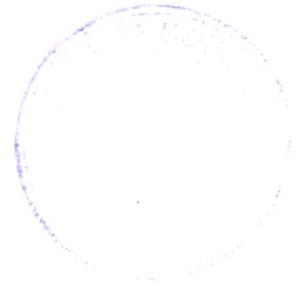
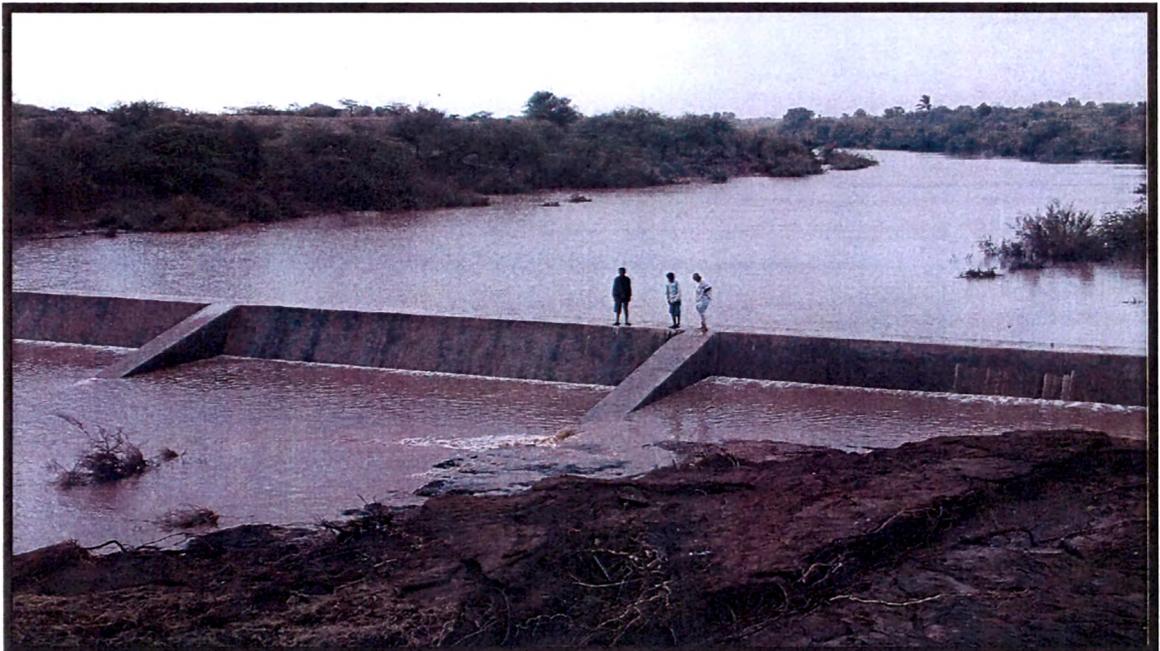


Chapter - 3



General Details of Rajkot District of Saurashtra Region - A Study Area



3 GENERAL DETAILS OF RAJKOT DISTRICT OF SAURASHTRA REGION – THE STUDY AREA

3.1 SAURASHTRA REGION

3.1.1 Geography

Saurashtra is a western most peninsular region of the state. It is situated between $20^{\circ} 30' N$ to $23^{\circ} 45' N$ latitude and $68^{\circ} 45' E$ to $72^{\circ} 15' E$ longitude. The Saurashtra region has low hills, alternating with tiny basins. The rivers in this region are characterized by their short stream length, very few exceed 150 km. Most of the Saurashtra rivers originate from the central plateau and drain in a near perfect radial pattern.

The region was earlier divided in 6 districts and 70 talukas. But with reorganization in October 1997, now it has 7 districts by formation of Porbandar district from the erstwhile Junagadh district and 77 talukas covering 4702 inhabited villages. The total area is 58804 km^2 , having population of 11.92 million (2001). The main cities are Rajkot, Jamnagar, Bhavnagar, Junagadh, Amreli, Porbandar, Morbi, Surendranagar and Gondal (Fig. 3.1).

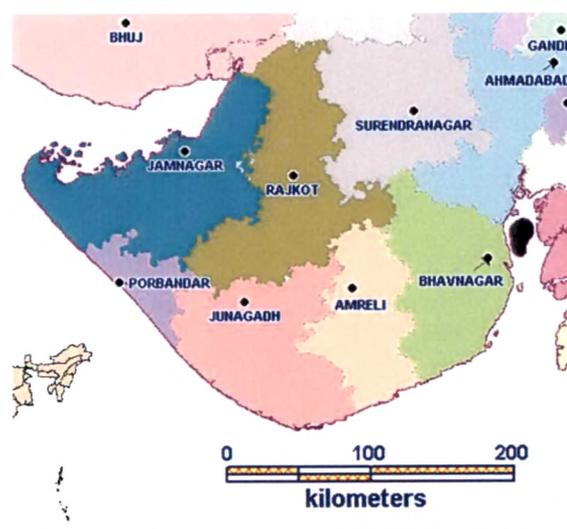


Figure 3.1 Districts of Saurashtra region

3.1.2 Physiography

Saurashtra region is bounded by Gujarat plains in the east and north-east, Gulf of Kachchh and little Rann in the north, and on the south-east by the Gulf of Khambhat. The Arabian Sea borders the entire southern sea coast. The central part of Saurashtra region is high and has isolated hills of Deccan traps forming Girnar, Chotila, Palitana, etc. The peninsula has rock formations comprising sand stone-shell & basalt formation with elevations varying from 150m to 5m, with slope radially merging into the coastal tracts.

3.1.3 Topography

The uplands of Saurashtra, comprises of sandstone- shale and basalt formations with elevations varying from 150 m to 500 m radially merging into the coastal tracts. Mount Girnar, an ancient volcano, is an isolated mountain (1117 m) in this region. The low lying saline coastal tracts, ranging in elevation from 3 m to 25 m, surround the Kachchh and the Saurashtra uplands and joining the low lying delta regions.

3.1.4 Drainage / Rivers

The central part of the region forms an elevated table land, from where most of the rivers start and flow radially. The terrain generally slopes gently towards the peninsular margin to merge in to the coastal plains and the great alluvial tract stretches to north-east and east. The sedimentary rocks along the coast form almost a low flat country.

The rivers in Saurashtra (Bhadar, Shetrunji, Sukhbhadar, Limbdi Bhogavo. Machhu, Hiren) originate from the central up lands and have developed radial drainage pattern (Fig 3.2). On account of several radially intruded basic dykes cutting through traps around Amreli and Jasdan, there are low and straight hill ranges, which are a characteristic feature.

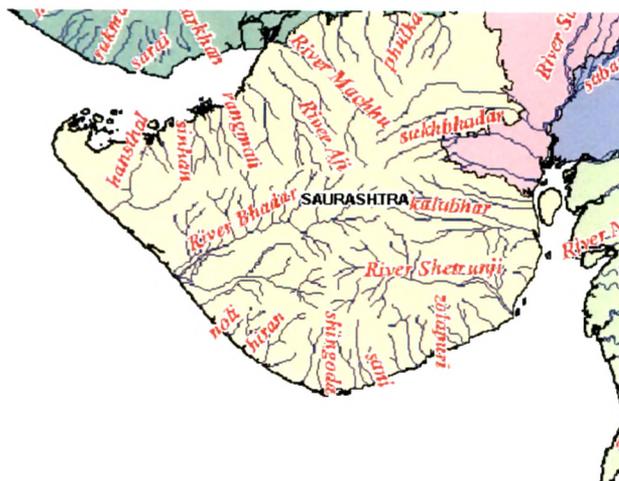


Figure 3.2 Rivers of Saurashtra region

3.1.5 Geology/ Lithology

The entire peninsular of Saurashtra (except coastal strips & parts of Surendranagar district) has underlying hard basalt rock of the Deccan trap formation. Most part of Surendranagar district has Jurassic sands stone, while the costal belts have lime stone.

3.1.5.1 Dhrangadhra and Wadhwan sandstone

Sand stone formations occupy on area of about 2500 km². in the northeastern part around Dhrangadhra, Morvi and Surendranagar.

(1) Deccan Traps

The basaltic rocks of the Deccan Trap igneous activity constitute the most dominant rock formation of the Saurashtra Peninsula covering almost the whole area except the coastal tracts and the north eastern part. The rock formations mainly consist of lava with the usual varieties viz. dark grey, compact, porphyritic, amygdaloidal etc.

(2) Dolerite Dykes

A number of dykes are encountered in the Deccan trap. Mostly these dykes consist of coarse dolerites with their general trending east-west, north-south and nw-sw and cutting across others.

3.1.5.2 Tertiary formation

The Tertiary succession in Saurashtra begins with Miocene period. These formations are exposed as small disconnected outcrops on the fringe of coastal alluvium round the southern limits of the trap area. The beds are horizontal.

(1) Gaj Beds

These beds are seen near Okha Mandal and south of Bhavnagar in the coastal region. These formations are represented by variegated clays, marls and impure limestones and are fossiliferous.

(2) Ghogha Beds

This formation occurs in the eastern part of the peninsula near Bhavnagar. It consists of thinly bedded grits, conglomerates and sandstones that occur near Ghogha and western tip of the Gulf of Cambay.

(3) Piram Beds

The Piram island near Bhavnagar is well known for its mammalian fossils of Pliocene age. The beds overlie the Gaj beds on the east coast also.

(4) Dwarka Beds

It occurs in the north-west corner of Saurashtra around Dwarka. It consists of gypsiferous clays, silts and sandy fossiliferous limestone.

3.1.5.3 Quaternary formation

Pleistocene formation is represented by oolitic arenaceous limestone containing the foraminifera shells (Milliolite). It occurs almost all along the coast except the north west corner and is also found in land area on Chotila hill, Junagadh etc.

3.1.5.4 Alluvial formation (Recent and sub-recent)

Alluvial formations includes soils, coastal sands, tidal flat, and beaches. Along the south coast of Saurashtra, there is very little alluvium. Its place has been taken up by a calcareous grit with marine shells.

Laterite, a highly porous and red coloured rock material, occurs along the Deccan Trap border in discontinuous linear belts of strips of which the largest is near Bhavnagar.

3.1.6 Geohydrology

In Saurashtra region, there are three major hydrogeological units, namely, hardrock, soft rock and semi consolidated rocks. The major fractures and shear zones in the rocks connect the pheratic and shallow confined aquifers to give rise to semi confined condition. In basaltic aquifers, the fracture porosity is insignificant in depth. There are major shear zones which penetrate deep enough to create condition similar to the confined aquifer. Dug wells, dug cum bore wells & shallow bore wells are feasible in Saurashtra particularly due to availability of sufficient weathered zones with fracture and joint rocks. These wells may tap to a maximum of 30m to 40m depth, below which the ground water circulation is negligible. The yields of wells vary from few cubic metres to about hundred cubic metres per day, for draw down of 3 m to 8 m. The quality of ground water is generally acceptable for irrigation purposes. However, in the coastal part TDS of 3000 to 5000 ppm is observed. In Surendranagar district and in some part of Rajkot district, 40 m thick fine to coarse green sand stone is inter banded with carbonized shale & carbonaceous shale and basaltic sills are observed. In this area, tube well tapping done to 100 m to 200m of aquifer gives a discharge of 14 to 80 m³/hour.

Milolite limestone is observed in southern & western Saurashtra coast and few inland valleys below 200 m elevation. These cavernous milolite limestones

are vary useful aquifers. Dug well tapings are capable of yielding 200 m³/day. Due to over exploitation and easy ingress of sea water, the coastal belt is now saline.

The Gaj beds continue below 300 m depth and deeper zones yield meager supplies of saline water. The quality of ground water in the upper Gaj limestone is much better, because of flushing effect of infiltrating rain waters.

The Dwarka beds are about 150 m thick with poor quality of ground water and chloride content of 500 ppm to 700 ppm. The alluvial aquifers prevail in the narrow southern and northern coastal plains and in somewhat wider areas in the eastern parts. The discharge of wells range from 60 m³/hr to more than 100 m³/hr. The water source of this aquifer is the direct rainfall recharge over its outcrops, and perhaps also a certain inflow from the neighboring Deccan – Trap volcanic aquifer in the north and east.

3.1.7 Climate

The climate in Saurashtra is characterized by three seasons i.e. Summer, Monsoon and Winter. A large part of Saurashtra lies between 22.38°C. to 38.64°C. Summer isotherm. The sea breeze which penetrates 30 to 40 km in land is influencing the summer temperature along the coast. The coastal part of the Saurashtra has warm winters with temperature range of 12.27°C to 35.61°C. Climatically south coastal Saurashtra has humid climate & north Saurashtra has arid climate.

3.1.8 Rainfall

The south coastal part of Saurashtra has humid zone, whereas north Saurashtra has arid zone. The monsoon period is generally between June to October. Some time few occasional showers are experienced in the first

fortnight of October, which is the transitional period. The average rainy days are 27. The break up of rainy days v/s rainfall in Saurashtra are as under (Table 3.1 & Table 3.2).

Table 3.1 Rainy days v/s rainfall in Saurashtra

	Days	Rainfall (mm)
January to April	0.1	1
May	0.4	3
June	4.4	98
July	9.0	196
August	6.3	153
September	5.0	105
October	1.0	10
November	0.5	2
December	0.1	1
Total	27	568

(Source : Director of economics and statistics, GOG)

Table 3.2 District wise average rainfall (mm)

District	Average Rainfall In mm (1996-2005)
Rajkot	637
Amreli	563
Bhavnagar	605
Jamnagar	665
Junagadh	813
Porbandar	592
Surendranagar	539

(Source : Director of economics and statistics, GOG)

Historical rainfall data analyses point to the fact that 70% to 75% of annual precipitation is received in 4 to 5 distinct spells i.e. cluster of rainy days. Even in bad years, by and large 250 mm to 300 mm rainfall is received within the first couple of spells and in later spell rain fails. The average intensity of rainfall on rainy days is high, consequently, the runoff is more and percolation of water is less.

3.1.9 Soils

Saurashtra region is generally covered black soils. Some areas have shallow black soils and the remaining areas have medium black soils. The coastal line having saline and alkaline soils, which are formed due to sea water intrusion. The black soils have also cretaceous sedimentary parent rocks. Small portion of Saurashtra has laterite soils with laterite and boxite capping.

3.1.10 Surface water potential

The catchment areas of Saurashtra region drain radially from the centre of the region, which serves as a water divide line towards the north, east and south. There are about 71 small and medium river basins, two of which, Shetrunji and Bhadhar, may be defined as major.

These 71 river basins have been classified by them into six basin groups and the potential has been computed as given in Table 3.3. The saline area is not considered in surface water potential calculation.

Table 3.3 Surface water potential of Saurashtra

Basin Group Name	Area Km ² (%)	Av. Rain fall (mm)	Runoff potential at different rainfall dependability			
			75%	60%	50%	Average
			Mm ³	Mm ³	Mm ³	Mm ³
1.Shetruji	5571 (11)	610	219	377	539	705
2.Bhadar	7076 (15)	775	272	474	687	770
3.Southern Saurashtra	10234 (21)	540	380	755	1038	1309
4.Northwest Saurashtra	7794 (16)	428	350	700	936	1119
5. N & NE Saurashtra	13259 (27)	499	571	885	1234	1444
6.East Saurashtra	5002 (10)	616	290	422	586	674
Saurashtra	48936	551	2082	3613	5020	6021

All the major, medium and minor irrigation schemes in Saurashtra are designed at 50% dependability. Untill now in Saurashtra, a total 2378 Mm³ surface water storage has been stored by constructing 129 dams. The details of dam storage are given district wise in Table 3.4.

Table 3.4 Storage of dams in Saurashtra

District	Name of project	Live storage (Mm ³)	District	Name of project	Live storage (Mm ³)
Amreli	Dhatarwadi	22.99	Jamnagar	Aji - IV	37.49
Amreli	Dhatarwadi-Ii	7.44	Jamnagar	Dai - Minsar	8.75
Amreli	Khodiar	29.94	Jamnagar	Demi - Iii	8.47
Amreli	Munjiasar	13.63	Jamnagar	Fulzar KB	16.28
Amreli	Raidy	6.38	Jamnagar	Fulzar - I	11.22
Amreli	Sankroli	7.86	Jamnagar	Fulzar - II	3.23
Amreli	Shell-Dedumal	7.34	Jamnagar	Gadhaki	9.14
Amreli	Surajwadi	6.37	Jamnagar	Ghee	12.26
Amreli	Thebi	9.98	Jamnagar	Kabarka	4.06
Amreli	Vadi	10.20	Jamnagar	Kankawati	6.39
Amreli	Vadia	5.09	Jamnagar	Phophal - II	5.89
Junagadh	Ambajal	9.60	Jamnagar	Puna	8.81
Junagadh	Bantva - Kharo	5.76	Jamnagar	Rangmati	3.58
Junagadh	Draphad	9.29	Jamnagar	Ruparel	3.42
Junagadh	Hasanpur	8.21	Jamnagar	Rupavati	2.62
Junagadh	Hiran - I	19.64	Jamnagar	Sani	47.48
Junagadh	Hiran - Ii	35.02	Jamnagar	Sapada	5.27
Junagadh	Jhanjeshri	9.79	Jamnagar	Sasoi	39.50
Junagadh	Machhundri	26.70	Jamnagar	Shedhabhadthari	4.99
Junagadh	Madhuvanti	11.30	Jamnagar	Sindhani	7.96
Junagadh	Mota-Gujariya	7.47	Jamnagar	Sonamati	7.09
Junagadh	Ozat - Ii	27.71	Jamnagar	Umiyasagar	1.14
Junagadh	Ozat - Weir	1.88	Jamnagar	Und - I	64.85
Junagadh	Ozat-Weir	1.54	Jamnagar	Und - II	32.87
Junagadh	Prempura	1.27	Jamnagar	Und - III	3.89
Junagadh	Raval	24.00	Jamnagar	Vartu	11.54

District	Name of project	Live storage (Mm ³)	District	Name of project	Live storage (Mm ³)
Junagadh	Shingoda	36.06	Jamnagar	Vartu - II	24.03
Junagadh	Uben	15.60	Jamnagar	Veradi	6.30
Junagadh	Vrajmi	10.05	Jamnagar	Vijarkhi	10.00
Porbandar	Advana	2.21	Jamnagar	Wodisang	5.58
Porbandar	Amipur	28.85	Surendranagar	Brahmani	56.29
Porbandar	Kalindri	6.50	Surendranagar	Dholidhaja	18.69
Porbandar	Khambhala	15.33	Surendranagar	Falku	12.69
Porbandar	Phodarness	22.26	Surendranagar	Limbdi Bhogavo	21.97
Porbandar	Sorthi	7.01	Surendranagar	Limbdi Bhogavo - II	13.00
Rajkot	Aji - I	28.66	Surendranagar	Morshal	3.05
Rajkot	Aji - Ii	20.75	Surendranagar	Nayka	15.15
Rajkot	Aji - Iii	57.20	Surendranagar	Nimbhani	5.77
Rajkot	Bangawadi	7.58	Surendranagar	Saburi	3.91
Rajkot	Bhadar - Ii	41.85	Surendranagar	Sukhbhadar	37.57
Rajkot	Chhaparwadi	16.76	Surendranagar	Tariveni	2.95
Rajkot	Demi - I	22.10	Surendranagar	Vansal	3.34
Rajkot	Demi - Ii	19.96	Rajkot	Khodapipar	2.36
Rajkot	Dhari	2.52	Rajkot	Lalpari	5.11
Rajkot	Dondi	2.41	Rajkot	Machhu - I	68.95
Rajkot	Ghelo - S	5.89	Rajkot	Machhu - II	90.79
Rajkot	Ghodadharoi	6.24	Rajkot	Malgadh	2.53
Rajkot	Gondali	9.96	Rajkot	Moj	36.69
Rajkot	Ishwariya	4.85	Rajkot	Motisar	2.35
Rajkot	Kabirsarovar	7.08	Rajkot	Nyari - I	25.02
Rajkot	Karmal	12.70	Rajkot	Nyari - II	11.52
Rajkot	Karnuki	8.31	Rajkot	Phadangbeti	5.37
Rajkot	Vachhapari	5.58	Rajkot	Phophal	48.82
Rajkot	Venu - Ii	18.80	Rajkot	Sodvadar	4.58
Rajkot	Veri	4.58	Rajkot	Survo	13.66

From the Table 3.4 it can be observed that only 2378 Mm³ storage has been created against the water availability of 5000 Mm³. Hence every year approximately 2622 Mm³ surface water remains unutilized, passing to sea.

3.1.11 Ground water resources

The average rainfall in Saurashtra is 568 mm. The rechargeable geographical area is 48000 km². The average volume of rain water is about 27264 Mm³. Actually the ground water recharge volume is 9500 Mm³ from 35% of rainfall. However, due to steep gradient of river, and rainfall mostly of high intensity and short duration, the ground water recharge obtained till now is 5500 Mm³ (58%).

Overall Saurashtra region is rocky. The main geology in the region is Deccan trap, which is highly fractured and weathered in top 30 to 40 m. After that depth the basalt is tight and there is no scope to store ground water except in some parts of Surendranagar and Rajkot. The coastal areas have limestone and sandstone in which the ground water is possible to be stored. As the surface water is scarce in the region, the farmers have constructed wells, dug-wells and tube wells. The gross irrigation in Saurashtra is 859700 ha, while the remaining area is rainfed.

3.1.12 Agriculture

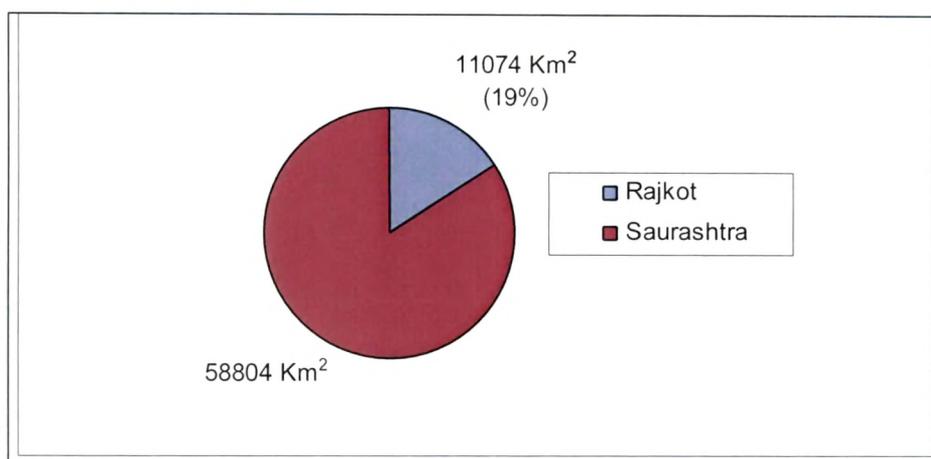
The net sown areas in various districts of Saurashtra are given in Table 3.5.

Table 3.5 Net area sown in various districts of Saurashtra

Sr. No.	Name of district	Net area sown	
		('00 ha)	%
1	Rajkot	7441	19.69
2	Jamnagar	6033	15.96
3	Junagadh	5281	13.97
4	Bhavnagar	5564	14.72
5	Amreli	5425	14.35
6	Surendranagar	6886	18.22
7	Porbandar	1153	3.05
	Total	37783	100

(Source : Director of Economics & Statistics)

The maximum area sown is in of Rajkot district (Table 3.5). The total net in Saurashtra sown area is 37783 km² which is 39.84% of Gujarat State (94814 km²). Rajkot district occupying about 19% geographical area, has about 20% of net sown area of Saurashtra (Table 3.5, Graph 3.1).



Graph 3.1 Geographical area of Rajkot v/s Saurashtra

The coverage of crop sown areas under irrigation from various sources in the districts of Saurashtra is presented in Table 3.6. Ground water in the major sources of irrigation in the whole Saurashtra. After Narmada Project, Surendranagar has largest surface water irrigation area.

Table 3.6 Area coverage under irrigation from surface and ground water sources

District	Gross area sown lakh ha	Irrigation in lakh ha		Narmada Project lakh ha
		Surface water	Ground water	
Rajkot	7.39	0.508	1.446	0.390
Jamnagar	6.13	0.027	0.802	---
Junagadh/ Porbandar	5.78	0.139	1.330	---
Bhavnagar	6.28	0.364	0.414	0.480
Amreli	4.93	0.101	0.985	---
Surendranagar	10.49	0.086	1.061	3.040
Total	41.00	1.225	6.038	3.04

(Source :Report of Sanshodhan Vaignanik, Junagadh Krushi University, Junagadh)

3.1.13 Water quality in Saurashtra districts

As ground water is excessively used, deterioration in ground water quality is evident in the region (Table 3.7). A total of 673 villages i.e.14.3% of the total Saurashtra villages encounter water quality problems of multiple types.

Table 3.7 Water qualities in villages of Saurashtra districts (nos)

District	Excessive fluoride	Excessive salinity	Excessive nitrate	Total no of villages
Rajkot	15	50	2	47
Bhavnagar	75	25	115	215
Amreli	70	8	65	143
Surendranagar	41	26	1	68
Jamnagar	11	47	23	81
Junagadh/ Porbandar	48	49	2	99
Total	260	205	208	673

(Source: GWSSB)

3.1.14 Salinity ingress

The Saurashtra region of Gujarat State is bounded by sea on three sides. The coast line is 765 km long. Ground water has been the main source of irrigation in this area. There are not adequate surface water sources except few tanks and minor irrigation dams. However, with advances in agricultural techniques people switched over to lifting water with pumping sets. Due to fall in ground water level, the wells were deepened in order to increase or continue the same pumping hours. The lowering of water table has resulted in saline water intrusion due to the reversal of hydraulic gradient. The tides water which travels upstream along river channels has not only contaminated surface water but has also affected the quality of ground water due to percolation. The effect of salinity in groundwater is conspicuous on the vegetation in this affected area. The persistent ingress of salinity in the coastal belt has created problems for supply of drinking water to many of the villages situated in this area.

Due to sea water intrusion, crop produces quality and crop yields have declined 1/10th to 2/3rd of original yields. This has caused health hazards in addition to reduction in cultivated areas. The causes of ground water salinity were identified as inherent salinity, lateral seawater intrusion, tidal ingress through creeks, spray of seawater and salt particles carried by inland winds. The measures for prevention, reclamation & management for providing an effective solution to the problem included changing cropping pattern, recharge through check dams and tanks, and salinity control techniques (tidal regulators).

3.1.15 Domestic water supply

The problem of domestic water supply is severe in Saurashtra region. In addition to salinity, problems of high fluoride and nitrate are also increasing. Increasing amount of fluoride in ground water has rendered water unfit for potable use in large number of villages/ towns in Amreli and Bhavnagar districts. In other districts also, the number of fluoride affected villages are increasing. In Saurashtra region domestic water demand for the year 2020 is projected as 1600 MLD. Most of the Major, Medium and Minor dams, which were earlier planned for irrigation only, have to cater to the domestic water supply due to now because of ground water quality problems. Even after shifting to the surface water sources, due to less rainfall in several years and also due to demand of farmers to have their Kharif crops for long term all villages and cities are now planned to be connected by Narmada base water supply schemes. About 40% works of domestic water supply through Narmada are already implemented and the remaining works will be completed by 2010-2011.

3.1.16 Occurrence of drought

Gujarat State is one of the most water scarce and acute drought-prone regions in India. It is on the verge of water crisis, which was manifested in

1999, and also apparent in 2000. Droughts, which, on an average occur in the State, once every five years or so, have an adverse impact on people and overall development of the State.

As per Irrigation Commission (1972) criteria Amreli, Bhavnagar, Jamnagar, Rajkot and Surendranagar are identified as drought prone districts. For Saurashtra region, drought intensity categorization on the basis of rainfall range has been done as follows:

<u>Rainfall range</u>	<u>Drought intensity</u>
< 373 mm	Disastrous
374 mm to 573 mm	Severe
574 mm to 673 mm	Moderate
> 674 mm	No drought

It is estimated that during the drought of 2000, 25 million people in 9500 villages, 4 metros and 79 towns in the state were affected by drinking water scarcity, and agricultural product of worth Rs. 4000 crores (40 billion) were lost. Because of the problems are manifested in the form of depletion and pollution of ground water aquifers, pollution of water bodies, water logging and salinity in canal commands, salinity ingress in coastal areas, growing competition for water giving rise to conflicts over water, and acute suffering of rural poor, especially women and children.

3.1.17 Check dams : Rain water harvesting & ground water recharge structures

Geology of Saurashtra in the top 30 to 40 m depth is highly weathered and fractured. Such of cracks, sheer zones, dykes, open joints, etc. which are best suited for ground water recharge.

Total Saurashtra region is hilly and ground slopes gentle to slopes varies from steep gradient. River, riverate and drains more or less in a very steep in slope. The rain fall duration is of about 27 days. Most of the rainfall is received in three to four spells in high intensity and short durations. As the gradient is steep, the rainwater runoff is more and the ground water recharge due to rainfall is comparatively less. Hence, the retention structure for storing rainfall runoff is essential. Uptill now, 2 major and 127 medium and minor dams are constructed which store 2378 Mm³ water against available runoff of 5000 Mm³ (50% dependability). Most of the dams in Saurashtra are shallow. The evaporation losses in these dams are approximately 500 Mm³ (20 to 25% of gross storage) (10 ft / year). Due to steep gradient, siltations in dams are also very high.

The rainfall in Saurashtra is confined to a limited period of the year during which its distribution is highly unpredictable and inadequate for crops. As a result, Kharif crops are subjected to sub-optimal moisture availability, and year to year variation in productivity of different crops is very high (45 to 50%).

In the aforesaid circumstances, it is essential to store the runoff by various means such as multiple rainwater harvesting structure like percolation tanks, check dams, village ponds, watershed structures, etc. Initially some progressive farmers and NGOs constructed check dams, percolation tanks and watershed structures. In course of time, various Government departments have also started to constructing the check dams.

However, a big momentum was started after 1999 and 2000 scarcity. A new concept of people participation has taken shape after Jalyatra throughout Saurashtra villages, and big religious and political leaders headed a meeting at Surat in 2000 in which more than 5.0 lakh businessmen, industrialists, diamond traders, progressive farmers and NGOs gathered. The political leaders, religious

leaders, bureaucrats, technocrats, farmer groups and NGOs etc. integrated in this new scheme and tremendous success in check dams was achieved. Sardar Patel Sahbhagi Jal Sanchay Yojana was started on 17.1.2000, in which beneficiary farmers groups can decide the design, location, type, height of check dams and construct the structures by themselves. The cost sharing is by Government to the extent of 60% and by farmers group to extend of 40% in the form of labour, material and money. As the scheme is very flexible and these is a cooperation by Government machinery, a huge number of check dams were constructed. The Earth Summit at Johnnesburg, India Today and Center for Science and Environment, Planning Commission, etc. has taken appreciating note of the People Participation Movement in check Dam construction. In 2001-02, the World reputed IIM (Ahmedabad) carried out special studies on check Dams. IIM(A) stated in their elaborated report as under:

(1) Groundwater recharge

The field survey indicated that the average number of times the check dams have overflowed during the reference year was 0.92. Given that a total of 10257 check dams were constructed during the reference period having an average storage capacity of 0.015 Mm^3 and which had overflowed on an average 0.92 times, the study estimated that the 60:40 scheme was able to recharge 138.47 Mm^3 of runoff water during a drought year. In a normal rainfall year with 2 overflows assumed, the generated water storage capacity could be 307.71 Mm^3 .

(2) Wells benefited

According to analysis based on official data of 8939 check dams, total 62225 wells were benefited from the check dams constructed in the five reference districts. Though the number of dug wells to be benefited from a check dam ranged from a minimum of one well to a maximum of 45

wells, the average number of wells benefited from the constructed check dams was seven.

(3) Distance from check dams

Distance of a dug well from the check dam can make a difference in terms of quantity of water recharged and the time needed to recharge a well. The distance of wells from respective check dams was included in the questionnaire and was recorded in feet. The average distance was 621 feet for the sample as a whole.

(4) Cost benefit

Taking the figure of 200 bighas (65 ha) per check dam as the standard for calculating the benefits, the net gain for an average check dam came to Rs. 80800 per year (200 bighas per check dam x Rs. 404 net gain per bigha during the drought year). Based on the calculation of actual cost of 9044 check dams of the reference districts, the average cost per check dam was Rs. 1,58,000. This means that even with the adverse climatic conditions, it was possible to recover the investment on a check dam in a very short period of 2 to 3 years, if we take only the crop related benefits. This was an impressive feature of the scheme. The investment becomes more attractive if one recognizes that the Government had in fact to invest only 60% of the average figure of Rs. 1,58,000 under the 60:40 scheme. A more comprehensive cost-benefit analysis indicated that within a period of three years, an initial investment of Rs. 1,58,000 on an average check dam fetched total benefits worth Rs. 2,51,582. In Saurashtra a total of 24509 nos of check dams are constructed.

3.2 RAJKOT DISTRICT

3.2.1 General details

The district is named after the industrial town of Rajkot, which is also the capital of the district. Rajkot district comprises of 14 talukas (Fig 3.3). The district is in the centre of Saurashtra peninsula and is bounded in north by the Gulf of Kachchh and little Rann of Kachchh; in north-east by Surendranagar district; in the east by Bhavnagar district; in south-east by Amreli district; in south and south-west by Junagadh district and in west by Jamnagar district. General features are tabulated in Table 3.8 and Table 3.9.

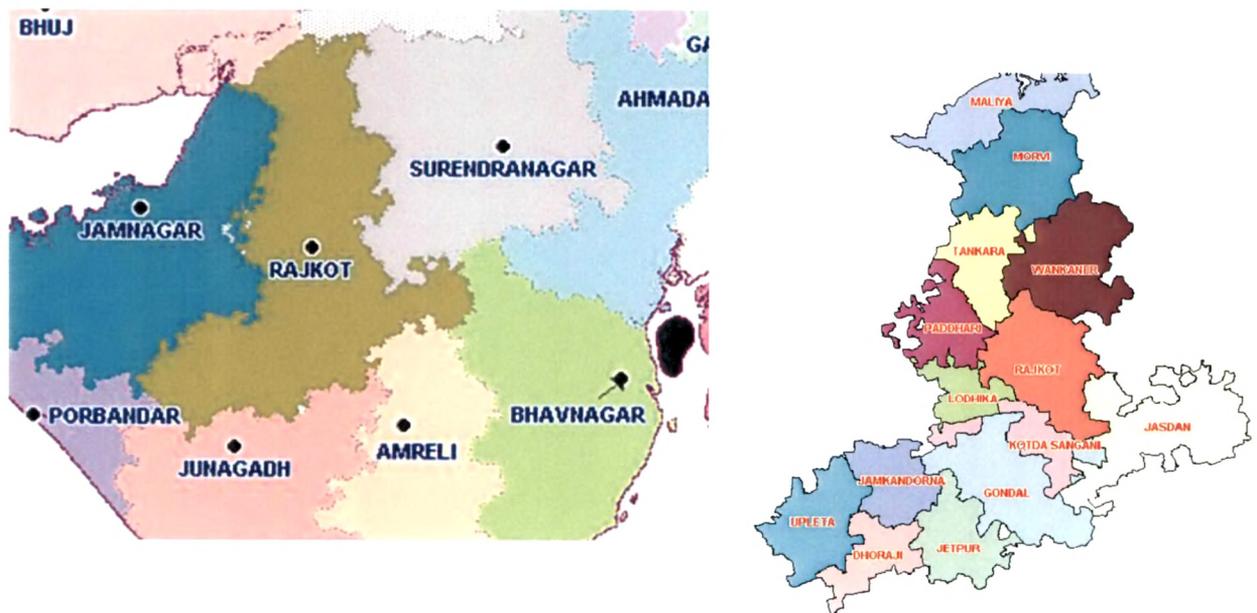


Figure 3.3 Rajkot district with talukas

Table 3.8 General features of Rajkot district

Sr. No.	Description	Saurashtra	Rajkot	
1	Geographical area	58804 km ²	11074 km ²	18.83%
2	Taluka	77	14	18.18%
3	Villages	4600	857	18.63%
4	Agriculture land	3778300 ha	744100 ha	19.69%
5	Population	11.92 Million	3.16 Million	26.50%
6	Number of rivers	71	14	20%
7	Number of dams	129	34	26.35%
8	Storage of dam	2378 Mm ³	809 Mm ³	34%
9	Number of check dams	24574	4754	19.34%
10	Surface water irrigation	1,22,500 ha	50,800 ha	41%
11	Ground water irrigation	6,03,800 ha	1,44,600 ha	24%
12	Ground water quality affected villages (fluoride, nitrite, sodium)	673 Nos	67 Nos.	10%

(Source : Director of Economics & Statistics)

Table 3.9 Details of talukas and villages in Rajkot district

Taluka	Area km ²	No. of villages	Population
Rajkot	914.30	85	1137984
Kotdasangani	447.02	41	79847
Gondal	1116.23	80	265954
Jetpur	595.31	46	227767
Dhoraji	415.06	30	149006
Upleta	742.16	50	170275
Jam Kandorna	560.29	46	75729
Lodhika	373.23	38	46276
Padadhari	629.45	61	73092
Morabi	1608.76	117	326995
Maliya	769.98	47	83471
Wankaner / Tankara	1101.54	100	186013
Jasdan	1263.60	100	262955
TOTAL	11043.00	857	3169881

(Source : Director of Economics & Statistics)

3.2.2 Physiography

The district has three distinct geomorphic zones (a) Eastern hilly area almost bordering Jetpur, Rajkot and Wankaner cities, (b) Alluvial plain of the Bhadar river in west and south-west and (c) Northern, old coastal plain, swampy coast and Little Rann of Kutch. In the eastern hilly area, there are irregular chains of barren hills and narrow ridges. Of these, Mandar and Thanga are the prominent hill ranges. This forms the watershed for almost all the rivers of Saurashtra peninsula. The western plain is drained by the river Bhadar and its tributaries and it forms the most important agricultural region of the district. The north-eastern plain is undulating and covered by alluvium towards the Rann. This merges into the new coastal plain where the coast line runs for about 35 km from Lakhiara to Savania. There is a long mud covered tidal flat with mangrove growth.

The Rann stretches for about 20 km from Vavania to Venasar. This is a low lying flat area covered by mud and sand, which, in rainy season, becomes a shallow lake. The district is drained by three major rivers- the Bhadar, the Machhu and the Aji. Bhadar is the largest river. The rivers of Rajkot district are presented in Table 3.10 and Fig. 3.4.

Table 3.10 Rivers in Rajkot district

Sr. No.	Name of river
1	Bhadar
2	Gondali
3	Machchhu
4	Aji
5	Nyari
6	Und

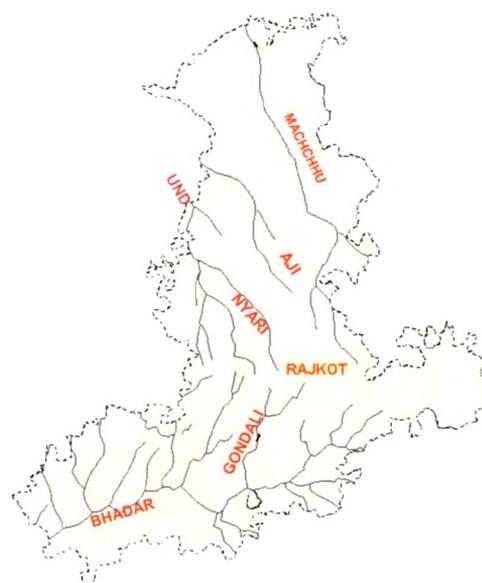


Figure 3.4 Rivers of Rajkot district**3.2.3 Geology and geohydrology**

Rajkot district lies between 70° 20' 05" to 71° 40' 53"E longitude and 20° 58' 06" to 23° 18' 15" N latitude. The east part of the district i.e Jetpur, Rajkot, Jasdan and Vakanare are hilly whereas the western part i.e. Gondal, Jamkandorna and Upleta are Bhadar is plain area. The northern part i.e. Vakaner to Morbi has undulating topography.

About 85% area of Rajkot district has deccan trap (basalt). The northern part is alluvial (saline); the east and south-east of Morbi taluka and Vakaner taluka as well as east and north-east have sandstone. The Talukawise geology and geohydrology are presented in Table 3.11. The geological map of Rajkot district is shown in Fig. 3.5.

Table 3.11 Details of geology and geohydrology of Rajkot district

Sr. No.	Taluka	Geology	Geohydrology
1	Maliya	Alluvial	Tubewell – 90 to 170 m TDS - 1500 to 5000 ppm Fluoride – 1.00 to 2.50 ppm Groundwater not potable in most of villages, all 47 villages get domestic water supply by Narmada and Morbi regional water supply.
2	Morbi / Tankara	Mainly basalt South-West – Sandstone below basalt North- Alluvial (saline)	Tubewell - 90 to 200 m TDS - 700 to 2500 ppm Fluoride - 0.5 to 2.0 ppm Southwest is good for groundwater, 60 villages receive regional water supply (Morbi, Machchu river, Lilapar, Hadmati, Khanpur)
3	Vakaner	Northeast & Northwest- Sandstone (10m to 300 m) along with Basalt and Sandstone	Tubewell - 90 to 400 m TDS - 500 to 3000 ppm Fluoride - 0.5 to 2.0 ppm Northwest – sandstone – Potable

Sr. No.	Taluka	Geology	Geohydrology
			water Southeast – sandstone – not potable water 20 villages have water supply from Hasanpur, Kherva-Kakhra regional water supply.
4	Tankara	Basalt Basalt-Sandstone	Tubewell - 30 to 600 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 2.0 ppm Groundwater not potable in most of the villages. 21 villages have regional water supply
5	Paddhari	Basalt Basalt with dykes	Tubewell - 30 to 60 m TDS - 1000 to 3000 ppm Fluoride - 0.5 to 2.5 ppm 8 villages have regional water supply from Aji, Nyari and Dondi rivers.
6	Rajkot	Basalt Basalt – Sand stone (Northeast and Southeast 200 m to 600 m Sandstone) Dykes networks	Tubewell - 60 to 90 m TDS - 1000 to 1500 ppm Fluoride - 1.0 to 1.5 ppm Basalt Sandstone Tubewell - 250 to 600 m TDS - 1000 to 2500 ppm Fluoride - 1.0 to 1.5 ppm 42 villages have Regional water supply schemes
7	Lodhika	Basalt Polerite Dykes	Tubewell - 30 to 60 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 1.5 ppm Nyari and Dondi rivers All villages have Narmada regional water supply.
8	Kotda sangani	Basalt	Tubewell - 60 to 90 m TDS - 1000 to 1500 ppm Fluoride - 1.0 to 1.5 ppm Gondli river
9	Gondal	Basalt Dykes network	Tubewell - 60 to 90 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 1.5 ppm Gondali, Chhaparwadi and Bhadar

Sr. No.	Taluka	Geology	Geohydrology
			rivers 23 villages regional water supply schemes.
10	Jasdan	Basalt dykes North- Basalt Sandstone Northwest and West Basalt-Sandstone (400 m below)	Tubewell - 60 to 90 m TDS - 1000 to 1500 ppm Fluoride - 0.5 to 2.5 ppm Bhadar and Machchu rivers All villages get water supply by Morbi base regional water supply schemes. Some areas have Nitrate problems
11	Jamkand orna	Basalt dyke with black cotton soil cover	Tubewell - 30 to 60 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 2.0 ppm 44 villages receive water by regional water supply schemes.
12	Dhoraji	Basalt	Tubewell - 30 to 60 m 300 to 400 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 2.0 ppm Bhadar river
13	Jetpur	Basalt	Tubewell - 30 to 60 m TDS - 1000 to 2000 ppm Fluoride - 0.5 to 1.5 ppm Bhadar, Ghlalo, Chhapparwadi rivers Dyeing industries cause ground water problems 27 villages have Morbi regional water supply schemes.
14	Upleta	Basalt West-Southwest Baslt- Limestone Phelsite in Dhanu	Tubewell - 30 to 60 m TDS - 1000 to 3000 ppm Fluoride - 0.5 to 3.0 ppm Venu, Moj and Bhadar rivers 12 villages have regional water supply schemes.

(Source: GWSSB & GWRDC)



Figure 3.5 Geological map of Rajkot district

The Dhrangadhra group of rocks are exposed in the northeastern parts of the district in Morvi, Wankaner and Malia talukas. The group is divided into three formations- Than (lower), Surajdeval (middle) and Ranipat (upper). The formation is represented by grey and carbonaceous shale with thin coal strings, which is very well exposed near Mahasar, Adopar, etc. The Surajdeval formation is composed of red friable shale and white felspathic sandstone. Ranipat formation is represented by ferruginous sandstone and conglomerate.

Deccan traps occupy almost whole of the northeastern part. The basaltic traps are 'Pahoehoe' type, where the acidic flows are trachytic, felsitic and occasionally having obsidian and pitchstone. Some of them carry geodes filled with zeolites, chalcedony, agate and calcite. Between Wankaner and Bamanpara and at Labhavad, the inter-trappen argillaceous and cherty limestone having fish fossils were deposited during the breaks in Volcanic eruptions forming Deccan traps. Both Dhrangadhras and Deccan traps are intruded by numerous dolerite and basaltic dykes forming low knolls, elongated mounds or serrated ridges. Miliolite limestone forms small isolated patches resting on the Deccan trap. They are generally restricted to the valley portions. The youngest deposits are represented by sand dunes, consolidated beach deposits, fresh water alluvium and soil. Several sand dunes are noticed near Rann of Kachchh.

3.2.4 Climate

The area mainly comes under the type tropical steppe, semi arid, hot region. The climate of the district is characterized by hot summer and dryness in the non-rainy seasons. The rainfall is variable as presented in Table 3.12. River basins, surface water schemes and ground water resources of Rajkot district are presented in Table 3.13, Table 3.14 and Table 3.15, respectively.

Table 3.12 Rainfall variations

Rainfall (40 years)			Rainy days			Maximum rainfall	Minimum rainfall
Mean	Standard deviation	CV	Mean	Standard deviation	CV		
567 mm	294 mm	27%	27 day	8.7 day	32 %	1370 mm (1970)	166.8 mm (1985)

(Source: Agricultural University, Junagadh)

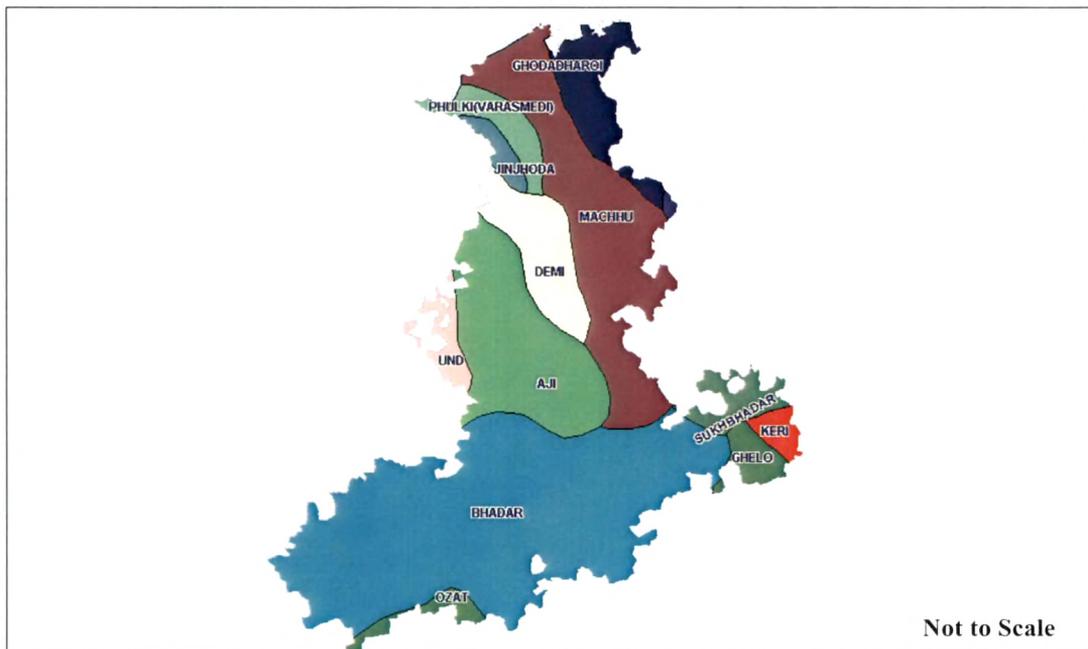


Figure 3.6 River Basins in Rajkot district

Table 3.13 Area of river basins in Rajkot district

Sr.No	Name of basin	Total area of basin km ²	Area of basin in Rajkot district km ²
1	Bhadar	7493	4759
2	Aji	282	1588
3	Machhu	2523	2039
4	Demi	928	705
5	Jhinjhoda	183	141
6	Phulki	353	326
7	Ghodadharoi	947	576
8	Sukhbhadar	2131	276
9	Ghelo	883	206
10	Keri	1142	144
11	Ozat	2634	160
12	Und	1647	195

(Source : Water resources planning for the state of Gujarat- Tahal Consulting Engineers Ltd. 1997)

Table 3.14 Surface water schemes in Rajkot district

Sr. No.	Name Of Scheme	C O D E	OSL (ft)	FRL (ft)	DLS (Mm ³)
1	2	3	4	5	6
1	Bhadar	Gated	320.03	354.02	187.91
2	Machhu - Ii	Gated	154.99	188.00	90.79
3	Machhu - I	Ungated	395.00	444.02	68.95
4	Aji - Iii	Gated	147.65	174.39	57.20
5	Phophal	Ungated	242.73	268.25	48.82
6	Bhadar - Ii	Gated	149.09	174.22	41.85
7	Moj	Gated	194.01	238.00	36.69
8	Aji - I	Ungated	455.01	484.01	28.66
9	Nyari - I	Ungated	317.76	339.58	25.02
10	Demi - I	FuseGate	175.01	198.01	22.10
11	Aji - Ii	Gated	211.95	242.01	20.75
12	Demi - Ii	Gated	137.80	157.49	19.96
13	Venu - Ii	Gated	160.77	180.46	18.80
14	Chhaparwadi	Gated	297.78	322.78	16.76
15	Survo	Gated	302.34	327.61	13.66
16	Karmal	Gated	541.37	554.49	12.70
17	Nyari - Ii	Gated	269.70	290.37	11.52

Sr. No.	Name Of Scheme	C O D E	OSL (ft)	FRL (ft)	DLS (Mm ³)
18	Gondali	Ungated	120.02	150.27	9.96
19	Karnuki	Gated	521.68	539.72	8.31
20	Bangawadi	FuseGate	119.17	139.93	7.58
21	Kabirsarovar	Ungated	92.00	107.09	7.08
22	Ghelo - S	Ungated	417.51	443.26	5.89
23	Phadangbeti	Ungated	609.18	620.93	5.37
24	Lalpari	Ungated	434.99	451.01	5.11
25	Ishwariya	Ungated	497.07	516.10	4.85
26	Sodvadar	Ungated	228.52	251.65	4.58
27	Veri	Gated	456.03	466.03	4.58
28	Malgadh	Ungated	504.19	522.89	2.53
29	Dhari	Ungated	146.00	161.00	2.52
30	Dondi	Gated	331.38	340.31	2.41
31	Khodapipar	Gated	173.47	181.34	2.36
32	Motisar	Gated	454.45	469.18	2.35
	Total				839 Mm ³

(Source: Flood Control Cell, Government of Gujarat)

Table 3.15 Ground water resources in Rajkot district (2002)

Gross storage	1200 Mm ³
Utilisable storage	960 Mm ³
Gross draft	725 Mm ³
Ground water balance	233 Mm ³
Category	Grey

(Source: GWRDC)

3.2.5 Agriculture

The economy is predominantly agriculture based in rural areas which are rainfed. The main crops cultivated in the basin are ground nut, cotton, sesamem, bajri, wheat, gram, mug, udid, cumin and juwar. The largest share is from non-edible crops covering 89.67% of the total area cultivated in the year 2000-01. Groundnut, sesamum, castor and cotton are the principal lying crops grown in the district. Cumin, onion and garlic are cash crops grown in the areas where irrigation facility is available. Productivity of most of the crops is fairly high especially of groundnut, cotton and caster but vary according to seasonal rainfall and availability of water for irrigation.

3.3 BHADAR RIVER BASIN

3.3.1 General

The drainage area of Bhadar(s) river basin is 7076 km². Bhadar river is one of the major rivers in Saurashtra and originates from hilly terrain of east of Jasdan taluka of Rajkot district and flowing almost in south-west direction and finally meets Arabian Sea near Navibandar, is about 32 km from Porbandar. The total length of Bhadar River is about 190 km. The river crosses in the middle of Saurashtra and travels through parts of Rajkot, Surendranagar, Amreli, Jamnagar, Junagadh, and Porbandar districts. The catchment of Bhadar(s) is located between longitude 69° 47'E to 71° 20 1/2'E and latitude 21° 27'N to 22° 11 1/2'N. The eastern and central parts of the basin are mainly hilly and undulating type. The undulating rocky area of Central Saurashtra extends upto Jetpur. The area down stream of Jetpur upto western coast is predominantly alluvial and known as Ghed area. The Ghed area is formed due to deposition of sediments brought by Bhadar and other rivers of the basin due to erosion. The central and eastern parts of the basin are composed of basaltic formation, while the western Ghed area is composed of sand and clay deposits which constitute alluvium. The taluka boundary in Bhadar basin is shown in Fig. 3.7. The geology of Bhadar basin presented in Fig. 3.8.

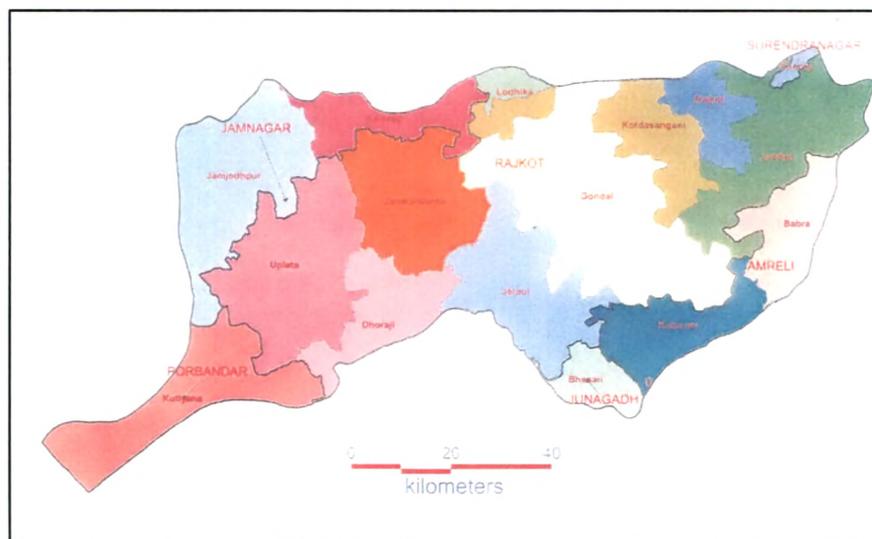


Figure 3.7 Bhadar basin talukas boundary

The basin is densely populated covering nearly 34% of the basin population in urban areas. Calcite, black trap and building stones are available as mineral resources in central & western parts of the basin. The basin has rapid growth in all sectors of economy and therefore, its water resources (both surface and ground water) are continuously under strain. The limited water resources are now posing conflicting problems of water such as drinking v/s agriculture or industrial water supply and therefore, they need very careful planning.

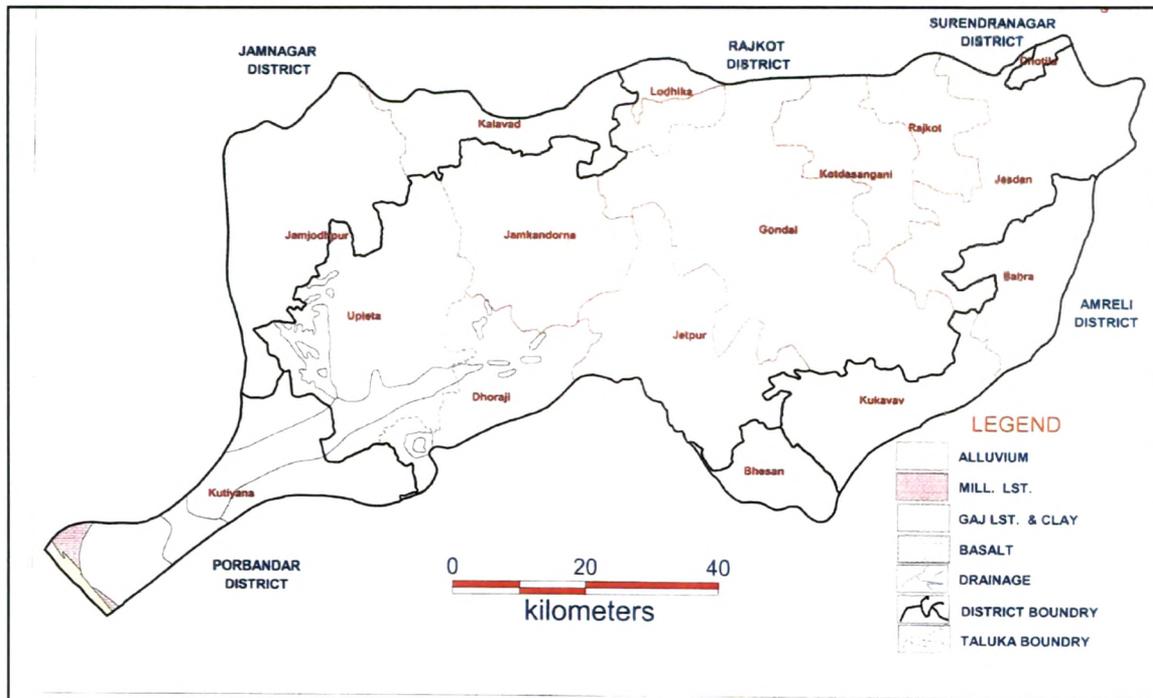


Figure 3.8 Bhadar basin geology

Bhadar basin is a unique one in Saurashtra region, although it is not areawise big enough. The basin is mainly divided in Bhadar-I, Bhadar-II and Lower Bhadar.

Major tributaries of river Bhadar are Karnuki, Karmal, Gondali, Survo, Galoliya, Chhapparwadi, Phophal, Utavali, Venu, Vasavadi and Moj. The details of these tributaries are presented in Table 3.16. The water resources related details of Bhadar(s) are given in Table 3.17.

Table 3.16 Details of tributaries of Bhadar basin

Sr. No.	Name of tributary	Distance from source to confluence with Bhadar river (km)	Side	Drainage area (km ²)	Length of tributary (km)	Project on the tributary
1	Karnuki	27	Left	81.0	16	Karnuki
2	Karmal	35	Right	206.88	33	Ishwaria Karmal
3	Gondali	67	Right	513.06	47	Veri Tank Gondali
4	Survo	79	Left	273.18	31	Vadia Khan Khijadia
5	Galoliya	82	Left	196.95	27	Reshamadi Galol and Khan Galol M.I. Schemes
6	Chhaparwadi	97	Right	454.72	44	Chhaparwadi-I Chhaparwad-II Motisar
7	Phophal	103	Right	589.60	48	Phophal-I Phophal-II
8	Utavali	120	Right	103.44	24	Savadi M.I. Scheme Sodavadar
9	Venu	137	Right	957.64	61	Venu-I Venu-II
10	Moj	129	Right	584.33	48	Moj
11	Vasavadi	53	Left	582.10	45	

(Source: Rajkot Irrigation Circle, Rajkot)

Table 3.17 Water resources related details of Bhadar (s)

Sr. No.	Details	Bhadar-I	Bhadar-II	Lower Bhadar	Total
1	Geographical area	2436 km ²	2054 km ²	2586 km ²	7076 km ²
2	Districts	Rajkot, Surendranagar, Amreli (Three)	Rajkot Amreli Junagadh Jamnagar (Four)	Rajkot Junagadh Jamnagar Porbandar (Four)	6 Nos
3	Talukas	Rajkot→ Gondal, Rajkot, Kotdasangani Jasdan Amreli→ Babra, Vadia Surendranagar→ Chotila (7 Nos)	Rajkot→ Jamkandona, Dhoraji, Jetpur, Gondal, Lodhika, Kotdasangani Amreli→ Vadia Junagadh→ Bhesan Jamnagar→ Kalavad (9 Nos)	Rajkot→Upleta, Jamkandona Dhoraji Jetpur Junagadh→ Manavadar Porbandar→ Porbandar Kutiyana Jamnagar→ Jamjodhpur Kalavad (9 Nos)	18 Nos
4	Projects	Bhadar-I – 199 Mm ³ Ishwariya– 4.84 Mm ³ Gundali – 997 Mm ³ Veri – 4.58 Mm ³ Vachcha Pari – 5.58 Mm ³ Karnuli – 2.49 Mm ³ <u>Karmal – 10.30 Mm³</u> (8 Nos) Total = 236.77 Mm ³	Chappar Wadi-I -3.94 Mm ³ Chhapar wadi-II-16.77 Mm ³ Sankroli-8.60 Mm ³ Phophal-I-49.12 Mm ³ Bhadar-II-77.44 Mm ³ Monsar -2.45 Mm ³ Phophal -II -5.88 Mm ³ <u>Survo -3.96 Mm³</u> (8 Nos) Total=168.188 Mm ³	Venu-II-18.80 Mm ³ Sodavadar-3.97 Mm ³ Fulzar-16.28 Mm ³ <u>Moj-38.92 Mm³</u> (4 Nos) Total =77.96 Mm ³	482 Mm ³

Sr. No.	Details	Bhadar-I	Bhadar-II	Lower Bhadar	Total
5	Average yield available	193 Mm ³	198 Mm ³	281 Mm ³	673 Mm ³
6	Yield at 50% reliability	177 Mm ³	178 Mm ³	245 Mm ³	593 Mm ³
7	Surface water (Utilised)	38 Mm ³	168 Mm ³	202 Mm ³	408 Mm ³
8	Utilisable ground water recharge (1991)	195 Mm ³	236 Mm ³	238 Mm ³	669 Mm ³
9	Gross draft	157 Mm ³	156 Mm ³	169 Mm ³	482 Mm ³
10	Net draft	110 Mm ³	93 Mm ³	115 Mm ³	318 Mm ³
11	Balance ground water	85 Mm ³	143 Mm ³	123 Mm ³	351 Mm ³
12	Surface water irrigation	9802 ha	14785 ha	14077 ha	38664 ha
13	Ground water irrigation	128711 ha	80087 ha	109287 ha	318085 ha
14	Total irrigation	138513 ha	94872 ha	123364 ha	356749 ha
15	Surface water duty	103 ha/ Mm ³	132 ha/ Mm ³	119 ha/Mm ³	
16	Ground water duty	246 ha/ Mm ³	245 ha/ Mm ³	245 ha Mm ³	
17	Population (1991)	5.06 lakh	4.38 lakh	4.42 lakh	13.86 lakh
18	Domestic water present requirement	14 Mm ³	11.67 Mm ³	11.60 Mm ³	37.27 Mm ³

Sr. No.	Details	Bhadar-I	Bhadar-II	Lower Bhadar	Total
19	Industrial water present requirement	2.5 Mm ³	3.00 Mm ³	5.16 Mm ³	10.65 Mm ³
20	Project water requirement (2021)	Irrigation -253 Mm ³ Domestic - 29 Mm ³ Industrial - 5.14 Mm ³ Total - 287.14 Mm ³	411 Mm ³ 24 Mm ³ 7.26 Mm ³ 442.26 Mm ³	431 Mm ³ 24 Mm ³ 11 Mm ³ 466 Mm ³	1095 Mm ³ 77 Mm ³ 23.4 Mm ³ 1195.4 Mm ³

(Source: Rajkot Irrigation Circle, Rajkot)

3.3.2 Geohydrology

The ground water conditions are controlled by geological formations. From ground water point of view, the shallow weathered and fractured zones are promising. The trap yields 300 to 400 LPM of water through dug wells for about 6 to 8 hours a day intermittently. The yield of the dug wells can be enhanced considerably by internal and/or vertical borings. The quality of ground water in trap is generally good and suitable for drinking and irrigation purposes. The interflow zones of weathering extending to the entire thickness of the basaltic formations also yield water under confined conditions. The dykes invariably act as sub-surface barriers and very often impound ground water. Even during summer and drought periods, such areas have shallow ground water levels and they support wells with good yields.

Geohydrologically, the area has been affected by salinity problem due to sea water ingress. The saline zone is up to about 3.5 km inland from the sea and the fresh water/saline water level is about RL (-) 15.00m. The salinity in terms of TDS distribution varies between 1000 and 8000 PPM. Good quality of ground water along the coast is mostly restricted to maillot limestone. In the inland areas of Ghed, alluvium is highly saline.

3.3.3 Agriculture

The agriculture is predominantly rainfed and its intensity varies among the districts of the basin. The paucity of irrigation makes multiple cropping impractical and enforces a single crop agricultural system. Besides, the farm crops such as wheat, juwar, bajri, cotton, groundnut, sesamum and fruits, some areas particularly near urban settlements are devoted to fodder crops and vegetables.

There are two crop seasons in the basin viz kharif and rabi. There is not much variation in cropping pattern within the basin. The basin produces mostly in Kharif.

3.4 CHECK DAMS IN RAJKOT DISTRICT

The number of check dams has progressively increased over years in the various talukas of the districts (Table 3.18).

Table 3.18 Taluka wise check dams in Rajkot district

Sr. No	Taluka	Year 1997	Year 2002	Year 2006
1	Upleta	19	120	307
2	Gondal	49	357	522
3	KotadaSangani	28	166	222
4	Tankara	0	248	275
5	Morbi	39	191	231
6	Lodhika	35	185	219
7	Dhoraji	14	125	165
8	Maliya	0	50	77
9	Jetpur	23	287	361
10	Rajkot	47	532	634
11	Jasdan	39	414	450
12	Paddhari	38	280	399
13	Wankaner	29	417	630
14	JamKandona	24	138	178
	Total	384	3510	4670

The benefits of check dams are as under:

- Assured Kharif irrigation having possibility of Rabi irrigation.
- Harvesting and conservation of surplus monsoon runoff in ground water reservoir,
- Rise in water levels in wells and tube-wells due to additional recharge of ground water and reduction in consumption of energy in over exploited areas.
- Sustainability to existing ground water structures.
- Changes in cropping pattern due to availability of additional water for irrigation.
- Increase in soil moisture and increase in green vegetation.
- Indirect benefits like decrease in soil erosion and improvement in the socio-economic condition of farmers.
- Green belt and supporting flora and fauna are benefited and migration of birds and animals from the surrounding is stopped,
- Drinking water is the responsibility of women in villages for which they have to take unbelievable strain. Check dams could relieve them to a considerable extent.
- Check dams are of utmost importance for sustainable use of water resources.
- In catchments, water is checked and hence soil erosion is controlled, moreover, the flow of water entering the river is controlled and hence, the check dams control the flood also.
- No land acquisition is required unlike medium or major dams.