

## A Note on the Salinity Conditions in Coastal Saurashtra, Gujarat Coastal Salinity Prevention Cell (CSPC)

Salinity intrusion is a major problem in this coastal reach; as per one estimate, the sea water intrusion is advancing on an average of about 0.6 Km. per year (Parthasarthy *et al.*, 2003). Technological interventions like artificial recharging, construction of spreading channels and tidal regulators, etc., are introduced by government and non government organizations working in the area to arrest the sea water ingress. However, they lack systematic and holistic approach and no proper managerial interventions are made hitherto to alleviate the water scarcity in coastal belt

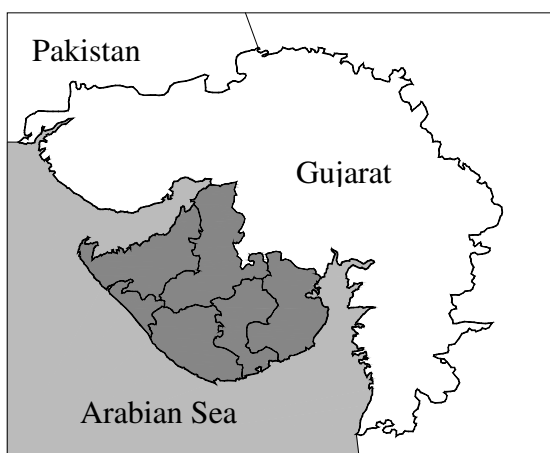
Imbalance between the ecology and economy in coastal regions can create serious problems for the life and livelihood of coastal population. One of these problems is ingress of salinity in to land and water resources on the coast. Gujarat State, with its more than 1600 Km of the coast, is suffering from this problem, and the coast of Saurashtra is affected maximum by this problem. A major consequence of this problem is the acute shortage of potable water in this region.

Historically speaking, the salinity problem first acquired serious dimensions on the Saurashtra coast in the 1970s. The state government, in collaboration with Physical Research Laboratory and Central Ground Water Board, carried out the first survey to investigate salinity in ground water in coastal Saurashtra. The survey observed that salinity in ground water was high due to the intrusion of sea water and vertical percolation of saline water along the creeks. This survey was followed by setting up of Recharge Committee in 1972, High Level Committee -1 in 1975 and High Level Committee - 2 in 1978. The HLC 1 investigated the salinity problem of the region between Madhavpur and Una, while HLC -2 addressed the salinity problem of the area between Una and Bhaynagar as well as the area between Madhavpur and Malia. These committees observed that one major consequence of the salinity ingress was shortage of potable drinking water in the region, and made elaborate recommendations and chalked out a phased programme to first arrest the salinity ingress and subsequently to push back the saline water towards the sea. The HLC-1 as well as HLC-2 suggested a three-pronged strategy consisting of management techniques, recharge techniques and salinity control techniques.

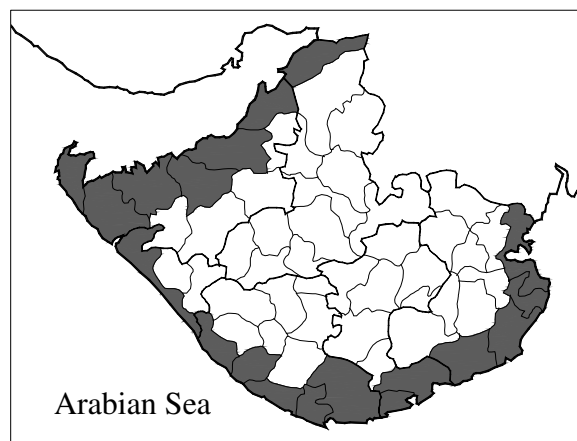
Unfortunately, the recommendations of HLC -1 & 2 ( Salinity prevention measures, Recharge measures and Management interventions) are not being implemented in an integrated manner, except for the component of salinity control works, which were designed in an elaborate manner by the committees. The only department that took up the responsibility of implementing this component was Irrigation Department, which set up SIPC (Salinity Ingress Prevention Circle) to implement the recommendations, which fell within the purview of their activities. The other two components, namely, management techniques (which included changes in the cropping pattern, regulation of ground water extraction and changes in agricultural practices etc), and recharge techniques (which included construction of check dams for directing surplus water to recharge tanks and wells, other recharge techniques to recharge ground water, afforestation etc) needs to be further enhanced. As control and reduction of salinity needs all the three components to be addressed in tandem, the implementation of only one component by the government remains to be inadequate.

### **Coastal Saurashtra**

The peninsula of Saurashtra forms a rocky tableland with fringed coastal plains. The inland area is covered with table lands of "Deccan trap", while the coast line is mostly covered with sandy beaches, wetlands, marshy land etc. Mud flats and marshy lands are common near the estuaries of the rivers, and sand dunes and beach ridges are also present in this area. The topography of Saurashtra resembles an inverted saucer, with the area being drained by number of South-Western flowing rivers. The major rivers are Netravati, Noli, Meghal, Devka, Hiran, Somat, Shinjoda, Rupen, Machchundri, Shetrunji, Shedhi, Aji etc. Most of these rivers are seasonal rivers, which dry up during the summer months. The rainfall in the region varies from 350 mm in Okhamandal in Jamnagar to 1000+ mm in Junagadh (Girnar). Most of the region receives rainfall around 600 mm to 750 mm. A major feature of the rainfall is its erratic nature and non dependability.



Six Districts of Coastal Saurashtra



Coastal Talukas of Saurashtra

The coastline of Saurashtra is of about 765 Km, from Jamnagar to Bhavnagar. There are six districts located on the coast. There are Jamnagar, Porbandar, Junagadh, Amreli, Rajkot and Bhavnagar. Jamnagar has the longest coastline of 370 Km or 41 percent of the total Saurashtra coastline, followed by Junagadh (19 percent), Bhavnagar (18 percent), Porbandar 12 percent), Amreli (7 percent) and Rajkot (27 Km or 3 percent).

These coastal districts have 19 talukas and about 954 villages. Since all the villages are not inhabited, the number of inhabited villages comes to 886 (as per Census 2001). The following table shows that the maximum coastal villages are in Junagadh (302), followed by Jamnagar (250) and Bhavnagar (198). Rajkot has the smallest number of coastal villages (47).

**Table 1**  
**Coastal Saurashtra: Districts, Talukas and Villages**

District	Taluka	Villages
Amreli	2	92
Bhavnagar	4	198
Jamnagar	6	250
Junagadh	5	302
Porbandar	1	65
Rajkot	1	47
Total	19	954

### **Increasing Salinity on the Coast:**

The entire coast had a sweet water regime, until about the end of 1960s, due to a balance maintained between the sweet water on land and saline water in the sea. This balance was disturbed thereafter mainly due to the over drafting of ground water, encouraged by agricultural growth promoted by heavy drafting of ground water through electric engines and pumps. The over drafting encouraged sea water intrusion polluting the quality of ground water. The other reasons that encouraged salinity ingress were destruction of vegetation (i.e. mangroves and other vegetation), which caused tidal water intrusion as well as wind bound salinity; low availability of fresh water in rivers due to their damming; expansion of salt works and other industries which over drafted ground water, and disposed their discharges in an indiscriminate manner; and increase in the pressure of human settlements and their unsatisfactory manner of discharges. In short, salinity intruded in the region through underground sea water intrusion, surface water intrusion as well as wind bound spread.

Our study in 2003 has shown that the extent of salinity as well as salinity affected areas have increased in coastal Saurashtra, in HLC-1 area as well as in HLC – 2 areas (Hirway and Patel 2003). In spite of the construction of salinity control structures undertaken in HLC- 1 area (about 80% structures are completed), the salinity has *increased* in the HLC-1 talukas of Mangrol, Malya, Veraval, Kodinar and Una during 1977-2003. The extent of salinity affected area increased from 6 Km in 1977 to 7-40 Km area in 2003 in Mangrol and Malya (23-33 percent increase), from 5 Km to 6.24 Km in Veraval taluka (24 percent increase) and from 7.5 Km to 7.65 Km in Kodinar taluka during the same period. The salinity affected area increased from 100,000 ha in 1977 to 103524 ha in 2003, implying a 3.5 percent increase in spite of the focused efforts of SIPC in the region.

Green revolution in Gujarat has certainly increased the production, but at the cost of natural resource degradation. Agriculture intensity has increased the amount of water used per unit output. Change in cropping pattern towards cash crops along with free electricity has further raised the demand of water for agricultural purpose. As a result, the rate of withdrawal of ground water exceeded the rate of recharge. Over withdrawal of ground water has made water table lower. This lowering of water table has resulted in saline water intrusion due to reverse hydraulic gradient and capillary action. Moreover, Porous limestone in this region facilitates the salinity intrusion at faster rate (Lodhia et al 2004).

In the case of HLC-2 area, the increase in salinity affected area has been much higher. The sea water infected area increased more than 9 times during the past 22 years (1979 –2003) in the area from Una to Bhavnagar. The high increase reflects the pressure of the degrading forces in the region. It is worth noting that not a single taluka in the region shows any improvement in terms of decline in the salinity (Hirway and Patel 2003). Similarly the other HLC-2 areas, from Una to Malia (covering 13 talukas of Junagadh, Porbandar, Jamnagar and Rajkot) have shown an overall increase in the salinity affected area. Though there has been a decline in this area between 1980-2002, the overall scene is not positive. (Hirway and Patel 2003).

In short, salinity in the region is increasing rather than declining! It is clear that strong steps are needed to control salinity ingress to ensure drinking water to people in this region.

#### **Extent of Salinity in Coastal Villages:**

The latest data on the extent of salinity in the ground water of the coastal villages show that 379 villages out of the total of 954 villages (about 40 percent villages) are fully saline, i.e. the ground water has the TDS above 2000 mg per liter through out the year; 177 villages (about 19 percent) are partially saline, i.e. their ground water becomes saline (>2000 mg per liter) during the summer months; and 398 villages (about 41 percent) have ground water which has less than 2000 mg per liter TDS throughout the year.

**Table 2**  
**Status of Salinity in Ground Water in Coastal Saurashtra Villages**

District	No. of Taluka	Name of Taluka	Number of Villages	Number of Villages		
				Fresh Water	Partially Saline	Fully Saline
Amreli	1	Jafrabad	41	16	14	11
	2	Rajula	51	31	9	11
Amreli Total			92	47	23	22
Bhavnagar	1	Bhavnagar	28	7	6	15
	2	Ghogha	26	20	3	3
	3	Mahuva	68	33	11	24
	4	Talaja	76	53	15	8
Bhavnagar Total			198	113	35	50

Jamnagar	1	Jamnagar	59	34	10	15
	2	Jodiya	41		4	37
	3	Kalyanpur	41	7	12	22
	4	Khambhaliya	41	15	8	18
	5	Lalpur	22	18	3	1
	6	Okha Mandal	46		12	34
Jamnagar Total			250	74	49	127
Junagadh	1	Kodinar	46	22	10	14
	2	Maliya	26	14	2	10
	3	Mangrol	60	29	9	22
	4	Una	85	45	21	19
	5	Veraval	85	47	11	27
Junagadh Total			302	157	53	92
Porbandar	1	Porbandar	65	7	17	41
Rajkot	1	Maliya (M)	47			47
<b>Grand Total</b>			<b>954</b>	<b>398</b>	<b>177</b>	<b>379</b>

Source: SIPC, 2005

Note: Fresh Water: TDS < 2000 mg/l through out the year

Partially Saline: TDS > 2000 mg/l in summer months

Fully Saline: TDS > 2000 mg/l through out the year

This implies that almost 60 percent villages in the region do not have potable sources of drinking water through out the year! In the case of the rest of the villages, it needs to be noted that though the level of salinity here is below the 'maximum permissible limits', the salinity level here is frequently above the 'desirable' level of 500 mg / liter as per the WHO Guidelines. The limits have been raised in India because the overall salinity levels are too high in this region. That is, going by the ideal situation, most villages have non potable ground water on the Saurashtra coast.

Salinity is not the only problem; fluoride content above acceptable limit is present in many of the coastal villages in this region. The taluka wise range of fluoride content in ground water is given below.

**Table 3. Range of fluoride content in ground water of coastal villages of Saurashtra**

District	Coastal Taluka	Range of Fluoride in Ground Water (in ppm)	
		Minimum	Maximum
Amreli	Jafrabad	0.17	3.54
	Rajula	0.2	0.96
Bhavnagar	Bhavnagar	0.5	1.5
	Ghogha	0.5	1.2
	Mahuva	0.5	1.2
	Talaja	0.2	1.2
Jamnagar	Jamnagar	0.4	3.98
	Jodiya	0.4	4.49
	Kalyanpur	0.4	3.2
	Khambhaliya	0.3	0.8
	Lalpur	0.5	1.78
	Okha Mandal	1	3.2
Junagadh	Kodinar	0.5	2
	Maliya (H)	0.5	2
	Mangrol	0.5	2.5
	Una	0.5	2.5
	Veraval	0.5	2.5
	Sutrapada	0.5	2.5
Porbandar	Porbandar	0.5	2.8

Source: GWSSB, 2005

### **Drought Proneness:**

Thirteen out of the total nineteen talukas on the Saurashtra coast are either Drought Prone (covered under Drought Prone Area Programme –DPAP) or desert areas (covered under Desert Development Programme –DDP). That is, more than two third of the talukas are either DPAP or DDP talukas. All the six coastal talukas of Jamnagar are DDP talukas, while the only coastal taluka of Rajkot, Maliya, is a DDP taluka. Three talukas of Amreli, two talukas of Junagadh and one each taluka of Porbandar and Bhavnagar are DPAP talukas.

**Table 4**  
**DDP and DPAP Status of Coastal Talukas of Saurashtra**

District	Serial Number	Coastal Taluka	Status
Amreli	1	Jafrabad	DPAP
	2	Rajula	DPAP
Bhavnagar	1	Bhavnagar	DPAP
	2	Ghogha	
	3	Mahuva	
	4	Talaja	
Jamnagar	1	Jamnagar	DDP
	2	Jodiya	DDP
	3	Kalyanpur	DDP
	4	Khambhaliya	DDP
	5	Lalpur	DDP
	6	Okha Mandal	DDP
Junagadh	1	Kodinar	
	2	Maliya	DPAP
	3	Mangrol	
	4	Una	
	5	Veraval	DPAP
Porbandar	1	Porbandar	DPAP
Rajkot	1	Maliya (M)	DDP
<b>Total Coastal Taluka = 19</b>		<b>DDP = 7</b>	<b>DPAP = 6</b>

Source: Based on Statistics presented by Coastal Salinity Prevention Cell.

This state of affairs indicates that the coastal region is low in soil moisture and is subjected to frequent droughts. It also indicates the degradation of surface and ground water supply in the region. As a result, a marginal deviation from the normal rainfall or a small delay in the rainfall tends to cause severe shortage of water supply in the region. Taluka wise rainfall data has been given in the table below. Its evident from the data that in almost all the coastal talukas of Saurashtra the average yearly rainfall is much less than the state average. (Year wise rainfall data is given in appendix 6).

**Table 5**  
**Rainfall in Coastal Talukas of Saurashtra**

District	Coastal Taluka	Average Rainfall (mm)		
		1980 to 1990	1991 to 2000	2001-2003
Amreli	Jafrabad	560	583	661
	Rajula	605	491	672
Bhavnagar	Bhavnagar	529	537	663
	Ghogha	499	552	690
	Mahuva	581	508	564
	Talaja	554	477	545
Jamnagar	Jamnagar	566	439	815
	Jodiya	452	480	508
	Kalyanpur	512	545	855
	Khambhaliya	533	451	515
	Lalpur	590	479	724
	Okha Mandal	329	328	330
Junagadh	Kodinar	874	762	727
	Maliya (H)	878	704	714
	Mangrol	1057	687	557
	Una	755	644	772
	Veraval	814	718	676
	Sutrapada*	740	474	586
Porbandar	Porbandar	768	530	519
Rajkot	Maliya (M)	328	341	470
Gujarat State		866	853	833

Source: GWSSB, 2005

Note: Data for Sutrapada taluka, being new taluka was not available for most of other parameters in this report.

#### **Status of Ground Water in Coastal Saurashtra:**

There is not much problem with respect to the availability of ground water in coastal Saurashtra talukas. This is partly because of the seawater intrusion and partly because of the low level of use of ground water in agriculture due to its poor quality. Out of the total 19 talukas, 9 talukas are “white” talukas, which means that the level of extraction of ground water is “safe”. (i.e. below 70 percent ground water development). Eight talukas are ‘grey’, which implies that the level of ground water development is between 70 percent to 90 percent, i.e. a

“warning” situation. There is no “dark” taluka (indicating a dangerous status of ground water extraction) in the coastal region and only two talukas are ‘over exploited’, where the level of development of ground water is beyond the dangerous limit. In other words, the availability of ground water, though of poor quality, is there in this region. As we shall see later on, this characteristic of the region can allow the use of desalination methods for accessing potable water for local people. (Taluka wise ground water development data is given in appendix 7). However proper understanding of geological formation of the region and existing ground water pumping mechanism is highly required for further development of ground water resources in the region for long-term sustainability. Scientific data on geological formation and ground water pumping levels given in appendix 8.

**Table 6**  
**Status of Ground Water in Coastal Saurashtra**

Districts	Over Exploited	Dark	Grey	White	Total Coastal Taluka
Amreli				Jafrabad Rajula	2
Bhavnagar			Bhavnagar Ghoga Talaja	Mahova	4
Jamnagar			Jodiya Okha Mandal Khambhalia	Kalyanpur Jamnagar Lalpur	6
Junagadh	Mangrol		Kodinar Veraval	Una Maliya	5
Porbandar	Porbandar				1
Rajkot				Maliya	1
<b>Total</b>	<b>2</b>	<b>0</b>	<b>8</b>	<b>9</b>	<b>19</b>

Source: GWRE, 2002

Note: **Over exploited:** The level of development of ground water is more than 100 Percent.

**Dark:** The level of development of ground water is between 90 percent to 100 Percent

**Grey:** The level of development of ground water is between 70 percent and 90 Percent.

**White:** The level of development of ground water is below 70 Percent

### **Coastal Degradation Due to Industries, Mining, Infrastructure etc:**

Sea coast is always seen as an attractive site for setting up salt works and other industries, mining and quarrying, ports and jetties, ship building and ship breaking, tourism, for human settlements and for other infrastructure. Gujarat coast has been used freely for these purposes. The decisions about the location of these activities have been taken almost without paying any systematic consideration to the ecological aspects. Again, no proper steps have been taken to control discharges of pollutants by industries, to recover used mines, to stop mining and quarrying that invites massive inflow of saline water, to regulate excavation of huge amount of sands from sensitive zones, to control removal of mangroves for setting up infrastructure or industries or to control indiscriminate disposal of discharges of human settlements on the coast. Though there are a large number of rules and regulations for undertaking mining and quarrying, for discharging pollutants etc, and there are CRZ rules and coastal zone management plans (CZMP), these are not observed in reality, with the result that there are several villages on the coast, right from Jamnagar in the west to Bhavnagar in the east that suffer from polluted ground water, severe ingress of salinity in water and land, degraded agriculture, lost livelihood and acute shortages of drinking water. We visited many such villages like Rajpur, Ranjitpur, Padana, Jogvad, Gangva, Lakhtar etc in Jamnagar to Gundi, Sosiyo etc in Bhavnagar.

In short, the coastal Saurashtra region is largely saline (with the coverage of salinity increasing), drought prone and has poor quality of ground water. It is also highly polluted and degraded at places.