. The groundwater level during the premonsoon period (May 2012) ranged from 1.70 m to 32.01 mbgl. Depth to water level map for the pre-monsoon period 2012 is given in figure–4 . Shallowest water level of 1.70 mbgl was recorded in Radhanpur

Village and the deepest water level of 32.01 mbgl was recorded in Nedra village of the district. The range of groundwater level in the district is table-3.

Range Of Groundwater Level in Patan District During Pre monsoon May 2012.

Table -3

District	No of well analysed	DTWL mbgl		No of well in different Ranges & %				
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)
Patan	12	1.70	32.01	2	3	2	3	2
				6.6%	25%	16.67%	25%	16.67%

The groundwater level during the post-monsoon period (Nov 2012) ranges from 1.00 mbgl to 20.98 mbgl. Spatial distribution of groundwater level in the district is shown in figure -5. Shallowest water level of 1.00 mbgl was recorded in Radhanpur village and the deepest water level of 20.98 mbgl was recorded in Nedra village of the district. The range of groundwater level in the district is given in table-4

Range Of Groundwater Level In Patan District During Post Monsoon November 2012.

Table -4

District	No of well analysed	DTWL mbgl		No of well in different Ranges & %					
		Min	Max	0 to 2 (m)	2 to 5(m)	5 to 10(m)	10 to 20(m)	20 to 40(m)	>40(m)
Patan	12	1.00	20.98	1	5	1	4	1	-
				8.33%	41.67%	8.33%	33.33%	8.33%	-

58.33% of the wells in the district showed rise in the groundwater level between May to November 2012. Rise in the district ranges from 0.09 to 11.03 m. fall is observed in 41.67% wells. Fall in the district ranges from 0.09 to 0.34 m.

Minimum rise of 0.09 m was recorded in Dharmoda village and the Maximum rise of 11.03m was recorded in Nedra village. Minimum fall of 0.09 m was recorded in Vauva village and the Maximum Fall of 0.34 m was recorded in Dhinoj village.

Of the wells showing rise, 57.14% wells recorded rise between 0 to 2 m, 14.25 % wells recorded rise between 2 to 4m and 28.57% wells show rise of more than 4m between May to November 2012.

Of the wells showing fall, 100% wells recorded fall between 0 to 1m. Water level fluctuation map for the pre and post-monsoon 2012 is given in figure-6.

Long term water level trend during pre-monsoon period (2003 to 2012) shows rise in water level between 0.0438 to 0.7321 m/yr and fall between 0.1681 to 0.7926 m/yr. Long term water level trend during post monsoon period shows rise in water level from 0.1681 to 0.7926m/yr and fall from 0.0079 to 0.1055m/yr.

4.2 Ground Water Resources

The ground water resources with talukawise details are presented below in table no 5 and figure no. 6.

GROUND WATER DEVELOPMENT POTENTIAL OF PATAN AS ON 31ST MARCH, 2011

TABLE- 5

Taluka Wise Ground Water Resources, Availability, Utilization and Stage of Ground Water Development (2011)									
District : Patan									
Sr. No.	Taluka	Net Annual Ground Water Availability (ham) (7- 8)	ANNUAL GROUND WATER DRAFT (ham)			Projected Demand for Domestic and Industrial uses upto 2025 (ham)	Ground Water Availability for future irrigation (ham) {(9)-(10+13)}	Stage of Ground Water Development (%) (12/9) * 100	Category
			Irrigation	Domestic And Industrial uses	Total (10 + 11)				
1	**2**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1 #	**Chansma**	**4394.31**	**4714.00**	**450.20**	**5164.20**	**522.00**	**0.00**	**117.52**	**Over Exploited**
2 #	**Patan**	**13852.60**	**14712.00**	**894.00**	**15606.00**	**1199.00**	**0.00**	**112.66**	**Over Exploited**
3 #	**Sidhpur**	**7011.02**	**9552.00**	**577.00**	**10129.00**	**774.00**	**0.00**	**144.47**	**Over Exploited**
4	**Harij**								
5	**Sami**								
6	**Radhanpur**								
7	**Santalpur**								
District Total		25257.92	28978.00	1921.20	30899.20	2495.00	0.00	122.33	**Over Exploited**

 # ' Computation by RIF Method

4.3 Ground Water Quality

Ground Water Quality in the district can be divided into two groups for understanding viz. **Quality in phreatic aquifers** and **Quality in confined/user aquifers**

4.3.1 Ground Water quality in Phreatic Aquifers: The ground water quality in phreatic aquifer shows wide variation in chemical quality. The entire district can be divided into three distinct zones as below.

North eastern zone characterised by fresh water of bicarbonate type with TDS less than 1000 ppm.

Central zone with water of mixed, bicarbonate-chloride type with TDS up to 3000 ppm.

South western zone with water of chloride type containing TDS more than 3000 ppm.

4.3.2 Ground Water quality in confined aquifers: The ground Water quality in the deeper aquifers (with in about 300m depth) which may also be called user confined aquifer is generally fresh (TDS< 2000 ppm) in the north eastern and central parts and is good for drinking as wells as Irrigation purpose. Deterioration of ground water quality is observed from recharge area in the north-east to discharge area in south west.

4.4 Status of Ground Water Development (Taluka wise)

4.4.1 Feasibility, Yield potential, Depth and Dia of ground water abstraction structures

Table 6

Taluka	Wells feasible	Suitable drilling technique	Depth of well (m)	Diameter	Discharge (lpm)
Chanasma	Tubewells	Direct Rotary, Reverse Rotary	100-300	200-250 mm	600-1200
Patan	Dugwell	Manual	15-30	2.5-5 m	200-300
	Tubewells	Direct Rotary, Reverse Rotary	100-300	200-250 mm	600-1200
Radhanpur	Dugwell	Manual	10-25	2.5-5 m	200-300
	Tubewells/ Borewell	Direct Rotary, Reverse Rotary	50-150	200-250 mm	500-800

Santalpur	Tubewells	Direct Rotary, Reverse Rotary	100-300	200-250 mm	600-1200
Sidhpur	Dugwell	Manual	10-25	2.5-5 m	60-100
	Borewells	Down the Hole Hammer (DTH)	50-100	200-250 mm	60-150
Harij	Tubewells	Direct Rotary, Reverse Rotary	100-300	200-250 mm	600-1200
Sami	Dugwell	Manual	15-30	2.5-5 m	200-300
	Tubewells	Direct Rotary, Reverse Rotary	50-300	200-250 mm	500-800

4.4.2 Drinking water wells and water supply based on groundwater sources

Table 7: Type of Abstraction Structure

Taluka	No. of Dugwell	No. of Tubewell	Depth Range (m)	Discharge range (LPM)
Chanasma	0	0	0	0
Harij	0	0	0	0
Patan	0	0	0	0
Radhanpur	0	44	130-300	400-800
Sami	0	9	120-150	200-400
Santalpur	0	62	60-240	200-800
Sidhpur	0	117	220-400	400->800
Chanasma	0	47	250-400	400->800
Harij	0	120	220-300	400-800

Source: GWS&SB

4.4.3 Type of pumps and water lifting devices for Irrigation dugwells, shallow tubewells and deep tubewells

Table 8: Dugwells

Taluka	Electric pumps	Diesel pumps	Wind mills	Solar pumps	Man/Ani. Operated	Others	Total
Radhanpur	0	0	0	0	14	0	14
Sami	20	0	0	0	0	0	20
Santalpur	6	0	0	0	0	0	6
Sidhpur	44	8	0	0	0	0	52
***District Total**	**70**	**8**	**0**	**0**	**14**	**0**	**92**

*** No data available for the remaining 4 block(s)**

Table 9: Shallow Tubewells

Taluka	Electric pumps	Diesel pumps	Wind mills	Solar pumps	Man/Ani. Operated	Others	Total
Radhanpur	117	39	0	0	1	0	157
Sami	5	11	0	0	0	0	16
Sidhpur	14	0	0	0	0	0	14
***District Total**	**136**	**50**	**0**	**0**	**1**	**0**	**187**

*** No data available for the remaining 4 block(s)**

Table 10: Deep Tubewells

Taluka	Submersible pumps	Turbine pumps	Others	Total
Chanasma	689	0	0	689
Harij	717	51	0	768
Patan	1,857	0	0	1,857
Radhanpur	172	62	0	234
Sami	535	2	3	540
Santalpur	36	0	0	36
Sidhpur	1,308	0	1	1,309
Vagdod	690	0	1	691
District Total	6,004	115	5	6,124

4.4.3 Irrigation scenario from ground water sources

Dugwells

As per MI census 2000-01 there are 7823 dugwells out of which 2879 are in use. Irrigation potential created through these dugwells is 110.14 sq. km and potential utilized is 58.54 sq. km. area.

Shallow tubewells

As per MI Census 2000-01 there are 708 shallow tubewells out which 206 are in use. The irrigation potential created is 13.59 sq. km and utilized is 11.77 sq. km. area.

Deep Tubewells

As per MI census 2000-01 there are 9938 deep tubewells in the district out of which 9270 are in use. The irrigation potential created is 1902.20 sq. km. are and potential utilized is 1493.20 sq. km. area.

Following is the talukawise detail of irrigation potential fro ground water sources presented in table no. 11.

Table 11

Taluka	Dugwells		Shallow tubewells		Deep tubewells	
	Potential created	Potential utilized	Potential created	Potential utilized	Potential created	Potential utilized
Chanasma	0	0	0	0	22,386	21,902
Harij	0	0	0	0	20,602	17,949
Patan	0	0	0	0	49,415	47,788
Radhanpur	14	14	778	758	2,642	2,535
Sami	401	401	461	444	23,108	21,695
Santalpur	23	23	0	0	1,083	762
Sidhpur	534	534	244	244	27,717	26,757
Vagdod	0	0	0	0	22,248	21,950
District Total	**972**	**972**	**1,483**	**1,446**	**1,69,201**	**1,61,335**

5.0 Ground Water Management Strategy

5.1Ground Water Development

Three talukas in the district are categorised as **Over exploited** and four as **Saline** and as stage of development is 122.33% in the GWRE, 2011 report hence there is **no further scope** for development of the ground water resources.

5.2 Water Conservation and Artificial Recharge

The suitable recharge structures feasible in the district are Percolation tanks/ponds, Recharge wells, recharge shaft, check dams, nalla bunds and gully plugs etc depending on the terrain conditions.

In the phreatic aquifers with deep water levels and desaturation, spreading channels, recharge pits, recharge ponds etc are suitable to utilize surplus runoff and tail end releases from the canals.

In the confined aquifers artificial recharge by indirect injection technique is suitable that is dual purpose connector wells. These recharge wells should have screens against upper saturated aquifer and also against the targeted confined

aquifer. it would function under gravity since the piezometric level of confined aquifer is much below phreatic water level.

Various 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 have shown good impact on the groundwater scenario. Following is the list which shows impact of the recharge structures on ground water in the district.

6.0 Ground Water Related Issues and Problems

Over exploitation of ground water is the single major issue in the district resulting in the fast depletion of this resource. Piezometric heads of deep confined aquifer has also declined sharply owing to the huge withdrawal. In many parts of the district phreatic aquifers are desaturated needing urgent attention.

Replacement wells, increase in well depth, prime mover, declining well yields are also the major issues.

Since groundwater is the main source for irrigation and the farmers don't have control over power supply, therefore they irrigate the crops 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.

Control on the area under fodder crops like alfalfa is also to be done as this is water intensive crop and consumes much more water compared to other crops like wheat, bajra, castor, mustard etc.

Although ground water quality for irrigation practice is within the limit in most parts of the district but many parts of the district are having high fluoride (>1.5 ppm) content (Source: GWSSB)

Awareness among the people regarding rainwater harvesting and artificial recharge.

7.0 Awareness and Training Activity

Till now no mass awareness programme has been conducted in the district at. No Water management training programme has been conducted in the district by CGWB.

8.0 Areas Notified by CGWA/SGWA

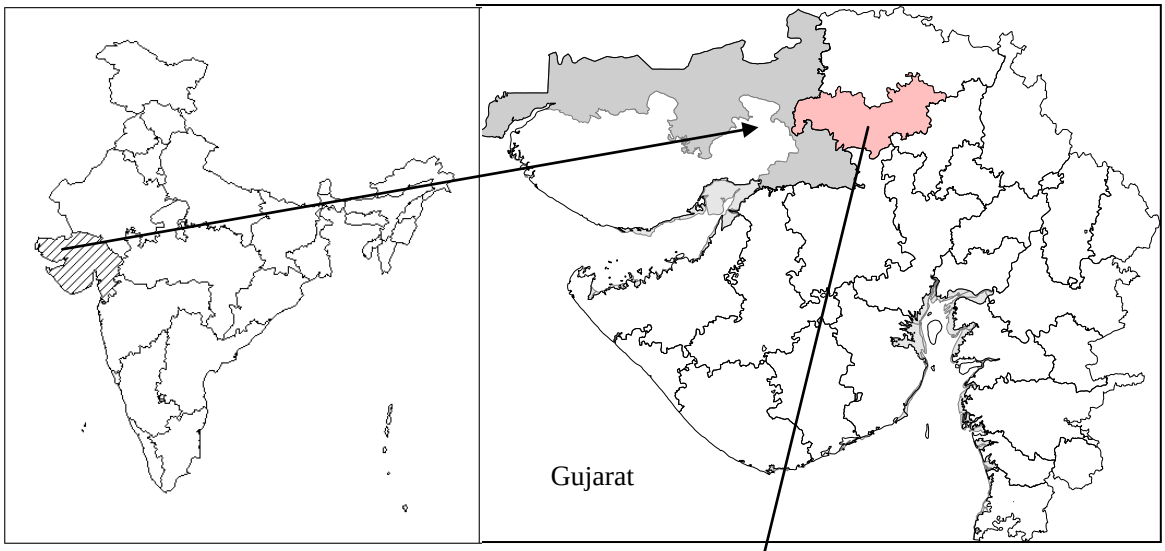
None

9.0 Recommendations

- There is an urgent need for management of resources for sustainable development.
- Suitable ground water legislation may be enforced and all future ground water exploitation by deep tube wells be completely banned
- Creating awareness among the farmers regarding water conservation through judicious use of water and adoption of efficient irrigation techniques like drip/sprinkler irrigation.

- 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.
- Resorting to artificial recharge practices by diverting surplus run-off during monsoon into ponds, percolation tanks,. Spreading basins, abandoned dugwells etc.
- Taking up artificial recharge 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.

LOCATION MAP OF PATAN DISTRICT



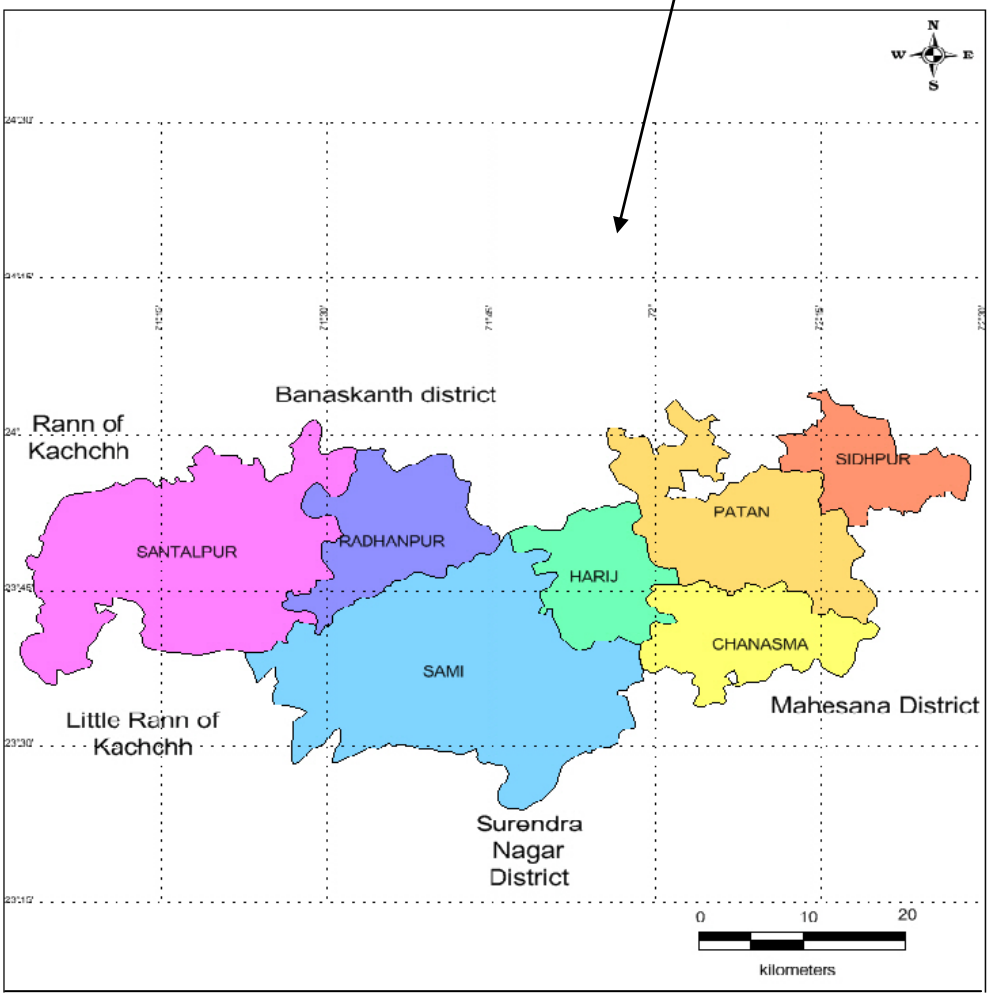


Figure 2

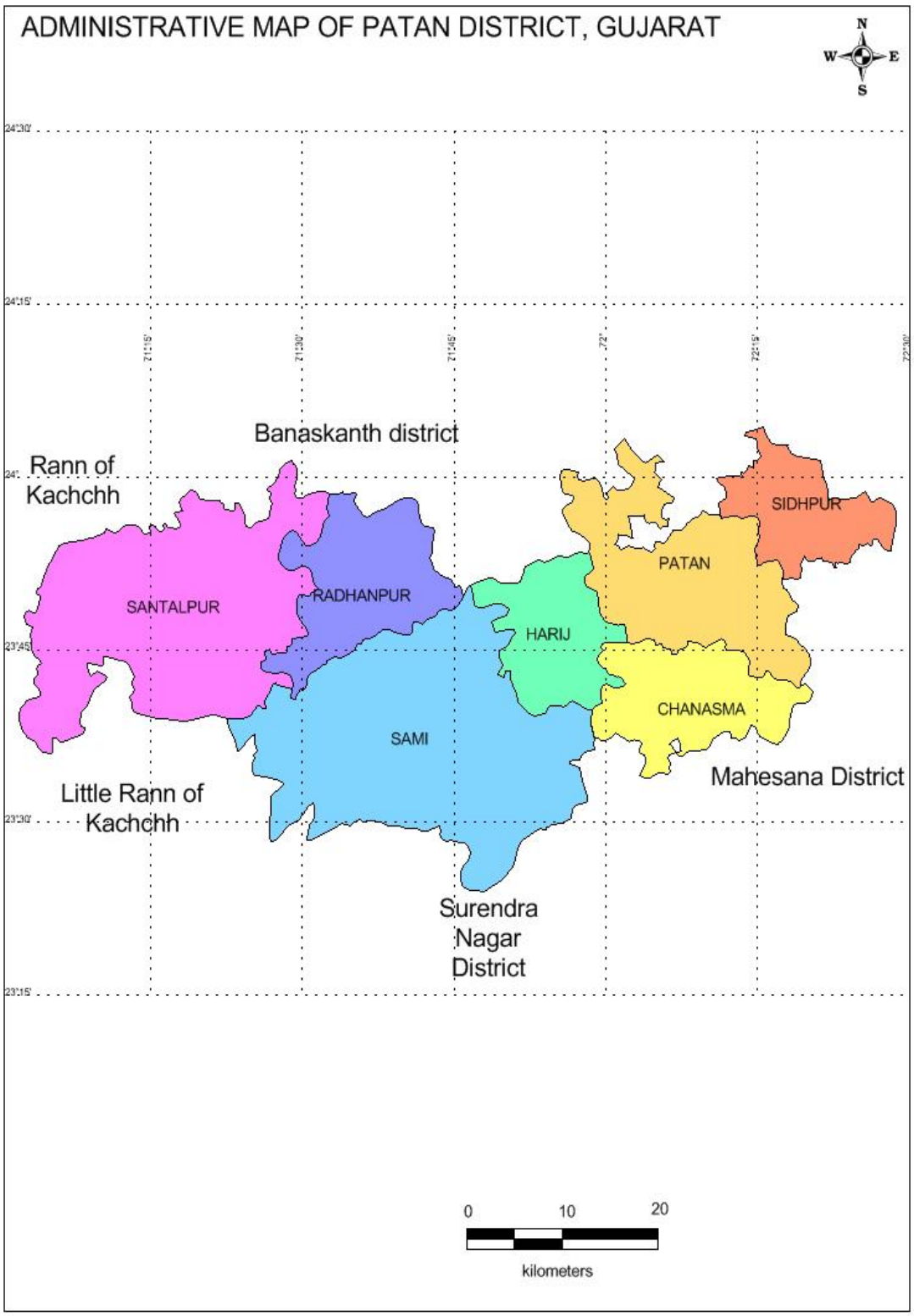
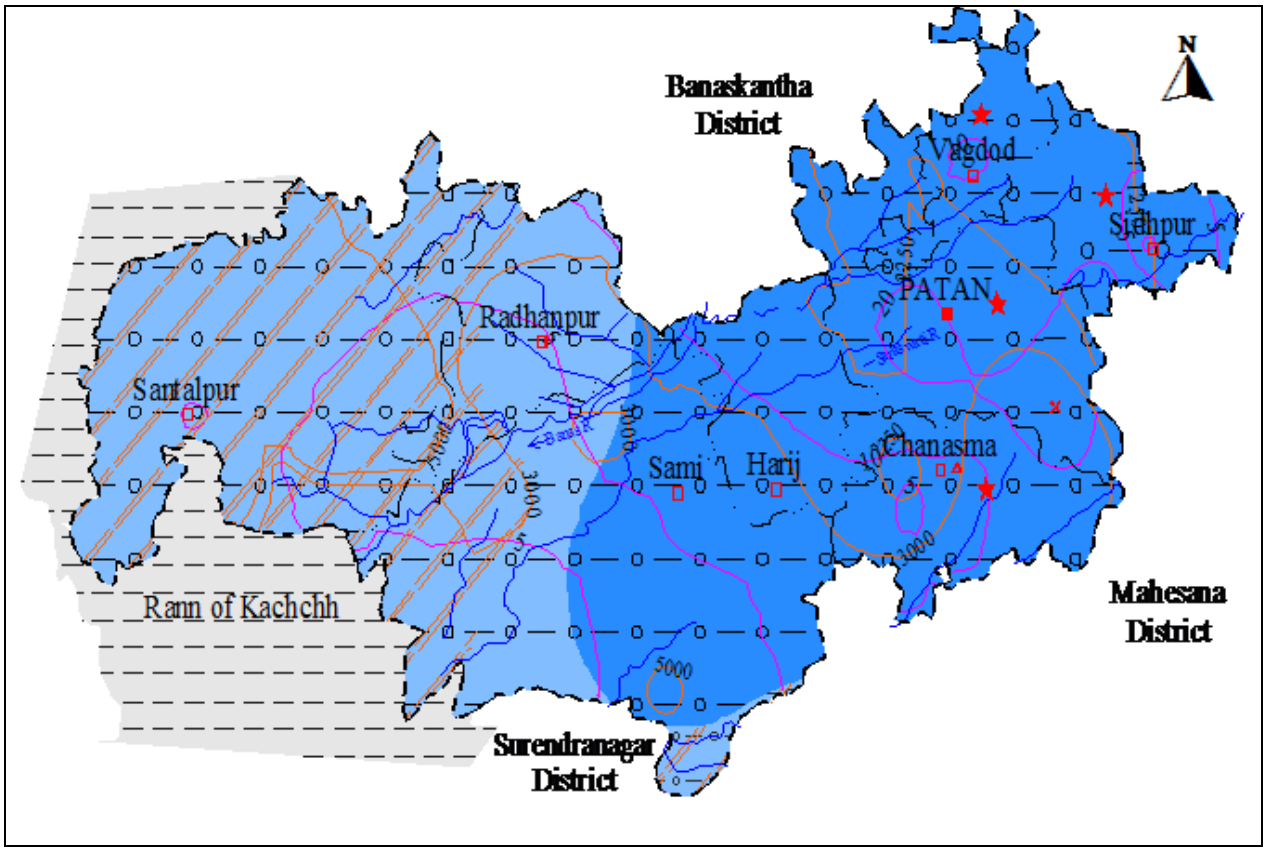

ADMINISTRATIVE MAP OF PATAN DISTRICT, GUJARAT
N
W
E
S
Banaskanth district
Rann of Kachchh
SANTALPUR
RADHANPUR
HARIJ
PATAN
SIDHPUR
CHANASMA
SAMI
Mahesana District
Little Rann of Kachchh
Surendra Nagar District
0
10
20
kilometers

Figure-3

HYDROGEOLOGICAL MAP OF PATAN DISTRICT



	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	15-30 100-200	200-300 300-600	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
Soft Rock Aquifer	Dug Well Tubewell	Manual Direct Rotary Reverse Rotary	15- 30 100-300	200-300 600-1200	Percolation Tanks/ Ponds, Recharge Wells, Recharge Shaft
Saline Areas	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				
	Drainage			District/Taluka HQ	
	Rann/Marsh				

Other Information

Geographical Area	**5,740 sq. km**
No of Blocks/ Talukas	**7**
Population (2011 Census)	**13,42,746**
Average Annual Rainfall	**664.87 mm**
Range of Average Temperature	**21-31 °C**
Major Drainage System	**Banas, Khari and Umardasi**
Major/ Medium Irrigation Scheme	
Major Geological Formation	**Soft Rock: Alluvium**
Utilizable Ground Water Resources	**252.58 MCM/Yr**
Net Ground Water Draft	**308.99 MCM/Yr**
Stage of Ground Water Development	**122.33 %**
Blocks Showing Intensive Ground Water Development	**Chanasma, Patan, Sidhpur**

Figure-4

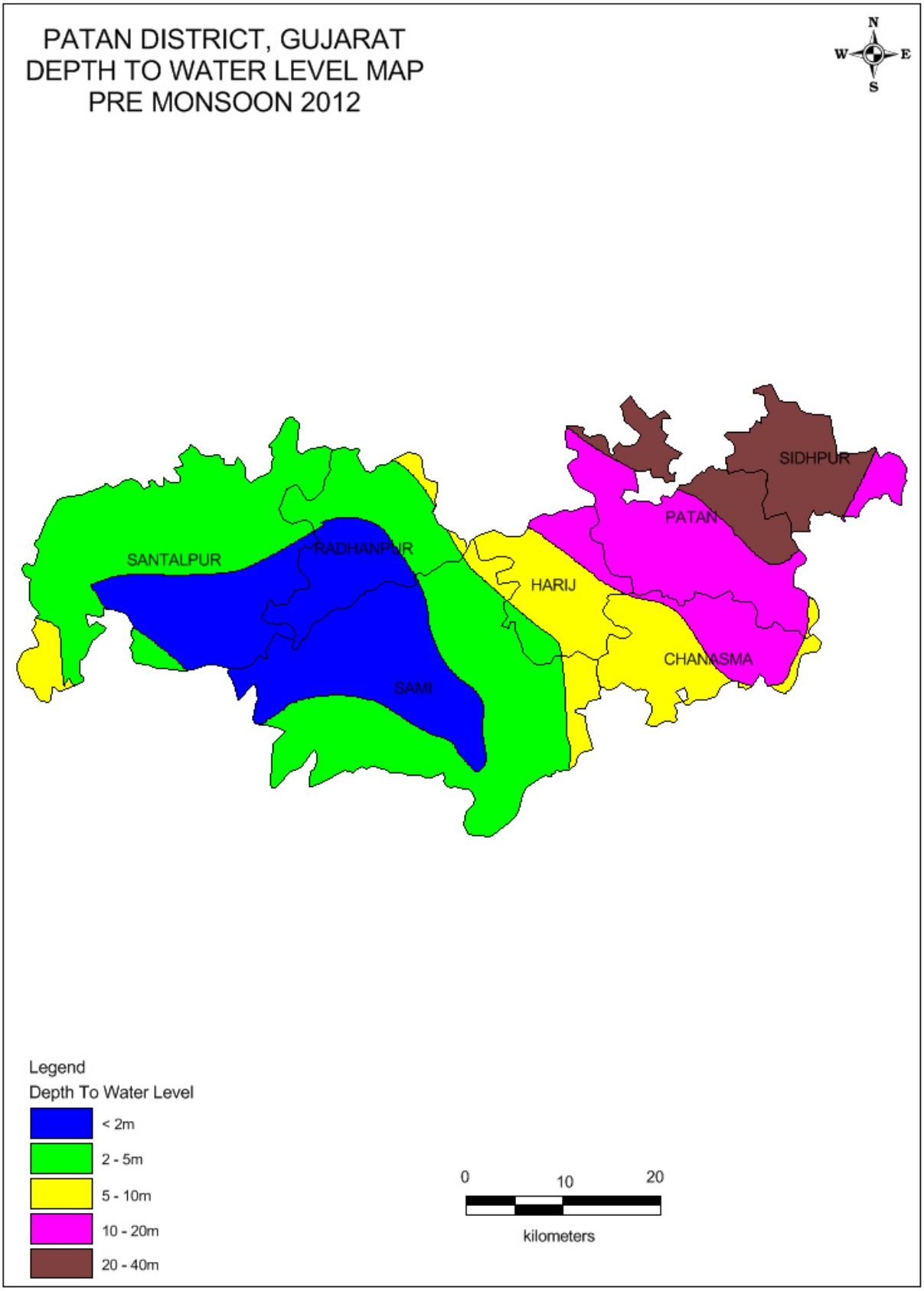
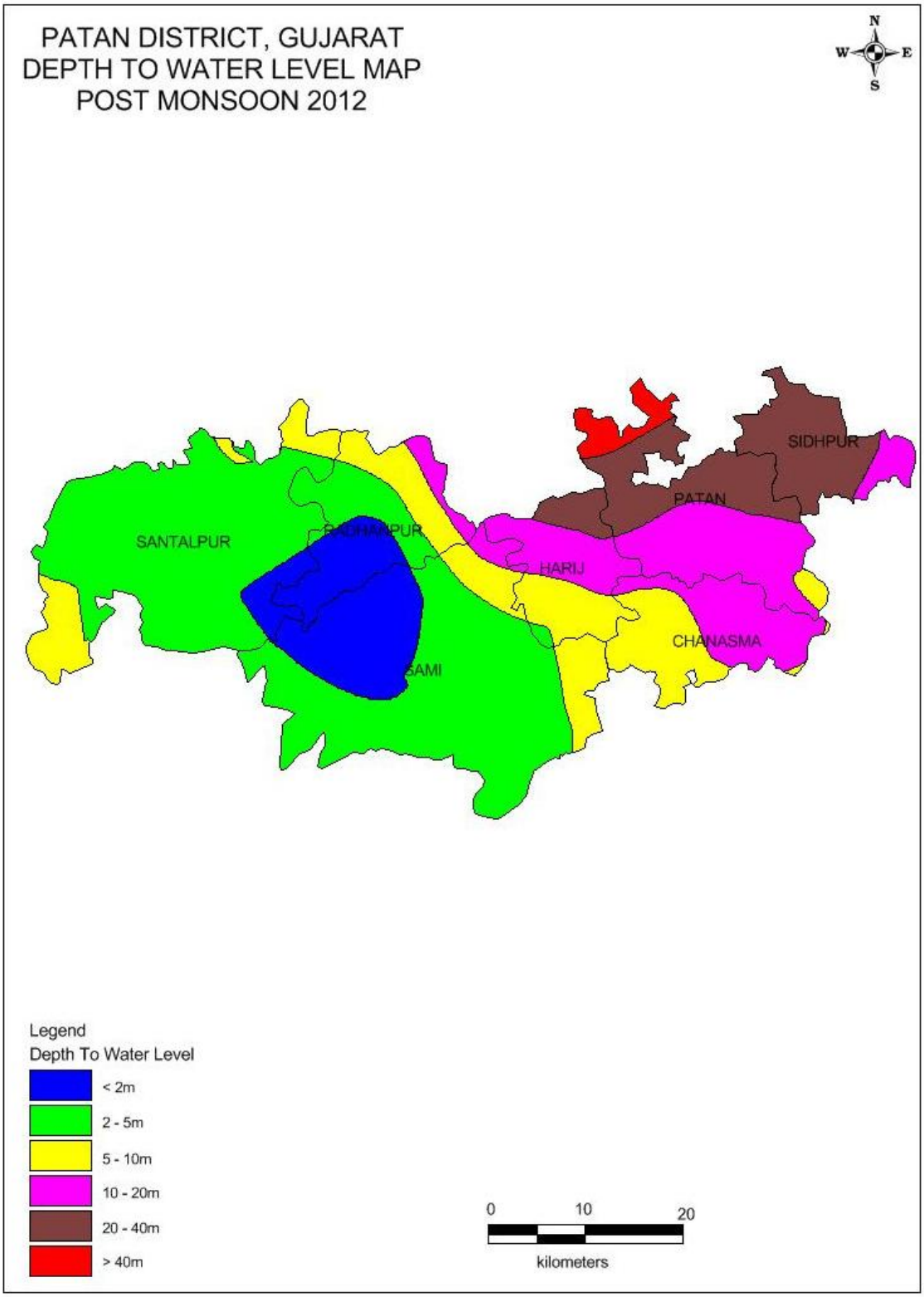

PATAN DISTRICT, GUJARAT
DEPTH TO WATER LEVEL MAP
PRE MONSOON 2012
N
W
E
S
SIDHPUR
PATAN
SANTALPUR
RADHANPUR
HARIJ
CHANASMA
SAMI
Legend
Depth To Water Level
< 2m
2 - 5m
5 - 10m
10 - 20m
20 - 40m
0
10
20
kilometers

Figure-5


PATAN DISTRICT, GUJARAT
DEPTH TO WATER LEVEL MAP
POST MONSOON 2012
N
W
E
S
SIDHPUR
PATAN
SANTALPUR
HARIJ
CHANASMA
Legend
Depth To Water Level
< 2m
2 - 5m
5 - 10m
10 - 20m
20 - 40m
> 40m
0
10
20
kilometers

Fugure-6

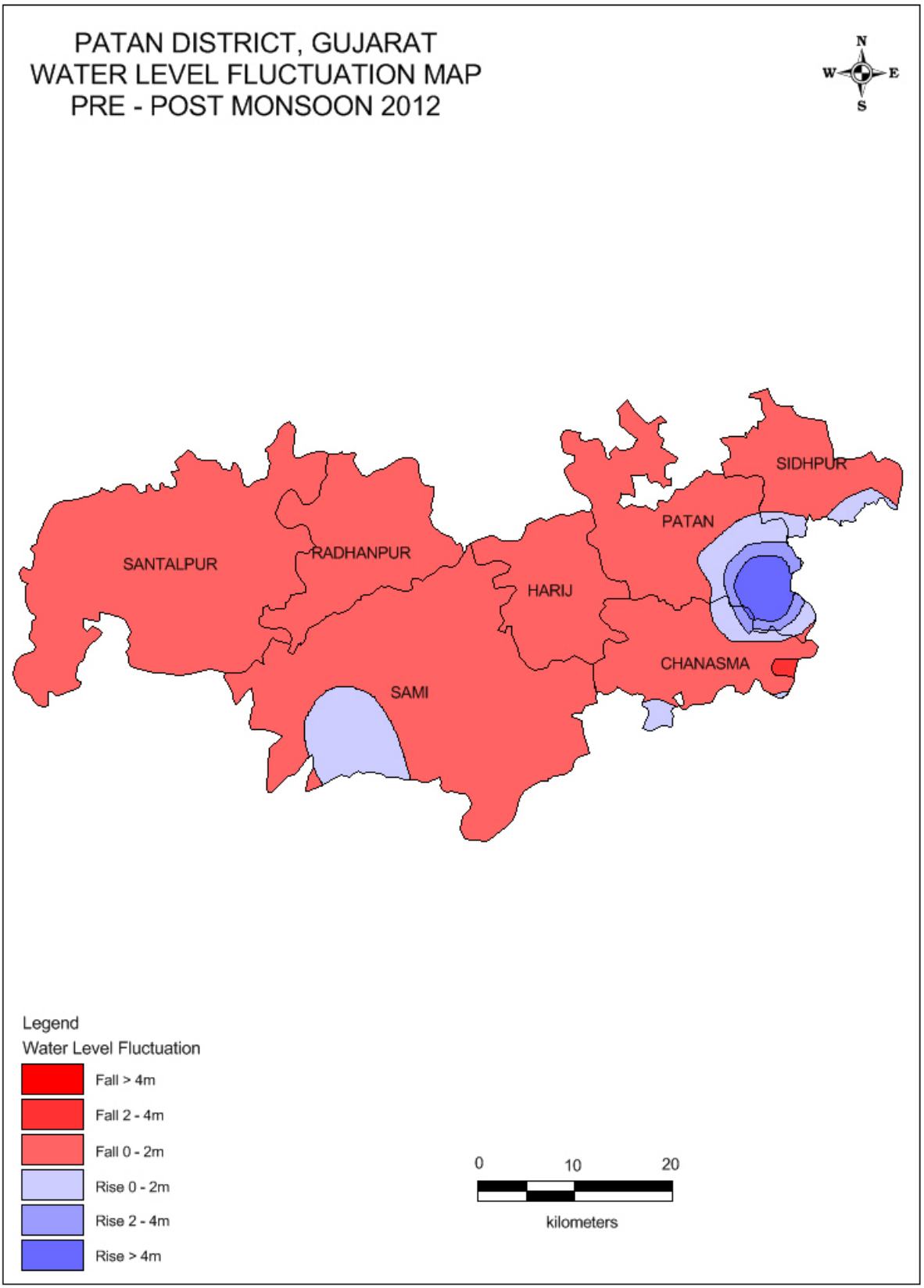
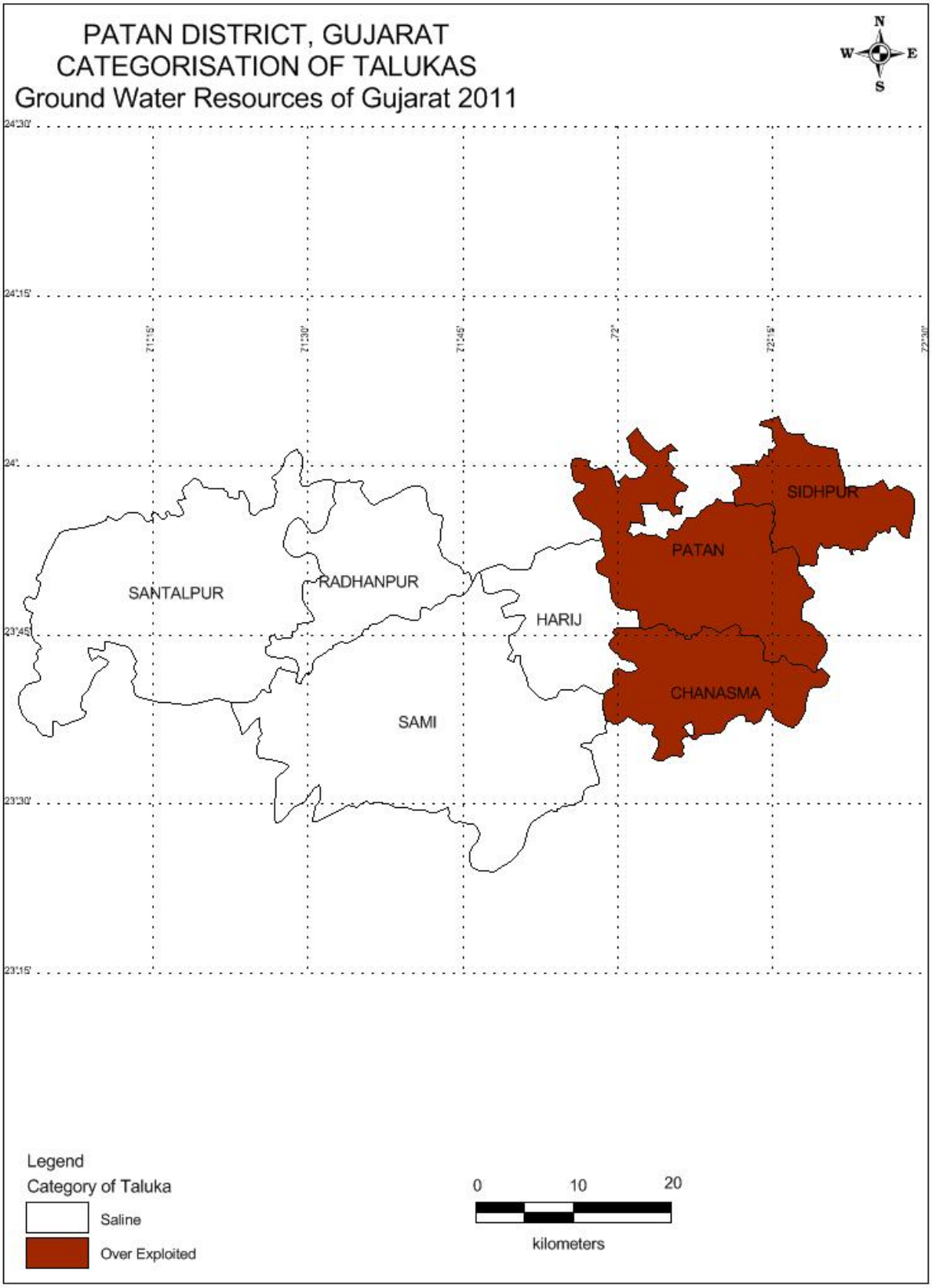

PATAN DISTRICT, GUJARAT
WATER LEVEL FLUCTUATION MAP
PRE - POST MONSOON 2012
N
W
E
S
SIDHPUR
PATAN
SANTALPUR
RADHANPUR
HARIJ
CHANASMA
SAMI
Legend
Water Level Fluctuation
Fall > 4m
Fall 2 - 4m
Fall 0 - 2m
Rise 0 - 2m
Rise 2 - 4m
Rise > 4m
0
10
20
kilometers

Figure-7


PATAN DISTRICT, GUJARAT
CATEGORISATION OF TALUKAS
Ground Water Resources of Gujarat 2011
N
W
E
S
24°30'
24°15'
24°
23°45'
23°30'
23°15'
71°15'
71°30'
71°45'
72°
72°15'
72°30'
SIDHPUR
PATAN
SANTALPUR
RADHANPUR
HARIJ
CHANASMA
SAMI
Legend
Category of Taluka
Saline
Over Exploited
0
10
20
kilometers