Socio Economic Impact Assessment Study of the Salinity Prevention Structures in Saurashtra Region
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ACKNOWLEDGEMENT

The study to analyze detail socio-economic impact of the salinity control initiatives carried out by SIPC in Junagadh district of Gujarat has it own importance. The study findings will help in providing socio-economic consideration, an important input for the ongoing and future salinity control programme in coastal Gujarat.

In this context, Coastal Salinity Prevention Cell (CSPC) is thankful to Salinity Ingress Prevention Circle (SIPC) of Irrigation Department of Government of Gujarat, for taking an initiative and providing an opportunity to conduct the study as well as arrange financial support. We are grateful to the officials of SIPC- Rajkot and Sub divisions of SIPC- Una, Mangrol and Kodinar for providing valuable information based on secondary sources. Our sincere thanks to the team members of Ambuja Cement Foundation (ACF) and Aga Khan Rural Support Program India (AKRSP-I), who in spite of their busy schedule spared their time in facilitating the field visits.

We are thankful to all the villagers from the study villages who were involved in long discussions and interviews irrespective of time limit. Their participation in the study has helped in enriching the study findings and capturing the ground realities and impacts.

CONTENT

1. BACKGROUND

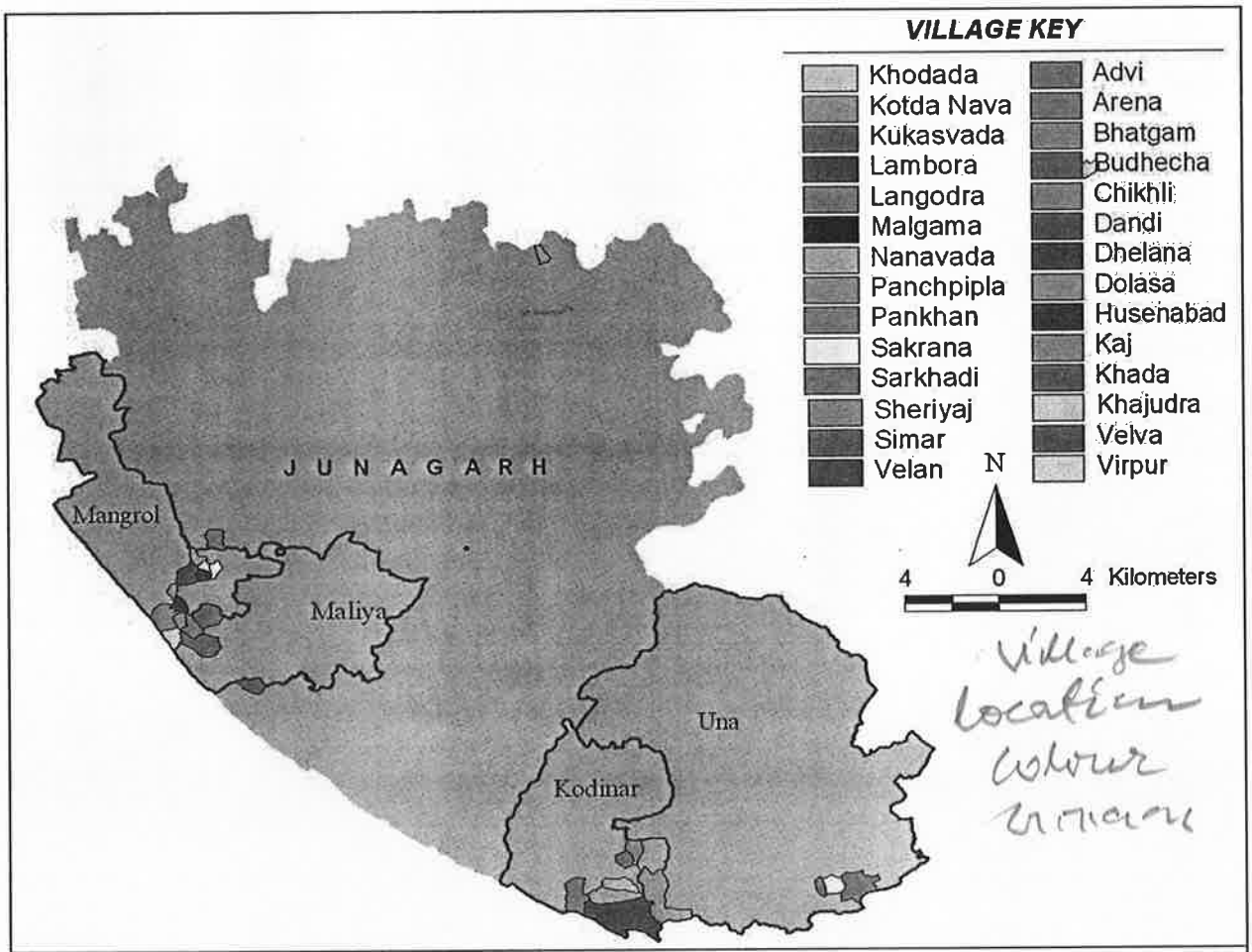
Coastal resource is one of the important natural resource, which provide platform for many occupations and support many developmental activities. Coastal resource is very fragile system which has threat of salinity directly from sea water ingress. Shaurashtra region of Gujarat state has also such fragile coastal resource. Sea water is a major source for salinity, which affects land and water resource most. Land and water resource based traditional occupation like agriculture and animal husbandry affect by salinity problem. Ultimately it impact on socio economic status of a family. Environmental degradation of this coastal area has also led to migration, decline in cattle population, acute crises of quality drinking water for the villages, especially for women. Prolonged use of saline water for irrigation has led to degradation in soil quality followed by decline in agricultural productivity and rendering the land unsuitable for future cultivation. Salinity has also caused social unrest in many coastal villages.

As a process of the salinity mitigation the Salinity Ingress Prevention Circle (SIPC), Government of Gujarat, has invested in building structures like tidal regulators, bandharas, check dams, spreading channels, reservoir for recharging ground water and controlling salinity and thereby improving water availability and quality of coastal aquifers. The proposed study ***will try to analyze in details the socio-economic impact of the various salinity control initiatives carried out by the department.***

The study is proposed to carry out in following command/ catchments /basin of the structure implemented in Junagadh district. The study is cover total 30 villages of Mangrol, Maliya, Kodinar and Una taluka. (Map No. 1.1)

Table no 1.1 Structure Wise List of Villages Considered for the Study

Sr. No.	Structure	Name of Villages
1	Noli River basin	Sakrana, Husenabad, Lambora, Shekhpur, Virpur, Bhatgam, Dhelana, Pankhan, Sheriyaj, Kotada
2	Langdi River Basin	Kukaswada, Budhecha, Langodra, Khodada, Arena
3	Khada Bandhara	Senjaliya, Dandi, Khajudra, Simar, Khada
4	Panch Pipalva TR	Nanavada, Advi, Panchpipalva, Malgam, Chikhali, Dolasa, Velva
5	Spreading Channel- Panchpipalva TR and Sodam	Kaj, Velan, Sarakhadi
Total Village Covered : 30		



Map No 1.1: Location Map of Study Villages

1.1 Approach and Methodology

Following activities have been carried out to achieve the aim of the study.

The participatory approach has adopted for the assessment. Group discussions in study villages and case studies were main methods to assess the impact of salinity prevention activities. Specific formats for both the exercise were developed (annexure I and II). In addition to that water and soil samples from different locations were collected to understand status of soil and water salinity in the study area. The chemical analyses of these samples were done by Central Soil Salinity Research Institute based at Bharuch. Secondary data were also considered for some analytical parts of the study especially to understand secular changes taking place in case of groundwater level and quality in surrounding area of particular structure. These data were mainly collected from SIPC of government of Gujarat. The quantum of work done under this study can be seen through following activities.

- Group discussions were held in 30 villages.
- Case studies were carried out for 12 families.
- 150 water samples were collected from all 30 villages.
- 150 soil samples were collected from all villages.

It is important to note that all sample locations were recorded longitudinally and latitudinal with the help of GPS.

2. ASSESSMENT IN NOLI RIVER BASIN

2.1 Characteristic of Noli River Basin

The Noli River basin is located in Mangrol taluka of Junagadh district. The main river originates about 30 km. from the dam site. The flow is almost in southern direction. River Noli flows through Deccan trap area in beyond village Meswan in Keshod taluka to Lambora in Mangrol taluka and then across the Limestone terrain. Topographically, the area around the site is even and flat. The left bank has small elongated ridges of limestone, while the right abutment has gently rising surface. The plain terrain on the left and right bank is under cultivation. Part of the bank is however covered by forest. The Noli River is passing through Sakrana, Husenabad, Lambora, Shekhpur, Virpur, Bhatgam, Dhelana, Pankhan, Sheriyaj and Kotda villages. These villages are located within 5 km area around the river. As the main occupation in these villages is agriculture they are totally dependent on the river as an only source of water. Along with that the river is a source of drinking water also. The seasonal agriculture is practiced in most of the villages located on the bank of river Noli.

2.1.1 Salinity Control Activities in Noli Basin

The Noli river bandhara is located near Sheriyaj village of Mangrol taluka. This bandhara is constructed to prevent the intrusion of high tide water from sea side towards inland which deteriorating the ground water quality in the surrounding area. Many salinity control activities have been implemented to stop the increasing salinity in groundwater. Many small check dams are constructed on the river bed to raise the ground water level. Many small tributaries and canals are also linked to the river for prevention of salinity and improve groundwater resource.

Major two structures have constructed in this river basin which are (01) Noli - Lambora Recharge Reservoir in upper catchment and (02) Sharadagram bandhara in lower catchment. Salient features of these two structures are given in Table no 1.1 and 1.2.

Table no 2.1 Salient Features of Noli - Lambora Recharge Reservoir on Noli River

1	**Project name**	**Noli Lambora Water Basin Project**		
2	Project Location	A	District	Junagadh
		B	Taluka	Mangrol
		C	Village	Lambora
		D	River	Noli
3	Surface Structure	A	Catchment area	150 Sq. Km.
		B	Total water capacity	106 MCFt
		C	Full tank level	28 Meters
		D	High flood level	29.53 Meters
		E	Waste weir length	650 Meters
		F	Body wall top level	28 Meters
4	Bund Length	A	Right bank	160 Meters
		B	Left bank	300 Meters
		C	Top of bund level	31.95 Meters
5	Submerge Area	A	Irrigated land	63 Hectors
		B	Un irrigated land	139 Hectors
		C	Total land	202 Hectors
6	Benefited Land	2284 Hectors		
7	Benefited villages	Pikhor, Sakrana, Juthal, Virpur, Bhatgam, Lambora, Dhelana, Shekhpur, Kotda, Husenabad, Mangrol, Sahpur, Seriyaj		
8	Initiation date	21st February, 1995		
9	Project completion date	15th March, 1996		
10	Projected budget	2,07,40,500 Rs.		
11	Revised budget	442.53 Lakh Rs.		
12	Total Cost	350 Lakh Rs.		
13	Government act	Gov-SIP/1091/2116/k-2, Date: 15-3-94		
14	Department act	Gov-SIP/1091/2116/k-2, Date: 10-6-94		

Table no 2.2 Salient Features of Saradagram Bandhara on Noli River

1	**Project name**	**(Khari) Noli Lambora Water Basin Project**		
2	Project Location	A	District	Junagadh
		B	Taluka	Mangrol
		C	Village	Sheriyaj
		D	River	(Khari) Noli
3	Surface Structure	A	Catchment area	290.56 Sq.Km.
		B	Total water capacity	102.95 MCFt
		C	Full tank level	2.50 Meters
		D	High flood level	5.50 Meters
		E	Waste weir length	280 Meters
		F	Body wall top level	2.50 Meters
4	Bund Length	A	Right bank	120 Meters
		B	Left bank	0.0 Meters
		C	Top of bund level	8 Meters
5	Submerge Area- Total land	1.72 Km^2.		
6	Benefited Land	2280 Hectors		
7	Benefited villages	Sheriyaj, Shapur, Arena, Husenabad, Kukasvada, Langdora, Khodada, Shapurbara.		
8	Initiation date	March, 1992		
9	Project completion date	October, 1992		
10	Total implement amount	378.92 Lakhs		
11	Government act	Gov-SIP/1187/1984/k-2, Date: 27-11-90		
12	Department act	Gov-SIP/1187/1984/k-2, Date: 21-1-91		

Source: SIPC, 2009

2.1.2 Land Use

The total land of the studied villages of the Noli river basin is 5858.76 hectors. Out of total land Sheriaj (972 Ha) and Dhelana (958 Ha) villages acquire highest land whereas village Virpur has total land about 312 Ha. (Table No. 2.3, Figure no. 2.1)

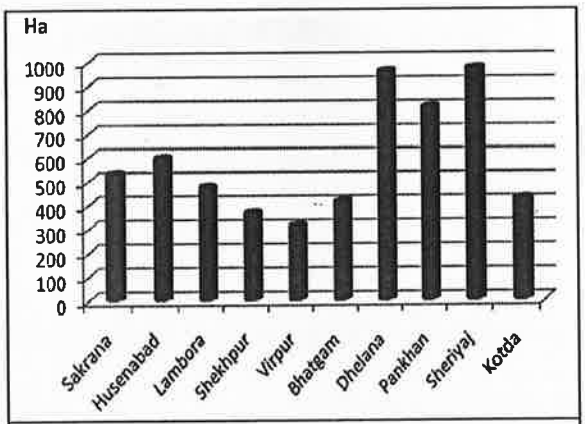


Fig. 2.1: Village Wise Total Land Distribution in Noli River Basin

Land use wise the agricultural land is 81%, the unirrigated land is 59%, while the pasture land is 7%. The waste land contributes 11% of the total land. There is very negligible 1% forest land. (Table No. 2.3) Out of total agriculture land, irrigated land is more than half. Husenabd village has the highest unirrigated land (69%). The total irrigated land is about 1294.8 Ha. Village Pankhan (33 %) has the highest irrigated land while the village Dhelana has the lowest irrigated land (9%). The pasture land spreads over 435.94 hectors of the total land. No pasture land in Lambora village, while Virpur has the highest pasture land (15%). (Table No. 2.4)

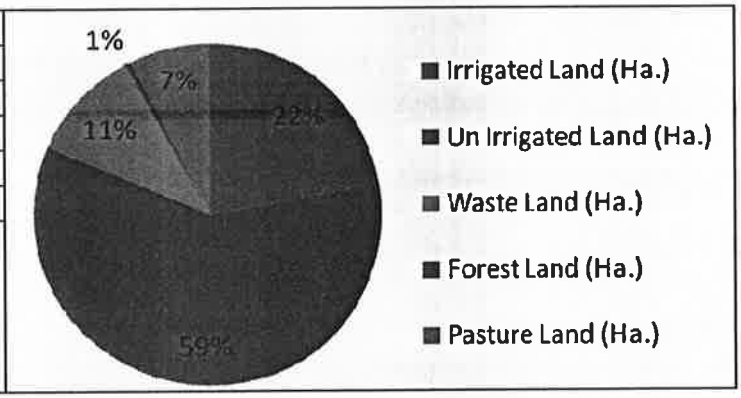
Table no. 2.3 Village Wise Land Use in Noli River Basin

Land Use	Irrigated Ha.	Un Irrigated Ha.	Waste Land Ha.	Forest Ha.	Pasture Land Ha.	Total Ha
Sakrana	205.71	240.01	0.00	0.00	84.28	**530.00**
Husenabad	105.70	412.99	19.48	0.00	57.43	**595.60**
Lambora	60.85	368.18	33.97	10.25	0.00	**473.25**
Shekhpur	175.48	132.15	0.00	5.32	53.16	**366.11**
Virpur	44.73	200.00	12.40	0.28	55.31	**312.72**
Bhatgam	60.34	246.22	65.14	0.00	42.09	**413.79**
Dhelana	100.00	736.94	86.73	0.00	34.84	**958.51**
Pankhan	403.52	219.48	145.51	7.39	35.51	**811.41**
Seriyaj	88.32	600	218.53	10.78	54.49	**972.12**
Kotda	50.15	319	37.27	0.00	18.83	**425.25**
Total	**1294.8**	**3474.97**	**613.09**	**34.02**	**435.94**	**5858.76**

Source: Census, 2001 and Field Survey, 2009

Table no. 2.4 Land Use Pattern in Noli River Basin Area

Land Use Type	Area Ha.
Irrigated Land	1294.8
Un Irrigated Land	3474.97
Waste Land	613.09
Forest Land	34.02
Pasture Land	435.94
Total	**5858.76**



Source: Census, 2001 and Field Survey, 2009

2.1.3 Demographic Status

Total population of study villages is about 14,408 distributed among about 2273 households. Pankhan (2434), Sheriyaj (2280) and Dhelana (2237) are maximum population villages in compare to others, whereas Lambora (809) has lowest population. (Table no. 2.5, Figure no. 2.2) The sex ration in the study area stands at 957 female against 1000 male population.

The general and OBC together are dominating categories followed by SC and ST communities. The general and OBC (other backward caste) together constitute large part of the population. That includes Brahmins, Karadia rajputs, Ahir, Patels, Lohana etc. Among all communities Karadia Rajputs and Ahir are most dominant communities in compare to rest. SC population in the villages of the Noli river basin consists of OBC, Harijans and Muslims. Rabari is main ST community in study area engaged in animal husbandry occupation.

Table no. 2.5 Village Wise Household and Population (Caste Wise) in Noli River Basin

Sr. No.	Village	House Holds No.	Population in No.								Total
			Men				Women				
			General	SC	ST	Total	General	SC	ST	Total	
1	Sakrana	118	413	41	00	454	400	36	00	436	**890**
2	Husenabad	200	742	75	34	851	735	65	28	828	**2041**
3	Lambora	60	383	28	03	414	369	24	02	395	**809**
4	Shekhpur	200	498	00	77	575	453	00	87	540	**1115**
5	Virpur	80	225	64	201	490	215	58	188	461	**951**
6	Bhatgam	118	311	104	00	415	309	103	00	412	**827**
7	Dhelana	664	611	273	280	1164	548	290	235	1073	**2237**
8	Pankhan	510	1097	126	00	1223	1098	113	00	1211	**2434**
9	Sheriyaj	578	1022	32	99	1153	1015	35	77	1127	**2280**
10	Kotda	205	624	00	00	624	562	00	00	562	**1186**
Total		**2273**	**5926**	**743**	**694**	**7363**	**5704**	**724**	**617**	**7045**	**14408**

Source: Census, 2001 and Field Survey, 2009

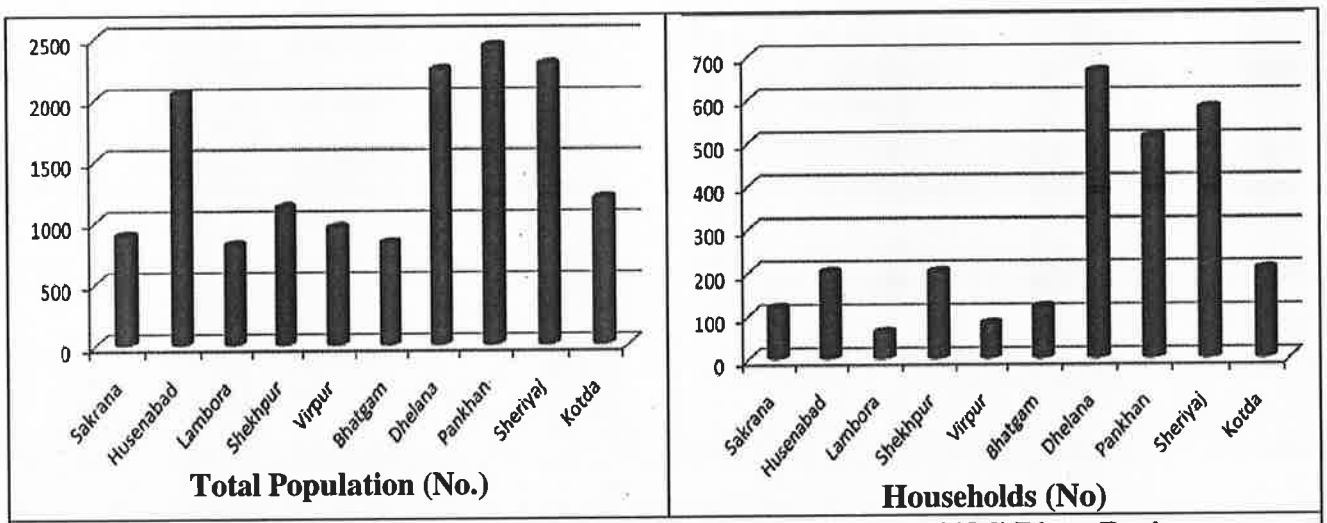


Fig. 2.2 Population and Number of Households in Study Villages of Noli River Basin

Source: Field Survey, 2009

2.1.4 Education Status

Minimum primary education system exists in all villages. Village Sheriyaj and Pankhan are having schools up to SSC. Table 2.6 shows village wise status of education units and numbers respective of students studying in village. Husenabad has maximum no. of students having primary education i.e. 600 while Kotda has the least no. of students in the primary education. There is no college and higher secondary school facility in any village.

Table no. 2.6 Village Wise Education Status in Villages of Noli River Basin

Village	Type of School					
	Aanganwadi		1 to 7 standard		8 to 10 standard	
	Number	Student	Number	Student	Number	Student
Sakrana	1	80	1	100	0	0
Husenabad	1	50	1	600	0	0
Lambora	1	30	1	160	0	0
Shekhpur	1	50	1	150	0	0
Virpur	1	20	1	120	0	0
Bhatgam	2	40	2	45	0	0
Dhelana	1	35	1	200	0	0
Pankhan	2	125	3	200	1	300
Seriyaj	4	100	1	250	1	100
Kotda	0	0	1	250	0	0
Total	**14**	**530**	**13**	**2075**	**2**	**400**

Source: Field Survey, 2009

2.2 Socio Economical Impact Assessment

Various impacts of salinity control activities in Noli River basin have assessed from social, livelihood and natural resource point of view. The social and technical indicators through those assessment had undertaken are (01) Residing community and land holding; (02) Gender sensitization; (03) Impact on Livelihood; (04) drinking water; (05) Health and (06) Assets point of view.

2.2.1 Residing Community and Landholding

To understand community wise impact, all households were classified as per their landholdings such as (01) Landless; (02) Marginal farmers (< 2.50 Acre); (03) Small farmers (2.5 to 5 Acre); and (04) Big farmers (> 5 Acre). Table no. 2.7 shows about 29.74 % of the total households are of landless class. From caste point of view maximum landless families belong to this category i.e. 65% of total SC population and 7.5 % of total households of all study villages. The landless family in general and ST community are 24 % (of total general caste) and 31.93 % (of total ST) respectively. However the percentage wise contribution of general and ST category's landless households in compare to total households of the all villages are 19 % and 3 % respectively.

Table no. 2.7 Caste Wise Landholding (No. of Households) in Noli River Basin

Caste	Land Less	Marginal Farmers	Small Farmer	Big Farmer	Total
General	517	157	618	842	**2134**
SC	205	65	37	8	**315**
ST	91	26	135	33	**285**
Total No.	**813**	**248**	**790**	**883**	**2734**
Percentage	**29.74**	**9.07**	**28.90**	**32.30**	**100**

Source: Field Survey, 2009

These clearly pinpointing that, any agriculture land base activity in Noli river basin cannot help directly to these families. In case of small farmers and big farmers, total 1460 families of general category directly benefited by agriculture land base activities which is about 53.5 % of total household. Types of benefits to these families are discussed in detail under the livelihood – agriculture section.

The village wise analysis of landless families shows maximum landless families of general caste are in Sheriyaj (191 HH) and Shekhpur (103 HH) villages whereas the same for SC communities are Dhelna (118 HH) Bhatgam (25 HH) and Husenabad (23 HH) villages. Landless families in ST community is maximum in Virpur (24 HH) village. (Table no. 2.8) There are no landless families in Sakrana village, while Sheriyaj has the highest landless families (206 HH). Pankhan village has the highest number of the big farmers (350 HH). The big farmers are at the dominating position (883 families). Mostly the general caste leads in the big farmers group while the SC and ST are mostly the marginal farmers or the small farmers.

2.2.2 Gender sensitization

As discussed in previous section female population in these villages are 7045 persons and male: female ratio stands at 957 female against 1000 male. To understand change taking place in gender sensitivity levels in the study villages due to salinity prevention activities following questions were asked to villagers.

Did the Bandhara help to save time of women for fetching drinking water? If yes, where they utilize the time?

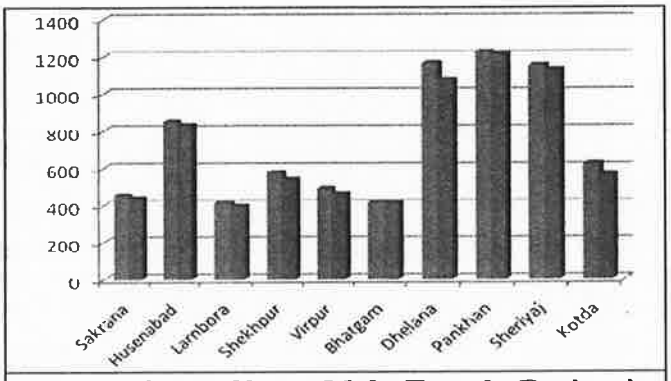


Fig. 2.3 Chart Shows Male Female Ration in villages of Noli River Basin

Do women take decision in your family?
Do women participate in community work?

The responses of these questions are described in table no 2.9.

Normally it is an assumption that, due to water harvesting/ groundwater recharge/ water conservation, groundwater quality and quantity improved at that level where every village can have their drinking water source at village level. And if the village has its drinking water source within the village, it decreases the time for women for fetching drinking water. Based on these two considerations, the first question was asked to the villagers. The people responses have clearly shown that only two villages, Dhelana and Kotada have drinking water facility at village level and the reason for this is improvement of water quality after Lambora dam construction. But rests of the villages till suffer from drinking water problem and therefore women of these villages have to use their most of the time for water fetching. So far the saved time is concerned, Dholana and Kotada people have responded that now women are participating in agriculture activities of their own family, and also give more time to their children.

Table no. 2.8 Caste Wise Classification of Land Holding in Study Villages of Noli River Basin

Land Holding	Caste	No. of House Holds										
		Sakrana	Husenabad	Lambora	Shekhpur	Virpur	Bhatgam	Dhelana	Pankhan	Sheriyaj	Kotda	Total
LL	General	0	47	30	103	10	40	42	11	191	43	**517**
	SC	0	23	6	0	12	25	118	15	6	0	**205**
	ST	0	2	0	5	24	2	29	10	19	0	**91**
	Sub Total	**0**	**72**	**36**	**108**	**46**	**67**	**189**	**36**	**216**	**43**	**813**
M F (<2.50 Acre)	General	4	40	32	0	9	0	5	00	61	6	**157**
	SC	0	0	1	0	8	15	0	41	0	0	**65**
	ST	0	0	0	0	22	0	2	2	0	0	**26**
	Sub Total	**4**	**40**	**33**	**0**	**39**	**15**	**7**	**43**	**61**	**6**	**248**
SF (2.5 to 5 Acre)	General	6	81	27	72	30	0	86	73	188	55	**618**
	SC	0	2	3	0	1	20	11	0	0	0	**37**
	ST	1	7	0	24	6	10	69	7	11	0	**135**
	Sub Total	**7**	**90**	**30**	**96**	**37**	**30**	**166**	**80**	**199**	**55**	**790**
BF (> 5 Acre)	General	13	79	25	7	28	8	114	350	110	108	**842**
	SC	0	0	1	0	2	0	1	00	4	0	**8**
	ST	0	2	0	0	10	00	13	1	7	0	**33**
	Sub Total	**13**	**81**	**26**	**7**	**40**	**8**	**128**	**351**	**121**	**108**	**883**
Total		**24**	**283**	**125**	**211**	**162**	**120**	**490**	**510**	**597**	**212**	**2734**

Source: Field Survey, 2009

Table no. 2.9 Responses of People on Gender Aspects

Village	Did Bandhara Help to Save Time of Women for Fetching DW? (Y/N)	If Yes, Than Where They Use Their Time	Do Women Take Decision in Your Family? (Y/N)	Do Women Participate in Community Work?
Sakrana	No		Yes	Group meeting and *Gramsabha*
Husenabad	No		Yes	*Gramsabha*
Lambora	No		Yes	*Gramsabha*
Shekhpur	No		Yes	*Gramsabha*
Virpur	No		Yes	*Gramsabha*
Bhatgam	No		Yes	*Gramsabha*
Dhelana	Yes	Agriculture, house activities	Yes	*Gramsabha*
Pankhan	No		Yes	Social activity
Sheriyaj	No		No	Social activity
Kotda	Yes	Agriculture, house activities	Yes	Group meeting and *Gramsabha*

Source: Field Survey, 2009

Besides these indicators the straight question regarding participation of women in household level decision making had asked during group discussion. In most of the cases people have responded positively but the type of decisions generally taken by women are mainly social like marriage of children, purchase of jewelry etc. Hardly women involves into occupation level decisions. While the response on inquiry regarding women's involvement in different kinds of public activity like meetings etc. People have said that women remain present in *gramsabhas* but are not actively participating in discussion. In some villages like Pankhan and Sheriyaj women also involve in social activities (*Svadhyay*) done by NGOs. In Sakrana and Kotda, women are also participating in group meetings (*Sakhi Mandals*) in addition to *gramsabha*.

2.2.3 Livelihood Impact

The main occupations in the study area are agriculture and animal husbandry. In addition several households are managing their income through wage labour. Some coastal villages like Sheriyaj people are also doing fishing. Among different occupations agriculture is one of the most vulnerable occupation can directly influenced by degradation of soil and water quality. While other means of livelihoods like agriculture labour and animal husbandry have indirect impact of degradation of such natural resources. Such impacts can be assess through studying increase/decrease production, migration pattern, increase/decrease milk production, change in livestock etc. Keeping this in mind, this section is discussing various impacts on different aspects of agriculture and animal husbandry occupations along with village wise migration pattern in study area.

2.2.3.1 Agriculture

Almost 70 % of the total families are engaged in agriculture in study area. Sea water intrusion and groundwater salinization have badly affected this backbone economy of the area. According to census record of government of Gujarat, 2001 about 59 % of total land is characterizes as rainfed (unirrigated) land while 22 % of total land is irrigated agriculture land. About 81 % of total land (4770 Ha) is under agriculture. (Table no. 2.4) Impacts of salinity ingress on agriculture after construction of water harvesting structure and bandhara, have assessed through estimation of changes taking place in different agriculture types, change in

cropping pattern, increase / decrease in irrigated area, and rise and fall in production. In addition, all these estimation were done seasonally i.e. Kharif, Rabi and Summer seasons. Table no. 2.11 shows village wise season wise before and after status of agriculture in term of crops, crop sown area, and production.

As far as field crop is concerned, groundnut in Kharif and Wheat in Rabi seasons were dominant crops in all the villages before bandhara construction, whereas Bajra and Jovar are common as second crops. Farmers of Lambora and Shekhpur villages, repeat Bajra as third crop while in case of Virpur, Dhelana, Pankhana and Kotda, Til and pulses are the third crop. Sakrana and Husenabad villages were not practicing summer crops even after bandhara. Table no. 2.10 shows before and after status of crop and respective unit production. Now days all seven villages are practicing summer irrigation but before bandhara and Lambora Irrigation scheme, there were only Lambora and Shekhpur were doing summer irrigation through wells.

Table no. 2.10 Season Wise Before and After Status Crop Area and Respective Unit Production in Surrounding Villages of Noli River Basin

Season	Crop	Area (Bigha)		Production Kg/ Bigha		Remark
		Before	After	Before	After	
Kharif	Groundnut	9930	9567	250	315	
	Bajra	395	287	300	400	
	Jowar	250	250	1000	1000	
	Cotton	200	0	600	0	
Total		**10775**	**10104**	--	--	
Rabi	Wheat	7243	9737	400	600	
	Jowar	0	575	0	--	Fodder only
	Isabgul	0	300	0	140	
Total		**18018**	**20716**	--	--	
Summer	Bajra	380	2355	400	400	
	Til	0	975	0	350	
	Pulses	0	625	0	175	
Total		**380**	**3955**	--	--	

Source: Field Survey, 2009

Based on above discussion and analysis, following impacts on agriculture can be listed out.

- About 2,700 Bigha land (15 % than previous) have increased in winter season.
- Decrease about 6 % sown area of about 670 Bigha land during Kharif season.
- About 3,500 Bigha land came under three season cropping.
- Availability of water resources has encouraged farmers for fodder cropping.
- Average per Bigha productivity of crops like groundnut, Bajara, Wheat has increased. However the reason explained by farmers for this is due to improvement of variety and availability of water.

Case Study: 1 Case of Nathiben Village: Dhelana

- After bandhara 2 acre of irrigated land has increased of this family.
- Per unit production of groundnut in Kharif season has increased from 200 kg/Bigha to 400 kg/ Bigha. The reason of increased in productivity is availability of water and improved agronomic practices.
- Rabi irrigation area also increased and fodder crop adopted in summer season.
- Annual agriculture income has raised up to 1, 00,000 Rs from 25,000 Rs.
- Before bandhara, she borrowed money from moneylender but now a days due to increased income she does not need to borrow money.

This case study clearly point that increase of irrigation area of 2 bigha land and secure irrigation facility has provided financial upliftment as well as stability of this family.

Table no. 2.11 Village wise Before and After Field Crop Status in Surrounding Villages of Noli River Basin

Village		Sakrana		Husenabad		Lambora		Shekhpur	
Season	**Crop**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Kharif	**Crop Name 1**	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut
	Area (Bigha)	500	500	700	700	500	500	2000	2000
	Production (Kg/Bigha)	300	300	400	200	400	400	150	150
	Crop Name 2	Jowar	Jowar				Bajra	Jowar	Jowar
	Area (Bigha)	100	100				50	150	150
	Production (Kg/Bigha)	1000	1000				600		
Rabi	**Crop Name 1**	Wheat	Wheat	0	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)	800	800	0	500	500	500	2000	2000
	Production (Kg/Bigha)	600	600	0	600	800	800	400	400
	Crop Name 2						Jowar		
	Area (Bigha)						50		
	Production (Kg/Bigha)						--		
Summer	**Crop Name 1**					Bajra	Bajra	Bajra	Bajra
	Area (Bigha)					300	300	80	80
	Production (Kg/Bigha)					600	600	200	200
	Crop Name 2								Til
	Area (Bigha)								50
	Production (Kg/Bigha)								200

Source: Field Survey, 2009

Table no. 2.11 Village Wise Before and After Field Crop Status in Surrounding Villages of Noli River Basin (contd...)

Village		Virpur		Kotda		Bhatgam		Dhelana	
Season	**Crop**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Kharif	**Crop Name 1**	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut
	Area (Bigha)	1680	1680	500	500	1550	1550	1500	937
	Production Kg/Bigha)	200	600	100	300	200	300	240	400
	Crop Name 2					Cotton		Bajra	Bajra
	Area (Bigha)					200		375	187
	Production (Kg/Bigha)					600		300	400
Rabi	**Crop Name 1**	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)	1050	1575	500	500	1550	1350	843	1312
	Production (Kg/Bigha)	600	600	800	600	100	600		400
	Crop Name 2		Jowar				Isabgul		
	Area (Bigha)		525				300		
	Production (Kg/Bigha)						140		
Summer	**Crop Name 1**		Til		Til		Bajra		Til
	Area (Bigha)		525		300		1350		100
	Production (Kg/Bigha)		200		300		700		500
	Crop Name 2		Bajra		Pulses				Pulses
	Area (Bigha)		325		200				225
	Production (Kg/Bigha)		400		100				200
	Crop Name 3				Moth bean				
	Area (Bigha)				200				
	Production (Kg/Bigha)				150				

Source: Field Survey, 2009

Table no. 2.11 Village Wise Before and After Field Crop Status in Surrounding Villages of Noli River Basin (contd...)

Village		Pankhan		Sheriyaj	
Season	**Crop**	**Before**	**After**	**Before**	**After**
Kharif	**Crop Name 1**	Groundnut	Groundnut	Groundnut	Groundnut
	Area (Bigha)	700	700	300	500
	Production (Kg/Bigha)	300	300	200	200
	Crop Name 2			Bajra	Bajra
	Area (Bigha)			20	50
	Production (Kg/Bigha)				200
Rabi	**Crop Name 1**		Wheat		Wheat
	Area (Bigha)		700		500
	Production (Kg/Bigha)		800		180
Summer	**Crop Name 1**		Bajra		
	Area (Bigha)		300		
	Production (Kg/Bigha)		400		

Source: Field Survey, 2009

So far the horticulture practices are concerned, Dhelana and Sheriyaj villages were having coconut orchards and in some farm of Virpur and Bhatgam villages had coconut plantation on boarders. Open wells were the main sources of irrigation and farmers were practicing flood irrigation method. The horticulture in Sheriyaj village seems to be more affected due to salinity increase in shallow groundwater zones. No change has found to seen in water quality even after the construction of bandhara. Overall in Noli river basin horticulture plantation has increased. Now a days total six villages (Table no. 2.12) are practicing horticulture. Significant change in horticulture plantation has been seen in Husenabad (300 Bigha plantation) and Kotda (200 Bigha plantation) villages after Bandhara. Another change can be seen through reduction in average income per plant from Rs. 500 per plant to 300 Rs per plant. The farmers have very strong opinion that water quality is main factor for this reduction.

In Sakrana, Lambora and Pankhan the horticulture is not at all practiced, while in Husenabad, Shekhpur and Kotda horticulture is practiced after the construction of the bandhara. The villages like Virpur and Bhatgam practiced horticulture before the construction of the bandhara. In Virpur and Bhatgam the income from horticulture is nill. Shekhpur holds the highest income through horticulture practice. The average annual income of horticulture of Shekhpur village is Rs. 24000 per Bigha.

The vegetable plantation is very negligible in these villages. Mainly kitchen garden is practiced in these villages. There is no plantation of the vegetables as a source of income.

To assess soil quality of agriculture land in study villages, total 43 soil samples were collected from farms. These samples are distributed in 12 villages, where two villages Pikhor, Sepa are not in study area. Average 4 to 5 samples collected from each study village. Table no 2.21 gives details of sample location and chemical properties like Ec and pH. This analysis was carried out by Central Soil Salinity Research Institute based at Bharuch. According to this, total 15 samples show high Ec value than normal range. This land shows more salinity than other land. Minimum Ec value shows in Dhelana Village (0.46), while maximum value is 5.9 in Husenabad village. pH range shows normal value from 7 to 8.5.

Table no. 2.12 Village Wise Before and After Bandhara Status of Horticulture in Noli Basin Area

Village		Tree Species	Area Under Plantation Bigha	Source of Irrigation	Irrigation Method	Average Production / Plant	Per Bigha Income
Sakrana	Before	--	--	--	--	--	--
	After	--	--	--	--	--	--
Husenabad	Before	--	--	--	--	--	--
	After	Coconut	300	Open well	Flood	100	5000
Lambora	Before	--	--	--	--	--	--
	After	--	--	--	--	--	--
Shekhpur	Before	--	--	--	--	--	--
	After	Coconut	20	Open well	Flood	300	24000
Virpur	Before	Coconut	5	Open well	Flood	0	0
	After	Coconut	5	Open well	Flood		0
Bhatgam	Before	Coconut	50	Open well	Flood	0	0
	After	Coconut	50	Open well	Flood	0	0
Dhelana	Before	Coconut	300	Open well	Flood	300	12000
	After	--	--	--	--	--	--
Pankhan	Before	--	--	--	--	--	--
	After	--	--	--	--	--	--
Seriyaj	Before	Coconut	414	Open well	Flood	50	2000
	After	--	--	--	--	--	--
Kotda	Before	--	--	--	--	--	--
	After	Coconut	200	Open well	Flood	100	5000

Source: Field Survey, 2009

2.2.3.2 Animal Husbandry

Livestock composition of the Noli River basin is dominated by large size animal of buffalo and cattle (cow and bullock) type. Current year total livestock population of these villages are 23,848 (including birds), which were about 11,148 before bandhara. Excluding bird population, there is a marginal increase (approximately 3 %) in total livestock population. Interestingly there were no cattle population in village Sakrana and Lambora before construction of Lambora Irrigation scheme. (Table no. 2.13)

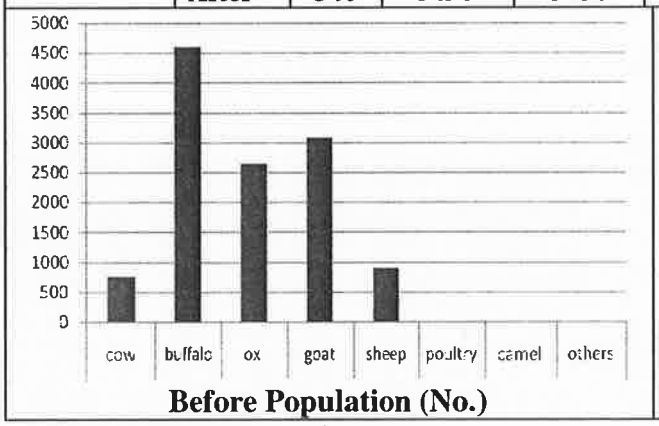
The survey results in the study area show gradual increase in buffalo (4400 to 5490) and bullock (2575 to 3430) population whereas decrease in cow (785 to 540) and goat population (2786 to 1980). There are rare amount of goat, sheep and camels. The population of goat decreased after the bandhara construction from 3085 to 1980.

Poultry farms are only in Husenabad and Shekhpur villages have approximately 12400 birds. There was no camel before bandhara construction in this area but now there are some camels in Pankhan and Dhelana village for transportation purposes.

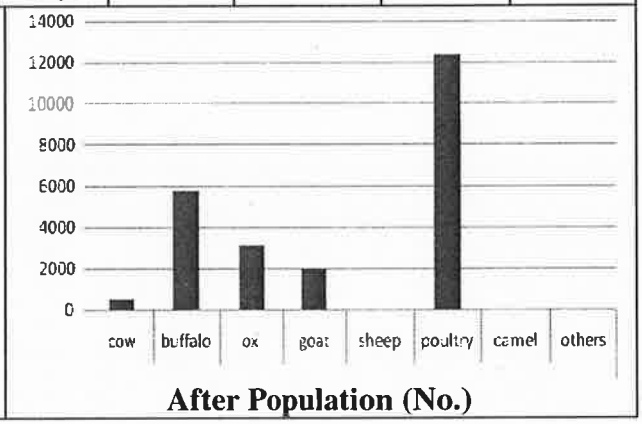
The interactions with farmers have revealed that increase in buffalo is mainly due to fodder securities improved due to water resources improvement. Another reason is its high milk yielding and better market opportunities through dairy development in this area. Increase in irrigation opportunity during winter and summer seasons is the main reason for increasing population of bullock in this area

Table No. 2.13 Before and After Construction Change in Livestock Population in Villages of Noli River Basin

Village		Cow	Buffalo	Bullock	Goat	Sheep	Poultry	Camel	Total
Sakrana	Before								**0**
	After	50	150	100					**300**
Husenabad	Before	50	1000	200					**1250**
	After	25	2000	200	150		400		**2775**
Lambora	Before								**0**
	After	15	40	100					**155**
Shekhpur	Before		200	200	35				**435**
	After	10	400	150			12000		**12560**
Virpur	Before	30	500	180					**710**
	After	30	350	180					**560**
Kotada	Before	50	500						**550**
	After	15	150	400					**565**
Bhatgam	Before	30	700	70	300	300			**1400**
	After	5	400	100					**505**
Dhelana	Before	200	500	550	2000	200			**3450**
	After	200	1500	1200	1500			4	**4404**
Pankhan	Before	25	600	875	150	100		3	**1753**
	After	150	400	950	30			4	**1534**
Seriyaj	Before	400	400	500	300				**1600**
	After	40	100	50	300				**490**
Total	**Before**	**785**	**4400**	**2575**	**2785**	**600**	**0**	**3**	**11148**
	After	**540**	**5490**	**3430**	**1980**	**0**	**12400**	**8**	**23848**



Before Population (No.)



After Population (No.)

Source: Field Survey, 2009

Table no. 2.14 Village Wise Details of Livestock and Milk Production in Villages of Noli River Basin

Cattle Type	Details	Sakrana		Husenabad		Lambora		Shekhpur		Virpur	
		Before	After	Before	After	Before	After	Before	After	Before	After
Cow	Nos		50	50	25		15		10	30	30
	Lactating Cattle		50	20	20		5		5	20	15
	Lactation Period (days)		210	210	210		210		210	210	210
	Milk Production lit/day		5	2	2				4	4	4
Buffalo	Nos		150	1000	2000		40	200	400	500	350
	Lactating Cattle		100	600	1500		10	100	280	300	150
	Lactation Period (days)		270	270	270		210	270	270	270	270
	Milk Production lit/day		8	4	5		5	8	8	6	6
Bullock	Nos		100	200	200		100	200	150	180	180
Goat	Nos				150			35			
Sheep	Nos										
Poultry	Nos				400				12000		

Table no. 2.14 Village Wise Details of Livestock and Milk Production in Villages of Noli River Basin (contd...)

Cattle Type	Details	Kotada		Bhatgam		Dhelana		Pankhan		Sheriyaj	
		Before	After	Before	After	Before	After	Before	After	Before	After
Cow	Nos	50	15	30	5	200	200	25	150	400	40
	Lactating Cattle	30	5	10	1	100	100		60	300	10
	Lactation Period (days)	210	210	210	210	240	240		150	210	240
	Milk Production lit/day	3.5	3	3	3	8	8		3	5	5
Buffalo	Nos	500	150	700	400	500	1500	600	400	400	100
	Lactating Cattle	200	100	300	200	250	300	195	195	400	100
	Lactation Period (days)	270	270	270	220	300	300	300	300	270	270
	Milk Production lit/day	7	7	5	5.5	8	10	6	6	6	6
Bullock	Nos		400	70	100	550	1200	875	950	500	50
Goat	Nos			300		2000	1500	150	30	300	300
Sheep	Nos			300		200		100			
Camel	Nos						4	3	4		

Source: Field Survey, 2009

Lactating Cattle Ratio: Herd management in animal husbandry occupation is the main factor that maintains its economical sustainability of a family. Again herd management is dependent on number of lacting cattle in a herd. The ratio of lacting cattle against total numbers of cattle is mainly deciding factor of total livestock population especially in milk base animal husbandry. In case of Noli River basin activities this ratio has been assessed as one of the indicators of socio economic impact assessment based on considerations that fodder security may increased throughout the year due to improvement in water condition. The analyzed survey results have presented in Table no 2.15.

Following are the analyzed status of lacting cattle ration after bandhara in Noli River basin.

- Lacting cow ration decreased in Virpur, Kotada, Bhatgam and Sheriyaj villages.
- In case of buffalo the decreased ratio has found in villages of Virpur and Dhalana. In both these villages average per day per cattle milk production has also increased.
- Virpur is only village where lacting ratio of cow and buffalo has found increased.
- In Sakarana and Lambora, there were neither cows nor buffalos before bandhara where as in Pankhan and Shekhpur there was no cow population before.

Table no. 2.15 Change in Lactating Ratio against Total Cattle Population

Village	Cattle Type	Change in Ratio of Lactating Cattle		Note
		Before	After	
Sakrana	Cow	0	100 %	No animal before bandhara
	Buffalo	0	67 %	
Husenabad	Cow	40 %	80 %	
	Buffalo	60 %	75 %	
Lambora	Cow	0	33 %	No animal before bandhara
	Buffalo	0	25 %	
Shekhpur	Cow	0	50 %	
	Buffalo	50 %	70 %	
Virpur	Cow	66 %	50 %	
	Buffalo	60 %	45 %	
Kotada	Cow	60 %	33 %	
	Buffalo	40 %	67 %	
Bhatgam	Cow	33 %	20 %	
	Buffalo	43 %	50 %	
Dhelana	Cow	50 %	50 %	
	Buffalo	50 %	20 %	
Pankhan	Cow	0	40 %	
	Buffalo	33 %	50 %	
Seriyaj	Cow	75 %	25 %	
	Buffalo	100 %	100 %	

Source: Field Survey, 2009

During group discussions an attempt were made to understand reasons behind these changes. Following main reasons were explained by the farmers.

- Due to water securities, fodder securities have also increased that played a major role in increasing invests in Animal husbandry.
- Market intervention through dairy development has influenced buffalo population due to its fatty milk fetched high values.
- Overall hardship of farmer has decreased for fodder and water after these activities.
- Immediate returns

Milk Production and Dairy development: Milk collection centers facility is in all the villages now except Dhelana. The milk collecting centers have started in these villages after bandhara construction. Only Bhatgam had milk collection center even before bandhara. All centers belong to NDDB. The average rate of milk paid by dairy is very from Rs. 18 to 22 per liter, that was Rs. 14 before. However the prices mainly depend on the fats content in milk. The annual milk collection is highest i.e. 3.65 lakh liters at Shekhpur center, whereas Pankhan and Bhatgam centers stands at second position by collecting 1.82 lakh liter milk per year.

Table no. 2.16 Village Wise Details of Milk Selling at Milk Collection Centers

Details		Total Household Selling milk	Daily milk Collection (Lit)	Annual Milk Collection (Lit)	Average Rate Rs/lit	Total Income from Milk Rs. in Lakh
Sakrana	Pre	0	0	0	0	0
	Post	0	120	43800	18	7.884
Husenabad	Pre	0	0	0	0	0
	Post	100	440	160600	18	28.908
Lambora	Pre	0	0	0	0	0
	Post	25	75	27375	20	5.475
Shekhpur	Pre	0	0	0	0	0
	Post	100	1000	365000	19	69.35
Virpur	Pre	0	0	0	0	0
	Post	75	100	36500	16	5.84
Bhatgam	Pre	118	200	73000	14	10.22
	Post	100	500	182500	18	32.85
Pankhan	Pre	0	0	0	0	0
	Post	70	500	182500	20	36.5
Seriyaj	Pre	0	0	0	0	0
	Post	20	40	14600	20	2.92
Kotda	Pre	0	0	0	0	0
	Post	50	200	73000	22	16.06
Total	**Pre**	**0**	**0**	**0**	**0**	**10.22**
	Post	**50**	**200**	**73000**	**22**	**205.787**

Source: Field Survey, 2009

As far as average rate is concern, milk of Kotada village fetches highest rate of Rs. 22 per liter, while maximum income from milk is in village Shekhpur. In spite of similar volume of milk collection at Bhatgam and Pankhan, total income differs due to variation in rates.

2.2.3.3 Migration and Labour

Increasing wage labours and rate of migration are indicators of degradation of natural resources. It is already discussed that salinization of groundwater has badly impacted back bone traditional occupation i.e. agriculture. Migration pattern of the area has shown in table 2.17. It clearly shows that migration was practiced by local people even before bandhara. However, before bandhara people of Lambora, Shekhpur, Dhelana and Sheriyaj villages were migrating regularly for labour works. Only Sheriyaj people being fisherman community were migrating for fishing. They are till migrating for fishing.

Husenabad, Bhatgam and Kotada are villages where migration has started during post bandhara time. The table no 2.17 clearly shows that there has no changed in numbers of migrating people in Lambora, Shekhpur and Dhalana village. In case of village Sheriyaj the

number of migrating people has increased vis-à-vis it has decreased in village Pankhan only. Overall area wise total number of migrating people has increased from 1240 to 1805 nos.

Main nearby places for migration are Mangrol, Veraval and Keshod locally, while people of village Bhatgam also migrate up to Surat in South Gujarat. Construction labor throughout the year and agriculture labour in winter and summer seasons are main works that they do during migration. In addition to labour, small and marginal farmers are also migrate for labour work, occasionally especially during finance crunch. They mostly migrate to nearby irrigated area.

On an average one person earns Rs.70 as labor. Cost benefit wise over income gain has increased almost double than the previous. (Table no.2.17) Total income from migration has almost doubled than the previous i.e. 0.93 lakh Rs to 1.915 lakh Rs.

Table no. 2.17 Migration Trend in Villages of Noli River Basin

Village	Migration		Persons No.		Migration Season		No. of days (Annual)		Income Rs. in Lakh (annual)		
	Before	After	Before	After	Before	After	Before	After	Before	After	Change
Saranac	No	No									
Husenabad	No	Yes		100		Daily		365	0	0.255	**0.255**
Lambora	Yes	Yes	300	300	All seasons		365	365	0.365	0.365	**0.00**
Shekhpur	Yes	Yes	700	700	All seasons		365	365	0.182	0.182	**0.00**
Virpur	No	No	0	0					0	0	**0**
Bhatgam	No	Yes	0	75		All season		365	0	0.365	**0.365**
Dhelana	Yes	Yes	100	100	All seasons		365	365	0.219	0.365	**0.146**
Pankhan	Yes	Yes	80	30	Winter, summer		240	240	0.018	0.018	**0.000**
Sheriyaj	Yes	Yes	60	300	All seasons		365	365	0.146	0.146	**0.000**
Kotda	No	Yes		200		Summer		60	0	0.219	**0.219**
Total			**1240**	**1805**					**0.930**	**1.915**	**0.985**

Source: Field Survey, 2009

2.2.4 Impact on Water Resources

There were two methods adopted to assess impact on groundwater resources of the study area. The methods are study of changes in groundwater level and quality mainly based on secondary data recorded by SIPC and availability of water for different uses. In these cases only drinking and irrigation uses have considered for assessment.

2.2.4.1 Change in Groundwater

Salinity Ingress Prevention Circle, Government of Gujarat is a responsible department for implementation of coastal salinity related programme in any coastal areas of state. In addition to implementation, impact assessment and long term monitoring of different water resource related parameters like groundwater level, water quality (status as well fluctuation) are also their responsibilities. Therefore, department has established their own observation network of well. In Noli river basin, department has monitored 5 wells in Sheriyaj village area. Besides these wells there is no any long term monitoring well in upper catchment areas of the basin. In any watershed area, any intervention carried out in upper reaches has their definite implications in lower catchment. The scale and type of impacts absolutely depends on specific

characteristics of the particular watershed or basin. Keeping this in mind the analysis of monitoring wells had carried out to understand fluctuation trends in water level and water quality in lower reaches (coastal parts) of Noli River Basin. Well inventory data (SIPC, 1989) shows cavernous limestone is a major aquifer in this area. (Table no. 2.18) Well hydrograph were prepared to understand secular and seasonal changes taking place in groundwater levels in last several years.

Random well inventory and sample collection carried out in each village during this study. Total 44 samples collected from these villages including bandhara surface water also. Table no 2.21 shows details of sample collection. Analyses of these samples were done by Central Soil Salinity Research Institute, Bharuch. Based on well inventory data, major aquifers are limestone and weathered basalt in these villages. This survey was carried out in month of June, year 2009.

It is important to clarify that the conclusions regarding the water level fluctuation and quality have following limitations.

- Analysis were based on secondary data recorded by SIPC
- Very limited Monitoring were in very limited area, lower reach of watershed i.e. monitoring in Sheriyaj village only
- Data were of only pre monsoon seasons therefore, seasonal changes in water level, due to rainfall was not possible to carry out

Water Level Fluctuation: The trends of water level in all the wells shows rise in water level taking place from 1991 to 2008. (Table no. 2.19)

This rising trends in all hydrographs clearly show, water level has risen in this area during 1991 to 2001. Individual well wise maximum water level has risen in O.W. SB1, is about 1.20 meter whereas similarly in SB3 and SB4 it is 0.5 m and 0.25 m minimum rise respectively. Water level behavior in SB5 well does not show large change in water level even after 15 years of construction of Bandhara.

Based on above discussions following impacts on groundwater level can be listed.

- Maximum water level rise in lower reach of Noli River Basin is 1.20 m.
- There is a variation in fluctuation even within the village area that indicates range of fluctuation may more as we move towards upper reaches of Noli River Basin area.

Based on well inventory data (Table no 2.21), it can say that in Dhelana and Shekhpur village, water level is more deep than other villages. Maximum depth water level is seen in shekhpur (54.1 m). Wells of Sheriyaj village show very shallow depth of water level than other villages.

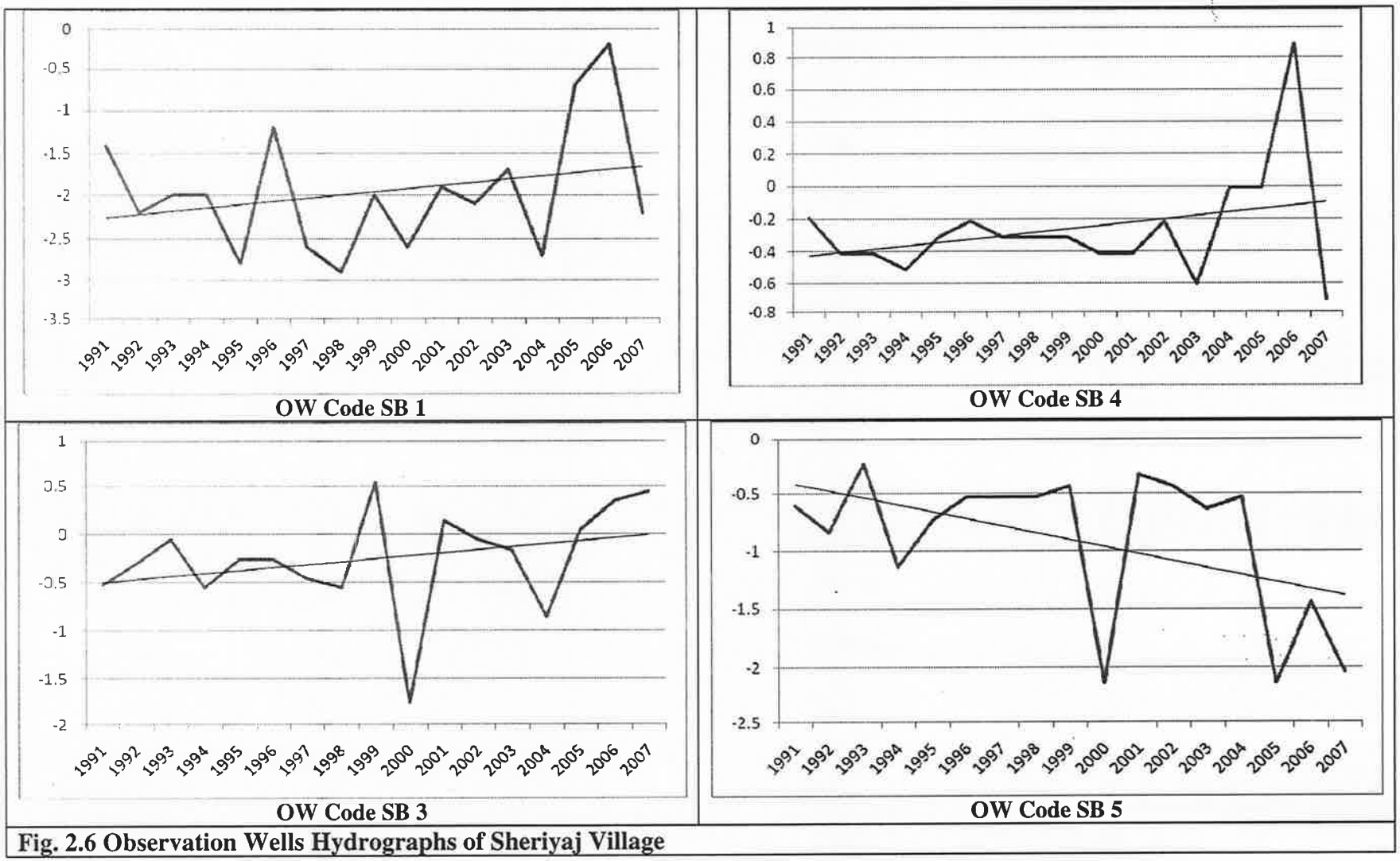


Fig. 2.6 Observation Wells Hydrographs of Sheriyaj Village

Source: SIPC, 2009

Table no. 2.18 Well Inventory and Litholog Data of Seriyaj Village

Sr. No.	Owner's Name	Survey No.	Ground Level (m)	Water Level Depth (1989) m				Total Depth (m)	Description of Geology	
				Pre Monsoon		Post Monsoon			Thickness	Strata
				Depth	RWL	Depth	RWL			
1	Jiva Ram Vadher	Govt. land	6.74	5.9	0.84	6.4	0.34	8.2	0.0 to 0.6	Overburden
									0.6 to 8.2	Brownish cavernous limestone
2	Naran Karshan Koli	105	4.24	3.5	0.74	4	0.24	5.7	0.0 to 0.30	Overburden
									0.30 to1.80	Hard sandy limestone
									1.50 to 5.70	Brownish cavernous shelly limestone
3	Kalabhai Vadliya	304	4.29	0	0	4.3	-0.01	7.5	0.0 to 0.8	Overburden
									0.8 to 7.5	Brownish cavernous sandy limestone
4	Kachra Jetha Koli	107	4.54	3.9	0.64	4.3	0.24	6.7	0.0 to 1.0	Overburden
									1.0 to 6.7	Brownish cavernous sandy limestone
5	Jetha Punja Koli	108	4.44	3.9	0.54	4.4	0.04	6.1	0.0 to 1.2	Overburden
									1.2 to 6.1	Brownish cavernous sandy limestone
6	Rama Punja Koli	108	4.29	3.7	0.59	4.3	-0.01	6.9	0.0 to 0.8	Overburden
									0.8 to 6.9	Brownish cavernous sandy limestone
7	Naran Karsan Koli	106	4.52	0	0	4.2	0.32	8	0.0 to 0.6	Overburden
									0.6 to 8.0	Brownish cavernous shelly limestone
8	Ladha Punja Koli	106	4.42	0	0	4.6	-0.18	7.6	0.0 to 0.5	Overburden
									0.5 to 7.6	Brownish cavernous sandy limestone
9	Giga Varjang Koli	84	7.09	0	0	6.6	0.49	7.4	0.0 to 0.30	Overburden
									0.3 to 7.4	Brownish cavernous sandy limestone

Table no. 2.19 Pre Monsoon Water Level in Wells of Sheriyaj Villages -Year 1991 to 2008

Well Code	R.L. (m)	Pre Monsoon RWL in Year from 1992 to 2008																
		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008
SB-1	4.8	-1.41	-2.2	-2	-2	-2.8	-1.2	-2.6	-2.9	-2	-2.6	-1.9	-2.1	-1.7	-2.7	-0.7	-0.2	-2.2
SB-2	4.52	-0.2	-0.18	0.07	-0.38	-1.08	-0.98	-0.38	-0.28	0.32	-2.18	0.02	-0.18	--	-1.48	-0.78	-0.18	1.12
SB-3	4.54	-0.53	-0.31	-0.06	-0.56	-0.26	-0.26	-0.46	-0.56	0.54	-1.76	0.14	-0.06	-0.16	-0.86	0.04	0.34	0.44
SB-4	4.29	-0.19	-0.41	-0.41	-0.51	-0.31	-0.21	-0.31	-0.31	-0.31	-0.41	-0.41	-0.21	-0.61	-0.01	-0.01	0.89	-0.71
SB-5	4.26	-0.61	-0.84	-0.24	-1.14	-0.74	-0.54	-0.54	-0.54	-0.44	-2.14	-0.34	-0.44	-0.64	-0.54	-2.14	-1.44	-2.04

Source: SIPC, 1989

Water Quality: Changing trends in groundwater quality has been understood by preparing well hydrographs (for fluctuating values of Total Dissolved Solids) and by studying changes in ratio of chloride carbonate ration.

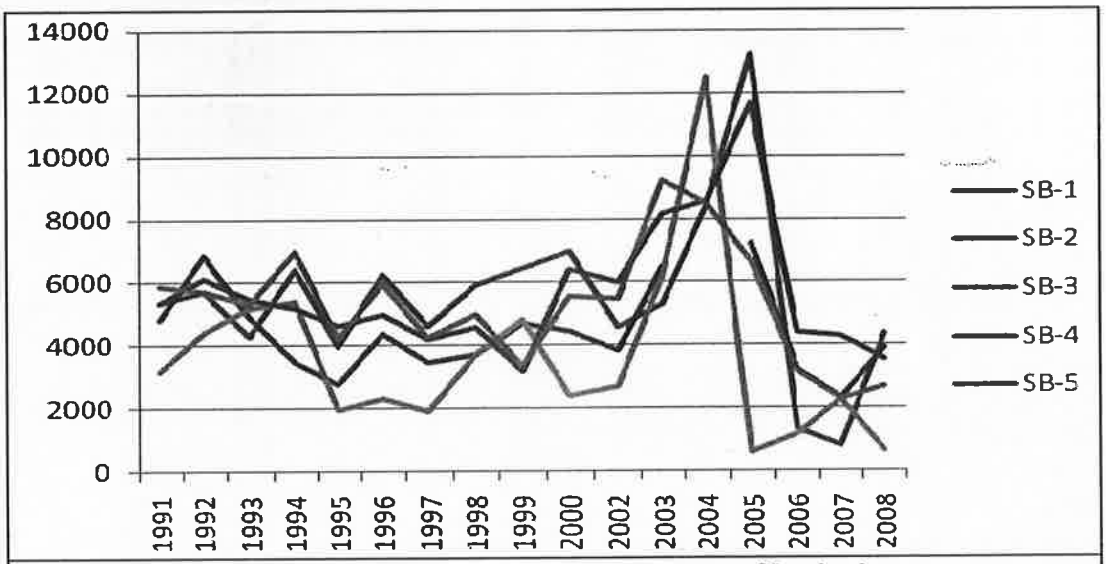


Fig 2.7 Hydrograph of TDS Value in Wells of Village Sheriyaj

Source: SIPC, 2009

Figure no. 2.7 is well hydrographs prepared for TDS values measured in area around village Sheriyaj which clearly shows the values of TDS was nearly same from year 1991 to 2001, whereas it has started increasing during years 2001 and 2002. The peak values of TDS were observed during year 2003 and 2004. Again sudden decrease in TDS concentrations has taken place during year 2005 and 2006. It was minimum in compare to previous years. Currently again the increase in TDS is taking place in SB1, SB2 and SB5 no. of observation wells. Overall hydrographs shows average decrease in TDS is almost 1500 ppm.

Based on well inventory data (Table No. 2.21), it can interpret that out of total 44 samples, 17 well samples show high TDS/Ec than normal or potable water range it means more than 2.8 Ec (1800 ppm TDS). That means total 27 well samples indicate potable water quality. Surface water of Seriyaj bandhara shows 9.6 Ec indicates highly salinity water. In groundwater, maximum salinity observed in Shekhpur village (19.6 Ec), while also seen in the same village (0.98 Ec). If we see pH range, it seems normal range in all the samples.

In addition to TDS concentration Chloride, Carbonate and Bicarbonate ration in groundwater of the study area was computed. (Table no.2.20) Almost in all the wells the ration is much more than 6 that again clearly indicates injurious contamination of groundwater by sea water. Except one well (SB1) where this value went below 6 (2.14) in year 2007 when there was very high rainfall was recorded in this area. However, in rest of the wells the value till remained more than 6.

Following conclusion can be draw based on this behavior of the monitoring wells.

- The stable concentration of TDS during year 1991 to 2001
- Abrupt salinity increased in the area during year 2003-2004 may be due to over exploitation of groundwater and low rainfall during these years.
- Sudden decrease in salinity has taken place during 2005 to 2007 which may be due to heavy rainfall during these years

Table no. 2.20 Water Quality in Wells of Sheriyaj Village, Noli River Basin (1991 to 2008)

		Well Code	SB-1	SB-2	SB-3	SB-4	SB-5
Pre Monsoon	1991	TDS (ppm)	5345	4816	3174	5345	5846
		Cl (ppm)	2640	2440	1560	2720	3160
		Cl:CO3 Ratio	33.96	31.38	36.93	55.12	74.8
	1992	TDS (ppm)	5696	6835	4386	6123	5696
		Cl (ppm)	2880	3560	2080	3240	2920
		Cl:CO3 Ratio	68.17	84.27	16.27	91.26	59.17
	1993	TDS (ppm)	4252	4892	5183	5475	5300
		Cl (ppm)	1920	2280	2480	2520	2520
		Cl:CO3 Ratio	19.32	32.17	58.38	18.68	22.23
	1994	TDS (ppm)	6403	3452	5401	5178	6960
		Cl (ppm)	2960	1560	2720	2600	3080
		Cl:CO3 Ratio	19.89	12.95	20.14	20.31	24.06
	1995	TDS (ppm)	3953	2784	1949	4621	4176
		Cl (ppm)	1800	1160	720	2040	1880
		Cl:CO3 Ratio	12.35	8.59	3.12	13.08	15.6
	1996	TDS (ppm)	6250	4345	2321	4970	5952
		Cl (ppm)	2800	1920	880	2200	2800
		Cl:CO3 Ratio	14.06	33.66	6.19	17.18	21.18
	1997	TDS (ppm)	4603	3452	1893	4198	4202
		Cl (ppm)	2120	1560	712	1960	2040
		Cl:CO3 Ratio	12.98	13.74	4.45	17.57	20.49
	1998	TDS (ppm)	5924	3702	3702	4557	4956
		Cl (ppm)	2920	1640	1640	2160	2440
		Cl:CO3 Ratio	31.6	9.06	10.48	22.58	25.50
	1999	TDS (ppm)	6437	4692	4813	3188	3309
		Cl (ppm)	3160	2280	2200	1400	1600
		Cl:CO3 Ratio	20.2	23.83	11.69	12.7	13.23
	2000	TDS (ppm)	6989	4424	2388	6406	5533
		Cl (ppm)	3440	2080	1080	3080	2680
		Cl:CO3 Ratio	64.67	45.01	13.87	86.76	63.08
	2002	TDS (ppm)	4566	3842	2673	6013	5457
		Cl (ppm)	2280	1840	1120	2920	2560
		Cl:CO3 Ratio	11.47	21.66	5.44	31.56	18.96
	2003	TDS (ppm)	5300	6465	6173	8154	9202
		Cl (ppm)	2640	3160	3040	4320	4680
		Cl:CO3 Ratio	41.24	21.68	30.55	50.84	27.45
	2004	TDS (ppm)	8452		12499	8571	8452
		Cl (ppm)	4200		6540	4280	4280
		Cl:CO3 Ratio	73.64		132.21	46.25	54.88
	2005	TDS (ppm)	13235	7219	602	11671	6618
		Cl (ppm)	7080	3520	208	6200	3320
		Cl:CO3 Ratio	124.14	47.11	4.2	145.94	67.12
	2006	TDS (ppm)	1340	3203	1165	4426	3145
		Cl (ppm)	328	1480	288	1960	1320
		Cl:CO3 Ratio	0.96	34.84	0.94	8.91	15.54
	2007	TDS (ppm)	792	2321	2262	4285	2262
		Cl (ppm)	272	960	960	1960	960
		Cl:CO3 Ratio	2.12	13.52	9.65	39.62	11.3
	2008	TDS (ppm)	4368	3902	641	3553	2679
		Cl (ppm)	2160	1800	176	1520	1200
		Cl:CO3 Ratio	23.34	13.33	1.55	12.62	15.39

Source: SIPC, 2009

Table No. 2.21 Details of Water and Soil Sample Collected in Study Villages of Noli River Basin

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min.	Sec.	Deg	Min	Sec				EC	PH	EC	PH
1	Sheriyaj	Sheriyaj Bandhara	21	4	37.7	70	8	56.1				9.6	7.6		
2	Seriyaj	Bhikha Vada	21	4	34	70	9	20.04	2.5	1.5	Limestone	5.9	8.1	1.34	7.9
3	Seriyaj	Rama Bhoja Sevra	21	4	42.8	70	8	59.6	6.65	4.55	Limestone	5.3	8.1	3.1	7.9
4	Seriyaj	Harda Poja Rathod	21	5	3.4	70	8	56.5	7	6.2	Limestone	4.3	8.3	2.7	7.6
5	Seriyaj	Vaghela Parivar deli	21	5	46.3	70	9	25.3	5.3	4.35	Limestone	5.1	7.9	2.5	8
6	Sakrana	Rana Bhai Kila Bhai	21	10	34.8	70	12	50.4	13.65	10.85	Basalt	3.7	8.1	2	8
7	Sakrana	KhimaBahi ArjanBhai Sholnki	21	10	19.5	70	13	16.4	15	13.75	Weathered Basalt	1.35	8.2	2.2	8.1
8	Sakrana	GovindBhai VashaBhai Kamadiya	21	10	39	70	13	7.1	19	15..9	Basalt	11.6	7.7	1.38	8.2
9	Sakrana	SarmnBhai MuruBhai Solnaki	21	10	22.6	70	13	31	20.8	18..35	Limestone	2.9	7.8	0.61	7.9
10	Virpur	KarshnBhai Meramanbhai Shnjva	21	9	33.9	70	12	45.4	26.05	21.8	Basalt	1.91	8	1.76	7.8
11	Virpur	DevaBhai RinaBhai Karmta	21	10	0.8	70	12	21.7	22.2	16.75	Limestone	1.52	8.1	1.64	7.7
12	Virpur	VasaBhai MeramanBhai Shnjva	21	10	7.9	70	12	1.5	21.7	17.4	Limestone	1.99	7.9	3.1	8
13	Virpur	ManshukhBhai HirjiBhai Panara	21	9	52.8	70	12	18.7	30.1	26.4	Limestone	1.58	8.5	2.7	8
14	Lambora	NajaBhai DevaBhai Vaja	21	9	36.6	70	12	12.8	25.1	18.1	Basalt	1.61	8.6	2.7	8.1
15	Lambora	VijayBhai JivaBhai Vara	21	9	23.5	70	11	30.6	17.2	10.5	Limestone	2.1	7.3	2.9	8
16	Lambora	LakhaBhai MunjaBhai Makliya	21	8	50.2	70	11	44.3	29.6	27.4	Limestone	2.3	8.2	3.1	7.9
17	Lambora	MeshuBhai NaranBhai Vala	21	9	13.8	70	11	31.9	23.4	20.1	Limestone	2.2	7.9	3.4	7.9
18	Pankhan	Punja Menan Parmar	21	12	37.5	70	12	37.2	7.1	6.7	Limestone	4.5	7.7	1.08	7.9
19	Pankhan	Lakhabhai Darbar	21	13	7.5	70	13	26.3	15.3	12.8	Basalt	5.5	7.7	2.3	7.5
20	Pankhan	Nathabhai Sevada Darbar	21	12	54.8	70	12	56.1	13	8	Basalt	4.3	7.9	1.18	7.7
21	Pankhan	Alabhai Kacharabhai	21	12	19.5	70	12	15.8	11	7.5	Basalt	2.3	8.1	0.81	8.1
22	Bhatgam	Lakhaman Arajan Solanki	21	10	43.1	70	12	11.1	10.8	7	Basalt	1.96	8	0.87	8.2
23	Bhatgam	Solanki Govindbhai Lakhamanbhai	21	10	50	70	11	48.5	18.75	10	Leterite	2.2	8.2	1.74	7.5

Source: Field Survey, 2009

Table No. 2.21 Details of Water and Soil Sample Collected in Study Villages of Noli River Basin Contd.....

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min	Sec	Deg	Min	Sec				Ec	pH	EC	pH
24	Bhatgam	Dayavanbhai Ahir	21	11	4.4	70	12	2.2	13	10.2	Basalt	3.5	7.7	1.53	7.7
25	Bhatgam	Gova Samant Parmar	21	9	57.6	70	11	26.5	15	4.7	Limestone	3	7.3	1.5	7.7
26	Dhelara	Hajihusen Rathod	21	8	18	70	11	18.6	34.6	25.75	Limestone	2.1	8	3.4	7.9
27	Dhelara	RanaBhai DoshaBhai Chavda	21	8	35.8	70	11	33.9	29.2	22.25	Limestone	4.5	8.1	3	8
28	Dhelana	Varzang Arajan Ker	21	8	45.3	70	10	29.4	38.8	27.8	Limestone	1.38	7.8	0.46	8.3
29	Dhelana	Hasanbhai Husenbhai Parsliya	21	8	57.3	70	10	47.6	34.7	27.7	Limestone	6.4	7.7	1.14	8.4
30	Kotada	BhagvanBhai ArjanBhai Kher	21	8	27.9	70	11	31.1	34.6	31.3	Limestone	2	8	3.2	8
31	Kotada	MeramnBhai HiraBhai Parmar	21	8	21.8	70	11	0.1	30.8	28.8	Limestone	1.79	8.1	2.9	7.9
32	Kotada	BhikhaBhai DevaBhai Kher	21	8	10.3	70	11	48.3	26.9	19.8	Limestone	1.66	8.1	4.1	7.6
33	Kotada	Pithad Mataji Mandir	21	7	20.3	70	9	59.9	20.9	18.7	Limestone	2.8	8	0.83	7.9
34	Kotada	Maganbapu (Kameswar Mahadev)	21	8	13.2	70	10	38.8	33.4	19	Limestone	1.31	7.9	0.85	7.9
35	Shekhpur	Mahamod Haji Khebhar	21	7	50.2	70	11	48.5	32.1	30.5	Limestone			3	7.9
36	Shekhpur	BudinBhai Husen Bhai Kher	21	7	29.9	70	11	4.9	34.2	32.8	Limestone	19.6	7.8	2.9	7.8
37	Shekhpur	GolaMohamd Ibrahim Khebhar	21	7	26.7	70	11	26	53.45	49.45	Limestone	0.98	8.5	1.7	7.7
38	Shekhpur	Dana Suda Rabari	21	7	13.5	70	11	11.2	56	54.1	Limestone	1.48	8.3	0.98	8.2
39	Hushena bad	Saran Vadi	21	6	56.4	70	9	58.2	44.1	27.65	Limestone	4.5	7.4	0.8	7.7
40	Hushena bad	HashnBhai KashamBhai Jada	21	6	28.5	70	10	12	33.9	22.65	Limestone	9.2	7.8	2.2	7.7
41	Hushena bad	DaudBhai SulemanBhai Karut	21	5	55	70	9	51.6	13.4	11.3	Limestone	12.2	7.7	5.9	7.2
42	Husenabad		21	6	28.1	70	9	55.8	25.2	17	Limestone	8.5	7.2	2.9	8.1
43	Pikhor	Kanabhai Govindbhai Solanki	21	11	20.7	70	11	51	17.7	12	Laterite	2.8	7.6	1.02	7.8
44	Sepa		21	6	57	70	11	20.2	53.1	48	Limestone	1.57	8.5	1.11	7.9

Source: Field Survey, 2009

2.2.4.2 Impact on Drinking and Irrigation Water

Impact of salinity control measures on water resource have also been assessed through village opinion during group discussion. In this process detailed discussion with villagers have held on before and after status of water resource from utilization (drinking and irrigation water use) point of view. This analysis was made based on information collected through group discussion and case study in study area.

Drinking Water: Table no. 2.22 shows villagers responses on before and after status of drinking in respective village.

Table no. 2.22 Before and After Drinking Water Status in Villages of Noli River Basin

Village		Problem of Drinking Water	Source of Drinking Water	Quantity of Water	Accessibility of DW	Quality of Water	Availability of DW for Livestock
Sakrana	Before	Yes	Well	Insufficient	100M	Saline	No
	After	Yes	Dam	Insufficient	22 KM	Turbid	No
Husenabad	Before	Yes	Well	Insufficient	100M	Saline	No
	After	Yes	Tank	Insufficient	50 KM	Sweet	No
Lambora	Before	No	Well	Sufficient	1KM	Sweet	Yes
	After	No	Well	Sufficient	1KM	Sweet	Yes
Shekhpur	Before	Yes	River	Insufficient	200M	Sweet	No
	After	Yes	Well	Insufficient	300M	Sweet	No
Virpur	Before	No	Well	Sufficient	0KM	Sweet	Yes
	After	Yes	Well	Insufficient	0.100KM	Turbid	No
Kotda	Before	Yes	Well	Insufficient	0KM	Sweet	No
	After	Yes	Dam	Insufficient	200M	Sweet	No
Bhatgam	Before	Yes	Well	Insufficient	0KM	Brackish	No
	After	Yes	Pipeline	Sufficient	300M	Sweet	No
Dhelna	Before	Yes	Well	Insufficient	1KM	Brackish	Yes
	After	Yes	Well	Insufficient	1KM	Brackish	Yes
Pankhan	Before	No	Well	Sufficient	1KM	Brackish	No
	After	No	Well	Sufficient	1KM	Brackish	No
Sheriyaj	Before	No	Well	Sufficient	IKM	Sweet	No
	After	Yes	Tank	Insufficient	40KM	Sweet	No

Source: Field Survey, 2009

The gist of the same are listed as…

- Lambora, Virpur, Pankhan and Seriyaj villages were not having drinking water problem before bandhara. However, Seriyan and Virpur have drinking water problem now the main reason given by farmer is increased salinity in groundwater.
- Except Lambora and Pankhan all villages are facing problem of drinking water now a days.
- Shekhpur, Kotda and Sheriyaj are facing problem of insufficient quantity of drinking water whereas rest of the villages are having both the problems i.e. quality (saline or turbid) and insufficient quantity.
- Open wells were the main drinking water source in all the villages before.
- There are river, tank and dams are additional drinking water source developed after bandhara.
- Sakrana, Husenabad, Bhatgam and Sheriyaj villages are connected with pipe water supply.
- Except Lambora and Dhelana all villages have insufficient water for cattle

- Some time water supply board provides water through tanker in Sheriyaj, and Husenabad villages.
- Dudhana, Dudheshwar and Maliya dams supplies water through pipeline.

Irrigation Water: To understand availability of irrigation water in study area a set of questions were asked during group discussion. Such question were focused on availability of water for all or individual season/seasons; type of water source; an introduction of water saving technologies etc. The responses from villagers are as follow.

- Open wells are till major water resource for irrigation.
- Before bandhara the wells were able to provide water only for support irrigation during Kharif season and very limited water remained left for Rabi crop.
- Even in present situation water in Husenabad, Seriyaj and Shekhpur villages is not sufficient for full crop during rabi season.
- Only about 200 farmers in villages of Sakrana, Lambora, Shekhpur, Bhatgam, Dhelana and Pankhan have adopted micro irrigation system for irrigation. Maximum farmers are in Sakrana and Pankhan villages.
- Salinity in groundwater is the main reason for very limited reception of micro irrigation techniques by farmers.

Major conclusion from above discussion can be draw as

- Even after taken so much of care villages are not self dependent their own drinking water management.
- There is a definite increase in Rabi season agriculture but the sufficient quantity of water is till question in front of farmers.
- Improvement in groundwater quality is not reached up to the level that can encourage farmers for large scale acceptance of micro irrigation technologies.

2.2.5 Impact on Health

It is already proven that 90 % of human health issues are related with water. Since the study area has a water quality threat due to salinity ingress the impact on health is assessed in study villages. There are many water born diseases exist in the villages of the Noli river basin. Following can be said the impact of water resources on health.

- The seasonal *Malaria* is seen in the villages like Shekhpur, Virpur, Bhatgam, Pankhan, Dhelana and Seriyaj. The malarial infection has not seen in the villages like Sakrana, Husenabad, Lambora and Kotda. However, the reason for malaria is water storage on surface not due to groundwater quality.
- Vector borne diseases and stones in kidney are seen in almost all the villages of the Noli river basin. The major agent of this kind of diseases is water. The village Kotda is safe from the stones in the kidney.
- The gastric problem is also major complained by villagers of the Noli river basin.
- Fluorosis which is caused due to excess of fluorine in water has seen Virpur village. The skin diseases are also results of poor quality of water in Virpur and Shekhpur.

2.6 Assets

Number of typical kinds of asset is an indirect indicator of overall socio-economic development of only area. Considering this, information on assets like four wheelers, two wheelers, tractors, water lifting devices were collected during village group discussion.

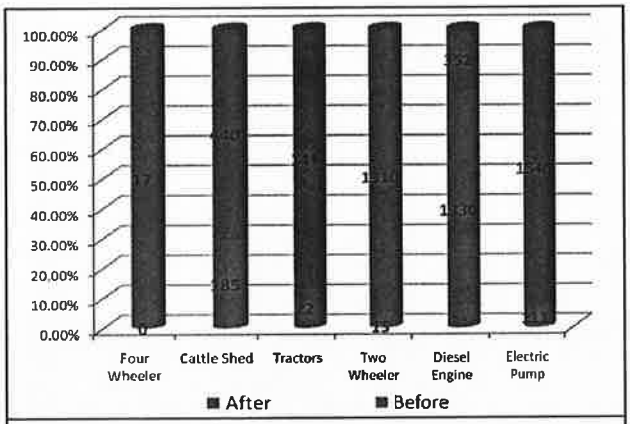


Fig. 2.8 Before and After Status of Assets in Villages of Noli River Basin

Table no. 2.23 gives detail accounts of assets in villages of Noli river basin. It is very clear that large decrease in numbers of diesel engine has took place due to electrification in all villages. One more important change taken place in this area is increasing numbers of tractors in agriculture practices.

Overall these two significant changes have influenced indirectly reduction of bullock population in some of the villages. Increased numbers of vehicle also indicating improvement in transportation facilities. Within vehicle category huge increase in two wheelers (from 15 to 1310) is noticed in this area. Pankhan (400) and Dhelana (225) are villages where maximum increased in two wheelers has been seen.

Table no. 2.23 Village Wise Before and After Status of Assets in Noli River Basin

Type of Asset		Four Wheeler	Cattle Shed	Tractors	Two Wheeler	Diesel Engine	Electric Pump
Sakrana	Before	0	0	0	0	200	1
	After	2	0	25	100	5	200
Husenabad	Before	0	0	0	0	150	50
	After	5	0	15	50	15	200
Lambora	Before	0	0	0	0	0	0
	After	1	0	5	50	10	60
Shekhpur	Before	0	0	0	0	150	0
	After	0	40	0	25	20	250
Virpur	Before	0	0	3	5	80	0
	After	2	0	11	60	50	175
Kotda	Before	0	0	15	0	100	0
	After	0	0	15	100	20	80
Bhatgam	Before	0	60	0	0	100	0
	After	0	200	10	175	50	50
Dhelna	Before	0	125	3	10	200	0
	After	3	200	45	225	25	225
Pankhan	Before	0	0	0	0	100	60
	After	0	0	10	400	7	200
Sheriyaj	Before	0	0	1	0	250	0
	After	4	0	8	125	150	100
Total	**Before**	**0**	**185**	**22**	**15**	**1330**	**111**
	After	**17**	**440**	**144**	**1310**	**352**	**1540**

Source: Field Survey, 2009

3. ASSESSMENT IN LANGDI RIVER BASIN

3.1 Characteristic of Langdi River Basin

The Langdi River is located in Mangrol taluka of Junagadh district. The bandhara on Langdi River is located at Sheriyaj village. The river originates about 15 km in upstream from the dam site. The river has almost southwestern flow. Langdi river merge with Noli river in down stream near Khodada village which knows as Khari river. The river bed of Khari is 360m wide and form meandering course before merging the sea about 3 km upstream of the dam site near village Khodada. Topographically, the area around the site is even and flat. The left bank abutment has small elongated ridge of limestone, while the right abutment has gently rising ground. The plain terrain on the left and right bank is under cultivation. Part of the left bank is covered with forest. The Miliolite Limestone is prime rock exposed in this area. Miliolite limestone is underlain by Gaj beads of upper Miocene and Pliocene age which are mainly composed of alternate beds of impervious clay and impure limestone. The Miliolite limestone is covered with soil, alluvium and coastal sands of recent age. The river passes through limestone area in tail portion.

Total five villages, Kukaswada, Budhecha, and Langodra of Maliya taluka and Khodada, Arena of Mangrol taluka were selected as a part of impact assessment of Langdi bandhara. Table no 3.1 shows salient features of Langdi Bandhara.

Table no 3.1 Salient Features of Langdi Bandhara

Total Catchment Area	290 Km^2
Full reservoir area	R.L. 2.50 Meter
High flood level	R.L. 5.50 Meter
Type of weir	Ogee shaped , Non gated
Location	River bed between Ch. 0.0 and 400 Meter
Length	280 Meter
Crest R.L.	2.50 Meter
Design discharge	1,32,840 Cusecs

Source: SIPC, 2009

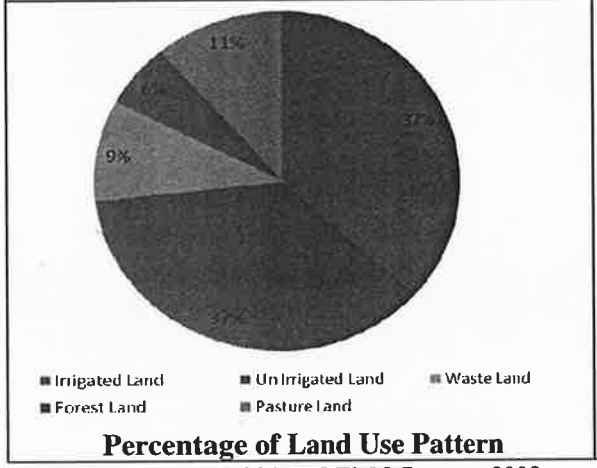
3.1.1 Land Use

The total land of the villages of the Langdi river basin is 5055.87 Ha. Out of total land Budhecha (1911.94 Ha) and Kukswada (1338.68 Ha) have more land whereas village Langodra has total land about 384.39 Ha. (Table No. 3.2) 74 % of the total land is used for agriculture purpose where irrigated as well as unirrigated land have equal ration. The pasture

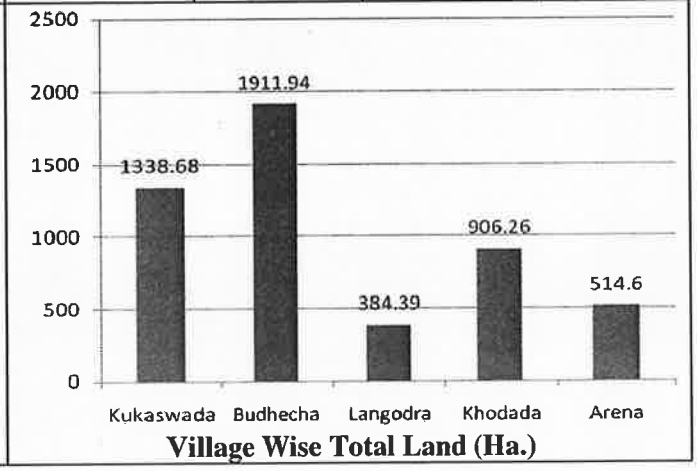
and waste land cover in the area are about 11 and 9 percentages respectively of total land use. Remaining 6 % is forest land.

Table no. 3.2 Village Wise Land Use in Langdi River Basin

Land Use (Ha.)	Kukaswada	Budhecha	Langodra	Khodada	Arena	Total
Irrigated Land	229.4	1200	200	86.84	131.31	**1847.55**
Un Irrigated Land	820.62	432.21	104.39	200	300.02	**1857.24**
Waste Land	191.33	95.5	20	94.57	80.78	**482.18**
Forest Land	0	0	0	310.75	0	**310.75**
Pasture Land	97.33	184.23	60	214.1	2.49	**558.15**
Total	**1338.68**	**1911.94**	**384.39**	**906.26**	**514.6**	**5055.87**



Percentage of Land Use Pattern



Village Wise Total Land (Ha.)

Source: Census, 2001 and Field Survey, 2009

According to the analysis Kukaswada has more unirrigated land than the agricultural land. The main reason of the increase in unirrigated land is change in water quality. The village Budhecha has maximum irrigated land is about 1200 Ha, whereas Langodra has minimum agricultural land. Kukaswada has the maximum waste land whereas Langodra has the least waste land. Forest land is only in Khodada village. (310.75 Ha.) Arena has the least pasture land or very negligible land.

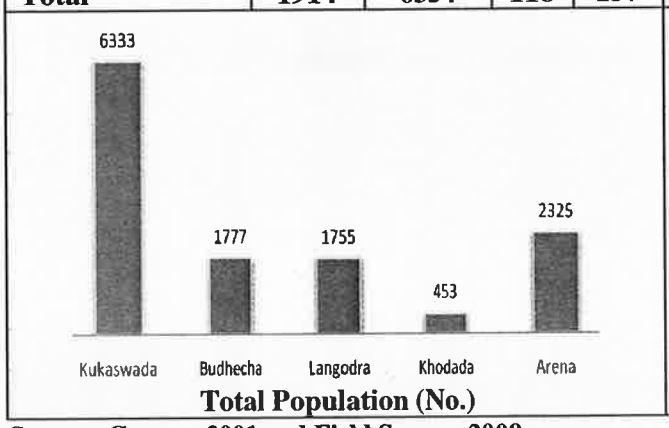
3.1.2 Demographic Status of the Study Villages

Total population of the area is about 12,643 distributed among 1914 households. Kukaswada (1000 No) is maximum population village whereas minimum population is in Kholada village (350 No). (Table no. 3.3) The sex ration in the study area stands at 912 female against 1000 male. The general caste is a dominating category.

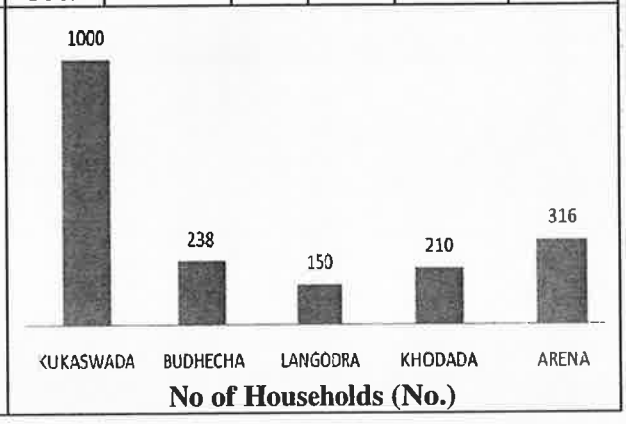
The general and OBC (other backward caste) together constitute large part of the population. These include Brahmins, Karadia rajputs, Ahir, Patels, Lohana etc. Karadia rajputs and Ahirs are most dominant communities among all. SC population in this area consists of Kolis, Harijans and Muslims. Rabaries (a marwadi caste), are main ST community in study village engaged in animal husbandry occupation.

Table no. 3.3 Household and Population (Caste Wise) in Study Villages

Sr. No.	Village	House Holds No.	Population								Total No.
			Men				Women				
			General	SC	ST	Total	General	SC	ST	Total	
1	Kukaswada	1000	3221	6	100	**3327**	2924	7	75	**3006**	**6333**
2	Budhecha	238	908	73	0	**981**	741	55	0	**796**	**1777**
3	Langodra	150	890	0	12	**902**	846	0	7	**853**	**1755**
4	Khodada	210	216	0	6	**222**	226	0	5	**231**	**453**
5	Arena	316	1119	39	19	**1177**	1089	46	13	**1148**	**2325**
Total		**1914**	**6354**	**118**	**137**	**6609**	**5826**	**108**	**100**	**6034**	**12643**



Total Population (No.)



No of Households (No.)

Source: Census, 2001 and Field Survey, 2009

3.1.3 Education Status

All the villages are facilitated by at least primary education systems. In addition village Kukaswada and Arena are also having schools up to SSC. Table no 3.4 shows status of education units and numbers of students studying in different villages. Kukaswada has maximum no. of students in the primary education i.e. 600, while Kotda has the least no. of students in the primary section. There is no college and higher secondary school facility in any village. Total about 11 Anganwadis and 9 schools are in Langdi river basin area.

Table no. 3.4 Village Wise Education Status in Villages of Langdi River Basin

Village	Type of School					
	Aanganwadi		1 to 7 Standard		8 to 10 Standard	
	Numbers	Students	Numbers	Students	Numbers	Students
Kukaswada	3	150	1	1200	1	800
Budhecha	2	50	1	60	0	0
Langodra	2	100	2	135	0	0
Khodada	2	45	1	222	0	0
Arena	2	45	2	325	1	180
Total	**11**	**390**	**7**	**1942**	**2**	**980**

Source: Field Survey, 2009

3.2 Socio Economical Impact Assessment

Impact of implementation of salinity prevention activities in Langdi River basin have been assessed from social, livelihood, and natural resource point of view. The socio-economical impacts of Langdi river basin development activities have assessed from (01) Residing

community and land holding; (02) Gender sensitization; (03) Impact on Livelihood; (04) drinking water; (05) Health and (06) Assets point of view.

3.2.1 Residing Community and Land Holding

To understand community wise impact, all households were classified as per their land holdings such as (01) Landless; (02) Marginal farmers (< 2.50 Acre); (03) Small farmers (2.5 to 5 Acre); and (04) Big farmers (> 5 Acre). Table no. 3.6 shows about 29.74 % of the total households are of landless class. Maximum landless families are in SC category. Total 85 % SC households are landless. The numbers of landless families in general caste are 27 % (of total general caste) and 26 % of total households of study area. Landless households of general and ST category are very negligible, instead maximum households of these categories are small farmers.

If we see the village wise analysis, landless families in general category are maximum in Kukaswada (419 HH) and Arena (152 HH) villages, whereas the same for SC communities are Langodra (24 HH) and Arena (13 HH) villages. (Table no. 3.5) Kukaswada, Langodra and Arena villages have highest number of the big farmers i.e. 838 farmers. According to the analysis, there are less marginal farmers in entire area. The big and small farmer categories in the area have equal numbers of households.

Table no. 3.5 Caste Wise Classification of Land Holding in Study Villages

Land Holding	Caste	No. of House Hold					
		Kukaswada	Langodra	Budhecha	Khodada	Arena	Total
LL	General	419	59	48	22	152	**700**
	SC	4	24	0	0	13	**41**
	ST	4	0	1	0	0	**5**
	Sub Total	**427**	**83**	**49**	**22**	**165**	**746**
M F (<2.50 Acre)	General	167	1	93	25	14	**300**
	SC	0	0	0	0	2	**2**
	ST	9	0	2	0	1	**12**
	Sub Total	**176**	**1**	**95**	**25**	**17**	**314**
SF (2.5 to 5 Acre)	General	399	80	87	35	99	**700**
	SC	0	2	0	0	2	**4**
	ST	22	3	1	2	4	**32**
	Sub Total	**421**	**85**	**88**	**37**	**105**	**736**
BF (>5 Acre)	General	412	270	51	10	156	**899**
	SC	0	1	0	0	0	**1**
	ST	2	20	0	0	1	**23**
	Sub Total	**414**	**291**	**51**	**10**	**157**	**923**
Total		**1438**	**460**	**283**	**94**	**444**	**2719**

Source: Field Survey, 2009

Based on this analysis it can broadly say that any agriculture land base activity cannot help directly to 25 % population of the area. Types of benefits to land holder families have discussed in detail under the livelihood – agriculture section.

Table no. 3.6 Caste Wise Landholding (No. of Households) in Study Villages

Caste	Land Less	Marginal Farmers	Small Farmer	Big Farmer	Total
General	700	300	700	899	**2599**
SC	41	2	4	1	**48**
ST	5	12	32	23	**72**
Total No.	**746**	**314**	**736**	**923**	**2719**
Percentage	27.44	11.55	27.07	33.95	100.00

Source: Field Survey, 2009

3.2.2 Gender sensitization

As discussed previously that female population in these villages is less than male and male: female ratio stands at 913 females against 1000 males. To understand change taking place in gender sensitivity levels in the study villages after Bandhara, some questions were discussed with the villagers such as,

Did the Bandhara help to save time of women for fetching Drinking Water? If yes where they utilize the time?

Did women take decision in your family?

Did women participate in community work?

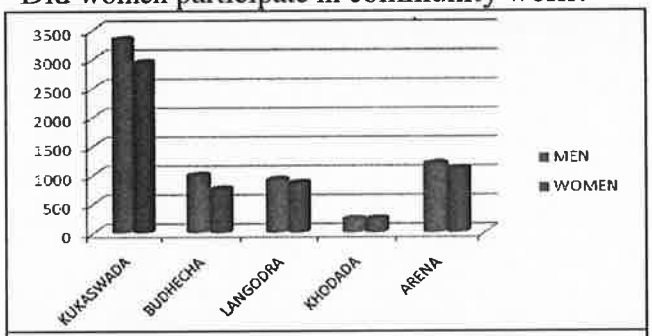


Fig. 3.1 Chart Shows Male Female Ration in villages of Langdi River Basin

Normally it is an assumption that, due to water harvesting/ groundwater recharge/ water conservation, groundwater quality and quantity improved at that level where every village can have their drinking water source at village level. And if the village has its drinking water source within the village, it decreases the time for women for fetching drinking water. Based on these two considerations, the first question was asked to the villagers. The people responses have clearly shown in this case, only two villages, Langodra and Arena have drinking water facility at village level and the reason for this is improvement of water quality after bandhara construction. But rests of the villages till suffer from drinking water problem and therefore women of these villages have to use their most of the time for water fetching. Women of Langodra and Arena villages have time saved from drinking water fetching and they can give attention to house hold activities.

Table no. 3.7 Village Wise Survey Results on Gender Sensitivity in Langdi River Basin

Village	Did the Bandhara Help to Save Time of Women for Fetching DW (Y/N)	If Yes Than Where They Use Their Time?	Do Women Take Decision in Your Family (Y/N)	Do Women Participate in Community Work
Kukaswada	No		Yes	Group meeting and *Gramsabha*
Budhecha	No		Yes	Group meeting
Langodra	Yes	Household work	Yes	*Gramsabha*
Khodada	No		No	*Gramsabha*
Arena	Yes	Household work	Yes	*Gramsabha*

Source: Field Survey, 2009

Regarding involvement of women in household level decision making people have responded positively, but the type of decisions generally taken by women are mainly social like marriage of children, purchase of jewelry etc. Hardly women involve into occupation level decisions. In village Khodada people have negatively responded. It is important to note that major population in Khodada is Rajputs.

While the responses on inquiry regarding women's involvement in different kinds of meetings, people have said that women passively involve in the *gramsabha* but they are not actively participate in discussion. In some villages like Kukaswada and Budhecha women are also involved into social activities done by NGOs and participating in group meetings besides *gramsabha.*

3.2.3 Livelihood Impact

The main occupations in the study area are agriculture and animal husbandry. In addition several households are managing their income through wage labour. Some people of the village like Kukaswada are also engaged with small trades. Among different occupations agriculture is one of the most vulnerable occupation can directly influenced by degradation of soil and water quality. While other means of livelihoods like agriculture labour and animal husbandry have indirect impact of degradation of such natural resources. Such impacts can be assess through studying increase/decrease production, migration pattern, increase/decrease milk production, change in livestock etc. Keeping this in mind, this section is discussing various impacts on different aspects of agriculture and animal husbandry occupations along with village wise migration pattern in study area.

3.2.3.1 Agriculture

About 75 % of the total families are engaged in agriculture. Sea water intrusion and groundwater salinization has badly affected this backbone economy of the area. According to census record of government of Gujarat, 2001 about 37 % of total land is characterizes as rainfed or un-irrigated land while 37 % of total land is irrigated agriculture land. Total about 74% of total land (3705 Ha) is under agriculture. (Table no. 3.2) Impacts of salinity ingress on agriculture after construction of water harvesting structures and bandhara in Langadi river basin have assessed through estimation of changes taking place in different agriculture types, change in cropping pattern, increase / decrease in irrigated area and rise and fall in production. In addition all assessment were done seasonally i.e. for Kharif, Rabi and Summer. Table no. 3.9 shows village wise season wise before and after status of agriculture in term of crops, crop sown area, and production.

In case of field crops, groundnut in Kharif and wheat in Rabi seasons are dominant crops in all the villages even after bandhara. Groundnut is main Kharif crop in all the villages, whereas Bajara is common second crop in Khodada and Arena villages. Bajara sown area has increased in Langodra village after bandhara, which is only change found in Kharif agriculture in this area. However, overall Bajara sowing area has decreased in this area. There is no second crop preference by farmers of this area during Rabi season due to limited water availability. There is only village, Budhecha where summer irrigation practices are going on for Bajara and Til crops. However, summer groundnut was sown by Langodra farmers before bandhara but in very limited area (115 Bigha).

Table no. 3.8 Season Wise Before and After Status Crop Area and Respective Unit Production in Villages of Langdi River Basin

Season	Crop	Area (Bigha)		Production Kg/ Bigha	
		Before	After	Before	After
Kharif	Groundnut	4050	4470	290	270
	Bajra	650	340	350	400
	Jowar	100	100	-----	-----
Total		**4800**	**4910**	-----	-----
Rabi	Wheat	3420	3730	500	500
Total		**3420**	**3730**	-----	-----
Summer	Bajra	500	500	800	800
	Til	500	500	200	200
	Groundnut	115	0	600	0
Total		**1115**	**1000**	-----	-----

Source: Field Survey, 2009

Table no. 3.9 Before and After Field Crop Status in Study Villages of Langdi River Basin

Village		Kukaswada		Budhecha		Langodra		Khodada		Arena	
Season	**Crop**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Kharif	Crop 1	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut
	Area (Bigha)	1750	1750	200	200	250	250	500	500	1350	1770
	Production (Kg/Bigha)	200	200	350	350	400	200	200	200	300	400
	Crop 2						Bajra	Bajra	Bajra	Bajra	Bajra
	Area (Bigha)						50	200	200	450	90
	Production (Kg/Bigha)							400	400	300	400
	Crop 3							Jowar	Jowar		
	Area (Bigha)							100	100		
	Production (Kg/Bigha)							For fodder	For fodder		
Rabi	Crop 1			Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)			2500	2500	250	200	400	400	270	630
	Production (Kg/Bigha)			1000	1000	800	300	500	500	600	800
	Crop 2									Jowar	
	Area (Bigha)									90	
	Production (Kg/Bigha)									For fodder	
Summer	Crop 1			Til	Til	Groundnut					
	Area (Bigha)			500	500	115					
	Production (Kg/Bigha)			200	200	600					
	Crop 2			Bajra	Bajra						
	Area (Bigha)			500	500						
	Production (Kg/Bigha)			800	800						

Source: Field Survey, 2009

There is very little increase in the agricultural land during Kharif (2 %) and Rabi (9 %) seasons after bandhara. Crop wise analysis shows decrease in Bajra sown area (about 52 %), whereas about 10 % increased in groundnut area is noticed during Kharif season. In case of Rabi season very marginal increase has seen in total agriculture area. Very marginal increase has seen in crop sown area during Rabi and reduction in crop sown area during summer season which indicate two possibilities i.e. (01) Insufficient water for irrigation, (02) Poor water quality.

Historically the area is very famous for horticulture and once upon it was known as "Lili Nager" due to its specific horticulture diversity. Besides Coconut, Nagervel, Guavaa, Saapota, varieties of Banana, and Kesar Mangoes were main crops of the area. Horticulture plantation was giving return of about Rs 5,000 per Bigha before a decade ago. Now a days due to degradation of groundwater quality horticulture crop diversity in the area has suffered a lot. Very few people of Arena village prefer Nagervel farming. Most of the farmers have replaced their plantation by groundnut or salt tolerant species of horticulture. And some farmers have totally destroyed their overheads and started field cropping only. Table no 3.10 shows status of horticulture in Langdi River basin villages. For all the village irrigation source for horticulture is shallow groundwater and farmers prefer flood method for irrigation. The vegetable plantation is very negligible and is not done as source of income but to fulfill the household requirements.

Case Study: 2 Case of Kalubhai Chudasam Village: Khodada

- Per unit production of groundnut in Kharif season has increased from 150 to 400 kg/ Bigha.
- After bandhara Rabi season irrigation facility increased.(Wheat sown in 9 bigha)
- Groundwater quality improved after bandhara.
- Annual agriculture income increased up to Rs. 2.5 lakh from Rs. 1.5 lakh.

Case Study: 3 Case of Sarmanbhai Bara Village: Arena

- Groundnut productivity increased by 300 to 450 kg/ Bigha.
- Bandhara water provided additional irrigation for rabi season (Wheat in 8 bigha, fodder in 2 bigha)
- After bandhara, farmer started coconut based horticulture in 5 bigha through river irrigation.
- Groundwater quality improved after bandhara.
- The increment in annual income was recorded by 20 per cent after bandghar construction. This gain was observed due to increased land under irrigation.

Table no. 3.10 Before and After Bandhara Status of Horticulture

Village		Species	Plantation Area (Bigha)	Irrigation Source	Irrigation Method	Income Rs/Bigha
Kukaswada	Before	--	--	--	--	--
	After	Coconut, Sapota	50	Well	Flood	5000
Budhecha	Before	--	--	--	--	--
	After	Coconut	100	Well	Flood	15000
Langodra	Before	Banana	250	Well	Flood	50000
	After	Coconut, Sapota	240	Well	Flood	15000
Kholada	Before	--	--	--	--	--
	After	Coconut, Sapota	90	Well	Flood	1000
Arena	Before	Banana, Nagarvel, Guava	600	Well	Flood	2400
	After	Coconut	1300	Well	Flood	7200
Total	Before		850			
	After		1780			

Source: Field Survey, 2009

To assess soil quality of agriculture land in study villages, total 23 soil samples were collected from farms. These samples were collected from total six villages, where Gotana village is

outside from the study area. Average 4 to 5 samples collected from each study village. Table no 3.18 gives details of sample location and chemical properties like Ec and pH. This analysis was carried out by Central Soil Salinity Research Institute based at Bharuch. According to this, total 4 samples show high Ec value than normal range; this land shows more salinity than other land. On the other hand total 19 samples from agriculture indicate normal value. Minimum Ec value shows in Khodada Village (0.3), while maximum value is also in same village (7.1 Ec). pH range shows normal value from 7 to 8.5.

3.2.3.2 Animal Husbandry

Livestock composition is dominated by large size animal like buffalo and cattle (cow and bullock) types. The present livestock population in these villages is 4132, which was about 3720 before bandhara. There is a significant 37 % increase in buffalo population. Cow population has also increased in this area, while no change in total bullock population in this area. However fluctuation in bullock population has seen within the village. One major change in small animal has seen in this area. Goat and sheep population has decreased at large extent that may be an indicator of fodder and water securities for large animal.

Village wise analysis shows following changes in livestock.

- In Kukaswada cow (from 100 to 200), buffalo (from 0 to 500) and bullock (from 0 to 200) population have increased.
- Buffalo population has decreased in Budhecha village from 400 to 300.
- In case of Langodra Cow and bullock population have decreased whereas buffalo population increased.
- Similar to Kukaswada population of all three large cattle have increased in Kholada village.
- Maximum buffalo population has increased in Arena village.

Table No. 3.11 Change in Livestock Population Villages of Langdi River Basin

Village		Cow	Buffalo	Bullock	Goat	Sheep	Camel	Total
Kukaswada	Before	100	0	0	0	0	0	**100**
	After	200	500	200	0	0	0	**900**
Budhecha	Before	150	400	50	20	0	0	**620**
	After	150	300	50	20	0	0	**520**
Langodra	Before	200	100	400	400	0	0	**1100**
	After	100	250	60	0	0	0	**410**
Kholada	Before	50	250	0	0	0	0	**300**
	After	293	405	240	250	0	0	**1188**
Arena	Before	100	100	300	1000	100	0	**1600**
	After	20	850	200	20	20	4	**1114**
Total	Before	**600**	**850**	**750**	**1420**	**100**	**0**	**3720**
	After	**763**	**2305**	**750**	**290**	**20**	**4**	**4132**

Source: Field Survey, 2009

Lacting Cattle Ratio: Heard management in animal husbandry is the main factor that maintains its economical sustainability. Again heard management is mainly depends on numbers of lacting cattle in a heard. The ratio of lacting cattle against total number of cattle is main deciding factor for total livestock population especially in milk base animal husbandry. In case of Langdi basin the lacting cattle ratio was analyzed to understand how animal husbandry occupation is contribute in economy of the area, where natural resource like groundwater is deteriorating by sea water ingression and damaging economy like agriculture. Table no 3.13 shows the before after bandhara changes in lacting cattle ratio in villages of Langdi river basin.

Table no. 3.12 Village Wise Details of Livestock and Milk Production in Villages of Langdi River Basin

Cattle Type	Details	Kukaswada		Budhecha		Langodra		Kholada		Arena	
		Before	After	Before	After	Before	After	Before	After	Before	After
Cow	Nos	100	200	150	150	200	100	50	293	100	20
	Lactating Cattle	600	80	75	100	80	25	30	200	50	20
	Lactation Period (days)	210	270	210	210	210	210	210	210	240	240
	Milk Production lit/day	4	3	3	3	4	4	8	8	6	6
Buffalo	Nos	0	500	400	300	100	250	250	405	100	850
	Lactating Cattle	0	400	250	200	30	125	150	300	50	425
	Lactation Period (days)	0	210	210	270	210	270	270	210	240	240
	Milk Production lit/day	0	4	5	5	6	6	10	10	7	7
Bullock	Nos	0	200	50	50	400	60	0	240	300	200
Goat	Nos	0	0	20	20	400	0	0	250	1000	20
Sheep	Nos	0	0	0	0	0	0	0	0	100	20
Poultry	Nos	0	0	0	0	0	0	0	0	0	0
Camel	Nos	0	0	0	0	0	0	0	0	0	4
Other	Nos	0	0	0	0	0	0	0	0	25	0

Source: Field Survey, 2009

Table no 3.13 Change in Lactating Ratio Against Total Cattle Population

Village	Cattle Type	Change in Ratio %		Remark
		Before	After	
Kukaswada	Cow	60 %	40 %	
	Buffalo	----	80 %	Dairy development and other trade
Budhecha	Cow	50 %	67 %	
	Buffalo	62 %	66 %	
Langodra	Cow	40 %	25 %	
	Buffalo	30 %	50 %	
Khodada	Cow	60 %	65 %	
	Buffalo	57 %	75 %	
Arena	Cow	50 %	100 %	Total population decrease
	Buffalo	50 %	50 %	

Source: Field Survey, 2009

In case of cow, numbers of lacting animal against total number of cows in heard has remained more or less same in Budhecha, Langodra and Khodada village, while it has decreased in Kukaswada village by 20 % than before. Where as in case of Arena village due to reduction of total population of cow, now very few families are keeping cow for their own milk requirement and therefore there are 100 % lacting cow population in village Arena.

In case of buffalo total population has increased in village Kukaswada, Khoda and Arena. All these villages are located near highway and development along this highway, as well as easy transport in addition to dairy development and fodder security seems to be main reason for such high population growth of buffalo. Impact of these facilities and securities on lacting cattle in a heard can also seen through the table that Khodada and Arena villages the ratio is more or less steady where in case of Kukaswada there was no buffalo before bandhara.

Milk Production and Dairy Development: Field survey data have clearly shown that milk collection centers have established in all villages after bandhara construction. Annually milk collection from all villages is about 4.64 lakh liters which contributes worth of Rs.206 Lakh income in the villages of Langdi River Basin. In previous section of cattle population, it is already discussed that buffalo population in these villages have increased suddenly. Dairy activity may be one of the strong reasons behind this increase. These all dairy centers are of NDDB. The average rate of the price fetch by milk is Rs 18 per liter. The price mainly depends on the fats of the milk. The maximum annual milk collection (2.92 lakh liter/year) is collected at Arana center. Total 482 households of all five villages sell their milk to the collection centers. (Table no. 3.14) Village wise maximum households of Kukaswada village (200 HH) sell their milk to the centers. Per household maximum 6.5 lit/HH is being sold to the center by Arena village people.

Table no. 3.14 Details of Milk Selling at Milk Collection Center in Study Villages

Detail		Total Household Selling Milk	Daily Milk Collection (Lit)	Annual Milk Collection (Lit)	Average Rate Rs/lit	Total Income From Milk Rs. in Lakh
Kukaswada	Pre	0	0	0	0	0.00
	Post	200	150	54750	16	8.76
Budhecha	Pre	0	0	0	0	0.00
	Post	50	100	36500	20	7.30
Langodra	Pre	0	0	0	0	0.00
	Post	10	120	43800	25	10.95
Kholada	Pre	0	0	0	0	0.00
	Post	100	100	36500	20	7.30
Arena	Pre	0	0	0	0	0.00
	Post	122	800	292000	22	64.24
Total	**Pre**	**0**	**0**	**0**	**0**	**0.00**
	Post	**482**	**1270**	**463550**	**103**	**205.79**

Source: Field Survey, 2009

The interaction with farmers during group discussion has revealed that …

- Increase in buffalo is mainly due to enhancement in fodder securities through improvement in water resources. Another reason for increasing buffalo population is its average milk production and increased market opportunity through dairy development in this area.
- Increase in irrigation opportunity during winter and summer seasons is the main reason for increasing population of bullock in this area.

3.2.3.3 Migration and Labour

Increase in wage labour and migration are also indicators of natural resources potentials. It is already discussed that salinity ingress in groundwater has badly impacted agriculture. Keeping these facts in mind migration pattern in Langdi basin area has understood. Before and after bandhara Migration pattern in Langdi river basin is presented in Table no. 3.15.

Following are main observations.

- There is only one village, Langodra where no migration has recorded even after the bandhara.
- Khodada and Arena are villages where migration is started after bandhara construction.
- Migration places are different for all villages i.e.
    - Kukaswada mainly maldharis migrates for cattle grazing in Gir area.
    - Budhecha people migrate in Savarkundla taluka for labour.
    - Khodada people migrated to Jamnagar for jobs in industries like driver.
    - Arena people migrate to neighbour villages as agriculture labour.
- Before and after bandhara numbers of migratory people remained same in Kukaswada and Budhecha villages, whereas it increased in Khodada (200 persons) and Arena (400 persons) villages. Total about 1805 persons are migrating from these four villages of Langdi river basin.
- So far the income is concerned migration is additional source of income for Khodada and Arena village after bandhara.

Table no. 3.15 Migration Trend in Study Villages of Langdi River Basin

Village		Kukaswada	Budhecha	Khodada	Arena	Total
Migration	Before	Yes	Yes	No	No	
	After	Yes	Yes	Yes	Yes	
Persons (No.)	Before	100	50			**1240**
	After	100	50	200	400	**1805**
Type of Work	Before	Grazing Cattle	Labor			
	After	Grazing Cattle	Labor	Industrial jobs	Agri. labor	
Place	Before	Gir	Savarkundla			
	After	Gir	Savarkundla	Jamnagar	Nearest village	
Season	Before	Winter, Summer				
	After	Winter, Summer	Summer	Winter,Summer	All seasons	
Days – Annually	Before	240	60			
	After	240	60	240	365	
Annual Income Rs.	**Before**	**24000**	**3600**	**0**	**0**	**27600**
	After	**24000**	**3600**	**36000**	**40000**	**103600**
	Change	**0**	**0**	**36000**	**40000**	**76000**

Source: Field Survey, 2009

3.2.4 Impact on Water Resources

There were two methods adopted to assess impact on ground water resources of the study area. The methods are study of changes in groundwater level and quality mainly based on secondary data recorded by SIPC and availability of water for different uses. In these cases only drinking and irrigation uses have considered for assessment.

3.2.4.1 Change in Groundwater

Salinity Ingress and Prevention Cell, Government of Gujarat is a responsible department for implementation of coastal salinity related programme in any coastal areas of state. In addition to implementation, impact assessment and long term monitoring of different water resource related parameters like groundwater level, water quality (status as well fluctuation) are also their responsibilities. Therefore, department has establish their own observation network of well. In Langdi river basin, department has monitored 8 wells around Khodada village. Besides these wells there is no any long term monitoring well in upper catchment areas of the basin. In any watershed area, any intervention carried out in upper reaches has their definite implications in lower catchment. The scale and type of impacts absolutely depends on specific characteristics of the particular watershed or basin. Keeping this in mind the analysis of monitoring wells had carried out to understand fluctuation trends in water level and water quality in lower reaches (coastal parts) of Langdi River Basin. Well hydrograph were prepared to understand secular and seasonal changes taking place in groundwater levels in last several years.

During this study, random well inventory and sample collection carried out in each village. Total 24 samples collected from these villages including bandhara surface water also. Table no 3.18 shows details of sample collection. Analysis of these samples were done by Central Soil Salinity Research Institute, Bharuch. Based on well inventory data, Limestone is one only main aquifer in the study area. This survey was carried out in month of June, year 2009.

Table no. 3.16 Pre Monsoon Water Level Fluctuation in Kholada Village Observation Wells (Years from 1991 to 2007) Khodada

Well Code		SB-6	SB-7	SB-8	SB-9	SB-10	SB-11	SB-12	SB-13
R.L.(m)		3.31	5.5	5	3.6	3	3	5.7	7
Pre Monsoon RWL	1991	----	-2.04	-1.35	-1.95	-1.28	-1.4	----	----
	1992	-1.49	-1.4	-1.4	-1.5	-0.6	-1.5	----	----
	1993	-1.19	-2.3	-1.3	-1.7	-0.8	-1	-0.8	1
	1994	-1.59	-1	-0.4	-1.5	-1.5	-1.2	-0.5	0.9
	1995	-2.19	-0.5	-0.6	-1.6	-1.2	-1.1	-0.8	1.1
	1996	-1.59	-0.9	-0.9	-1.5	-0.9	-1.1	-0.8	0.7
	1997	-1.29	-1.3	-1.4	-1.5	-1.1	-1	-0.8	-1.1
	1998	-1.79	-1.6	-3.4	-1.5	-1.1	-0.9	----	0.5
	1999	-0.79	-1.9	-1	-0.2	-0.6	-0.3	-0.1	-0.4
	2000	-2.99	-1.4	-1.7	-4.3	-3.8	-3.9	----	0.5
	2002	-0.89	-2.3	-0.5	-0.5	-1.1	-0.6	----	-1.1
	2003	-1.09	-1.3	-1.3	-1.9	-1.8	-1	----	-1.5
	2004	-1.29	0.4	----	----	-1.7	----	0	----
	2005	-2.29	-2.4	-3.3	-2.9	----	----	----	0.6
	2006	1.19	-2.1	-2.7	-4.2	-5.5	-5.2	-2.7	-0.4
	2007	-3.29	----	-1.5	-4.2	-5.1	-5.76	-2.8	0.8
		-0.79	-0.5	-2.2	0.3	-5.3	----	0	----

Source: SIPC, 2009

It is important to clarify that the conclusions regarding the water level fluctuation and quality have following limitations.

- Analysis were based on secondary data recorded by SIPC
- Very limited Monitoring well in very limited area, lower reach of watershed i.e. monitoring in Seriyaj village only.

- Available data were of only pre monsoon seasons therefore, a seasonal change in water level, due to rainfall was not possible to carry out.

Water Level Fluctuation: The trends of water level in all the wells show fluctuation from 1991 to 2008. (Table no. 3.16) Out of eight monitoring wells hydrographs of observations well no SB6, SB7 and SB10 have prepared.

Hydrographs of observation well SB6 and SB10 clearly shows that water level in this area has depleted gradually from 1991 to 2008 at a rate of 0.5 m to 2.25 m. There is little rise in water level in well no. SB7 but it is very low < 0.5 m.

Depletion condition of water level in the area shows water harvesting structures may have not influenced groundwater levels of the area. It may have impacted on groundwater quality through recharge.

Based on well inventory data (Table no 3.18), maximum depth of water level observed in Arena, Langodra and Budhecha, where maximum depth is 40.35 in Arena village. Khodada and Kukaswada villages have shallow depth groundwater.

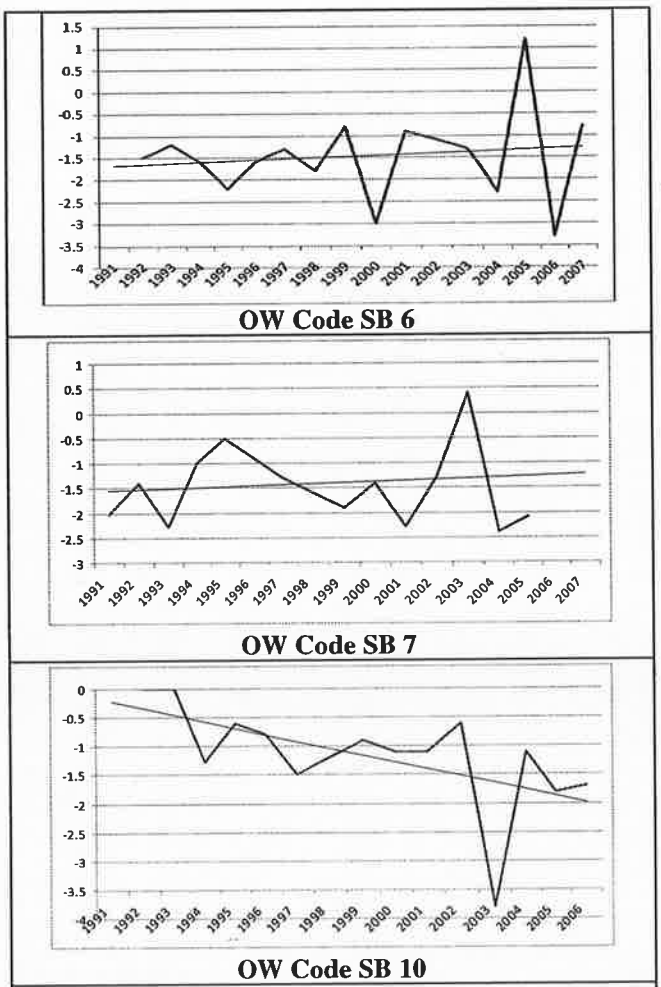


Fig. 3.2 Hydrographs of Observation Wells of Kholada Village

Water Quality: Changing trends in groundwater quality has been understood by preparing well hydrographs of fluctuating values of Total Dissolved Solids in groundwater as well as changes in ratio of chloride carbonate ration.

Figure no. 3.3 show well hydrographs prepared for measured TDS values in Kodada area. The TDS values remained nearly same during 1991 to 2000 whereas the sudden increase was noticed during years 2001 and 2002 and during 2003 and 2004. Again it suddenly decreased, in year 2005 and 2006; it was minimum in compare to last years. Than again it increased. It is important to notice that the same water quality fluctuation is observed in Sheriyaj observation wells also. Sudden rise and sudden fall in TDS value in observation well reflects there may be a factor which controls immediate recharge or discharge in groundwater by rainfall or recharge structure. Again lithologically the area has limestone as main aquifer. There are many cavities results due to hydrochemical weathering in limestone. Because of this secondary porosity in such limestone are very high. Sudden improvement in groundwater quality in this area may be a result of rapid recharge of such cavities due to rainfall or rainwater harvesting activities in the study area.

Table no. 3.17 Water Quality in Observation Wells of Kholada Village, (1991 to 2007)

Well Code			SB-6	SB-7	SB-8	SB-9	SB-10	SB-11	SB-12	SB-13
Pre Post Monsoon	1991	TDS	-----	4844	5457	5067	5986	4009	-----	-----
		CL.	-----	2400	2760	2560	3080	1920	-----	-----
		Cl:CO3 Ratio	-----	37.56	37.18	72.11	33.37	15.91		
	1992	TDS	5297	6935	7404	5183	6835	4671	-----	-----
		CL.	2680	3440	4040	2520	3520	2120	-----	-----
		Cl:CO3 Ratio	54.31	69.71	142.25	29.7	35.53	15.75	-----	-----
	1993	TDS	4717	4484	-----	4426	6698	7280	5708	5620
		CL.	2240	2080	-----	2120	3560	3880	2760	2720
		Cl:CO3 Ratio	52.73	24.35	-----	33.18	45.65	45.42	48.39	22.49
	1994	TDS	5234	7517	8630	6124	7795	7517	6403	8352
		CL.	2640	3600	4600	2800	3760	4200	2960	4400
		Cl:CO3 Ratio	19.55	23.08	43.19	17.95	29.37	39.43	23.12	51.79
	1995	TDS	4176	5234	7238	2784	6682	6403	7238	1503
		CL.	1920	2360	3880	1200	3240	3160	3680	520
		Cl:CO3 Ratio	14.99	15.33	32.21	5.92	23.99	22.25	34.55	3.76
	1996	TDS	3571	5952	7440	3928	6547	5446	4226	3571
		CL.	1640	2880	3760	1760	3240	2640	1880	1640
		Cl:CO3 Ratio	17.72	21.34	44.25	16.52	30.53	28.53	4.77	8.87
	1997	TDS	6220	4702	5714	3125	6119	7720	7029	2047
		CL.	3160	2280	2960	1440	3120	4000	3720	920
		Cl:CO3 Ratio	29.67	17.8	31.98	10.14	13.3	31.24	37.38	4.7
	1998	TDS	6095	7576	7576	5810	5354	8772	-----	6550
		CL.	3000	3840	3920	2920	2560	4600	-----	3480
		Cl:CO3 Ratio	32.42	28.47	46.17	22.83	20.01	58.99		49.01
	1999	TDS	5174	7821	3850	3489	3429	3549	3850	8422
		CL.	2560	4040	1840	1640	1640	1720	1840	4480
		Cl:CO3 Ratio	40.21	113.8	25.92	23.1	23.1	25.61	37.20	126.2
	2000	TDS	7047	7923	6290	4834	5009	5358	-----	7746
		CL.	3520	4000	3200	2360	2400	2640	-----	4040
		Cl:CO3 Ratio	26.07	80.86	75.32	44.37	56.49	49.63	-----	187.6
	2002	TDS	6013	5401	5568	3898	5735	6013	-----	5401
		CL.	2960	2720	2560	1840	2800	2840	-----	2760
		Cl:CO3 Ratio	31.99	25.54	18.03	17.28	43.74	57.41	-----	27.73
	2003	TDS	12813	10483	12813	5242	6173	10716	-----	9435
		CL.	6200	5040	6520	2640	3040	5720	-----	4720
		Cl:CO3 Ratio	62.3	50.64	26.24	37.18	35.78	57.48	-----	41.59
	2004	TDS	10118	13094	-----	-----	12499	-----	12499	-----
		CL.	5000	6680	-----	-----	6560	-----	6680	-----
		Cl:CO3 Ratio	70.42	104.35	-----	-----	77.21	-----	94.08	-----
	2005	TDS	6618	3730	10227	9024	-----	-----	-----	9024
		CL.	3320	1800	5240	4680		-----	-----	4720
		Cl:CO3 Ratio	116.42	31.56	73.8	94.61	-----	-----	-----	82.76
	2006	TDS	2912	4892	4543	11706	3028	4019	8154	3902
		CL.	1320	2400	2000	6320	1320	1840	4040	1720
		Cl:CO3 Ratio	20.62	48.52	12.82	77.35	14.28	17.28	40.6	16.15
	2007	TDS	4285	-----	4129	774	4404	4464	4166	714
		CL.	2040	-----	1960	280	1920	1920	2000	264
		Cl:CO3 Ratio	41.24	-----	30.62	4.91	24.62	14.22	40.43	3.11
	2008	TDS	3611	6406	3611	728	4601	-----	4543	-----
		CL.	1600	3240	1680	224	2240	-----	2240	-----
		Cl:CO3 Ratio	12.5	50.61	9.1	3.93	22.51	-----	39.28	-----

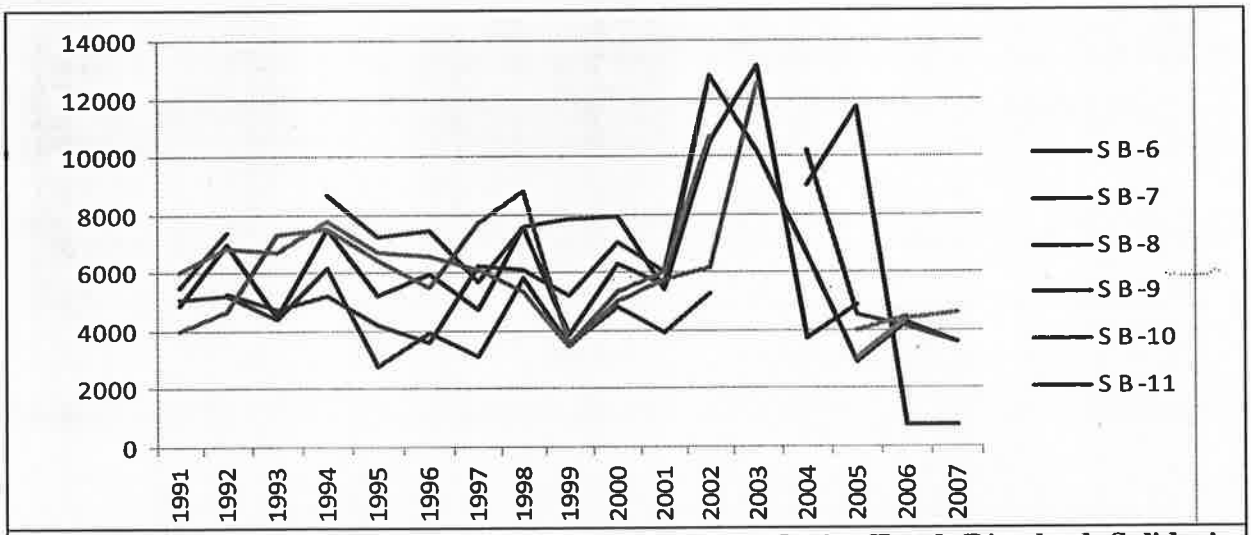


Fig. 3.3 Well Hydrograph Showing Changing Trends in Total Dissolved Solids in Ground Water

Source: SIPC, 2009

Based on well inventory data (Table No. 3.18), it can interpret that out of total 24 samples, only 9 samples belongs to potable water quality means Ec less than 2.8 (1800 ppm TDS). High Ec value has been observed in total 14 samples. Village Gotana and Budhecha have very low salinity in compare to other villages. Surface water of Langdi bandhara shows 10.9 Ec indicates highly salinity water. In groundwater, maximum salinity observed in Arena village (12.6 Ec), while minimum in Budhecha village (1.4 Ec). If we see pH range, it seems normal range in all the samples.

In addition to TDS concentration Chloride and Carbonate + Bicarbonate ration in groundwater of the study area was computed. (Table no.3.15) Almost in all the wells the ration is much more than 6 that also clearly indicates injurious contamination of groundwater by sea water. Following conclusion can be draw based on this behavior of the wells.

- The stable concentration of TDS during year 1991 to 2001.
- Abrupt salinity increased in the area during year 2003-2004 may be due to over exploitation of groundwater and low rainfall during these years.
- Sudden decrease in salinity has taken place during 2005 to 2007 which may be due to heavy rainfall during these years.
- In all wells TDS concentration during year 2008 is less than year 1991.

3.2.4.2 Impact on Drinking and Irrigation Water

Impact of salinity control measures on water resource have also been assessed through villager's opinion during group discussion. In this process detailed discussion with villagers have hold on before and after status of water resource from use (drinking and irrigation water use) point of view. This analysis was made based on primary information collected through group discussion and case study in the study area.

Table No. 3.18 Details of Water and Soil Sample Collected in Study Villages of Langdi River Basin

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min	Sec	Deg.	Min	Sec				EC	PH	EC	PH
1	Khodada	Langadi Bandhara	21	4	16.7	70	9	30				10.9	8		
2	Khodada	Siyabhai Virabhai garcha	21	4	3.2	70	9	25.5	5.9	4.9	Limestone	6.3	8.2	7.1	7.3
3	Khodada	Bhupatsinh Parmsinh Darbar	21	4	2	70	9	42.9	4.9	4.15	Limestone	2	8.2	1.17	7.5
4	Khodada	Shurabhai Devayat Chavda	21	4	5.3	70	10	27.9	6.9	6	Limestone	10.8	7.9	0.56	7.8
5	Khodada	Momay Mataji Mandir	21	4	7.5	70	10	51.1	4.3	3.6	Limestone	5.1	7.9	0.3	7.8
6	Kukaswada	Arjanbhai Samtabhai Ram	21	4	4.5	70	11	1.4	5.15	4.55	Limestone	8.3	7.5	1.86	7.7
7	Kukaswada	Arshibhai Jadav	21	4	8.7	70	11	30.5	10	9.1	Limestone	4.2	8	0.59	7.7
8	Kukaswada	Lhakhabhai Shejabhai Charia	21	4	8	70	11	29.4	10.5	8.7	Limestone	11.5	7.8	3.2	7.4
9	Kukaswada	Rajabhai Raiabhai Solanki	21	4	2.1	70	11	43.4	15	12.3	Limestone	12.5	7.7	2.5	7.8
10	Aarena	Hamibhai Markhibhai Dhramrotia	21	4	29.7	70	11	10.1	14	10	Limestone	8.9	8.1	1.34	7.7
11	Arena	Siyar Jetha Garsar	21	5	3.06	70	0	57.9	36.6	27	Limestone	9.3	7.4	3	7.9
12	Arena	Siva Arajan Samath	21	5	15.4	70	10	55.8	18.3	14	Limestone	12.6	7.3	2.9	7.8
13	Arena	Heera Kesur Ram	21	5	27.1	70	10	58.7	52	40.35	Limestone			1.7	7.7
14	Langodra	Javiben Sarmnbhai Malm	21	4	22.7	70	11	31.4	23	9	Limestone	10.9	7.8	2.4	7.5
15	Langodra	Ukabhai shavdas bhai Parmar	21	4	31.1	70	11	41	29.72	25	Limestone	8.7	7.6	2.2	7.9
16	Langodra	Parbatbhai Naranbhai Jotava	21	5	5.9	70	12	23.4	53	35	Limestone	2.5	7.2	2.3	7.9
17	Langodra	Gokadbhai Ramabhai Nannera	21	5	6.3	70	12	34.2	54	36.4	Limestone	1.9	7.6	1.15	8.2
18	Gotana	Haja Deva Gotana	21	5	37.1	70	13	42.4	23.3	20	Limestone	1.45	8.4	0.8	8.2
19	Gotana	Maheswaniya Bharatkumar	21	5	5.2	70	14	12.3	42	25	Limestone	1.84	8.4	1.1	8.3
20	Gotana	Bhagavan Natha Mori	21	4	45.5	70	14	26.3	32.9	31.1	Limestone	1.45	8	0.63	8.2
21	Budhecha	Karsan Thobhan Padhiyar	21	5	28.9	70	13	7.5	36.6	28	Limestone	1.8	8.6	0.46	8.2
22	Budhecha	Karubhai Vastabhai Jadav	21	6	12.4	70	12	9	45.75	36	Limestone	1.18	8.2	0.9	8.4
23	Budhecha	Hemantpuri Devpuri Goswami	21	5	53.5	70	12	37.3	24.4	20	Limestone	4.2	8.1	1.07	8
24	Budhecha	Raysingvhai Meramanbhai	21	5	30.1	70	13	28.7	30	25	Limestone	1.4	8.3	0.65	8.3

Source: Field Survey, 2009

Drinking Water: Table no. 3.19 shows on before and after status of drinking water in villages. The gist of the same are listed below.

- Langodra and Arena villages were not having drinking water problem before bandhara. Lagondra is still does not have drinking water problem.
- Insufficient quantity is major drinking water problem in all villages.
- Earlier open well was the main drinking water source in all the villages.
- Khodada and Arena villages have salinity problem in drinking water, whereas in Kukaswada turbidity of water is quality issue.
- Gotana dam supplies water through pipeline to village Kukaswada

Table no. 3.19 Drinking Water Status in Villages of Langdi River Basin

Village		Problem of Drinking Water	Source	Quantity	Accessibility of DW	Quality of Water	Availability of DW for Livestock
Kukaswada	Before	Yes	Well	Insufficient	100M	Turbid	No
	After	Yes	Tank	Insufficient	3 KM	Sweet	No
Budhecha	Before	Yes	Well	Insufficient	150M	Sweet	No
	After	Yes	Well	Insufficient	150M	Sweet	No
Langodra	Before	No	Well	Sufficient	0KM	Sweet	Yes
	After	No	Tank	Insufficient	0	Sweet	No
Kholada	Before	Yes	Well	Insufficient	0KM	Saline	No
	After	Yes	Well	Insufficient	0KM	Saline	No
Arena	Before	No	Well	Sufficient	0KM	Sweet	Yes
	After	Yes	Well	Insufficient	0KM	Saline	No

Source: Field Survey, 2009

Irrigation Water: To understand availability of irrigation water in study area, a set of questions were asked during group discussion. Such question were focused on Availability of water for all or individual season/seasons; Type of water source; and Introduction of water saving technologies etc. The responses from villagers are as follow.

- Open wells are till major water resource for irrigation
- Before bandhara the wells of Budhecha, Langodra and Arena villages were able to provide water for support irrigation during Kharif season and there was sufficient water for Rabi irrigation also. The same quantity of water is still supply by wells in these villages.
- In case of Langodra, wells were supplying enough water during summer season before bandhara years.
- About 275 farmers of Kukaswada and Langodra villages have adopted micro irrigation system for irrigation. Maximum farmers are in Langodra village. Salinity in groundwater is the main reason for very limited reception of micro irrigation techniques by farmers.

Major conclusion from above discussion can be draw as .....

- Most of the villages in this basin are self dependent for their drinking water.
- There is a definite increase in Rabi season but sufficient quantity of water is till question.
- Improvement in groundwater quality is not reached up to the point that do not encourage farmer for large scale acceptance of micro irrigation technologies.

3.2.5 Impact on Health

Since the study area has a water quality threat due to salinity ingress the impact on health is assessed in study villages. There are many water borne diseases exist in the villages of the Langdi river basin. Following can be said the impact of water resources on health.

- The seasonal malarial has seen in the villages like Langodra, and Arena. The malarial infection has not seen severely in rest of the villages.
- Vector borne diseases and stones in kidney are also in all villages.
- Fluorosis which causes due to excess of fluorine in water has seen Arana village.
- The skin diseases are mainly seen in Langodra.
- The gastric problem has seen generally in all villages.

3.6 Assets

Number of asset is an indirect indicator of overall socio-economic upliftment. Information on assets like four wheelers, two wheelers, tractors, water lifting devices have collected during village group discussion. Table no. 3.20 gives detail account of assets in study villages. Diesel engines have been replaced by electric motors in all villages. Moreover increase in two wheeler and four wheeler has found in the area. Tractors are also increasing in this area. All these mechanization in agriculture have caused impact on following.

- Decrease in livestock population
- Decrease agriculture labour opportunity

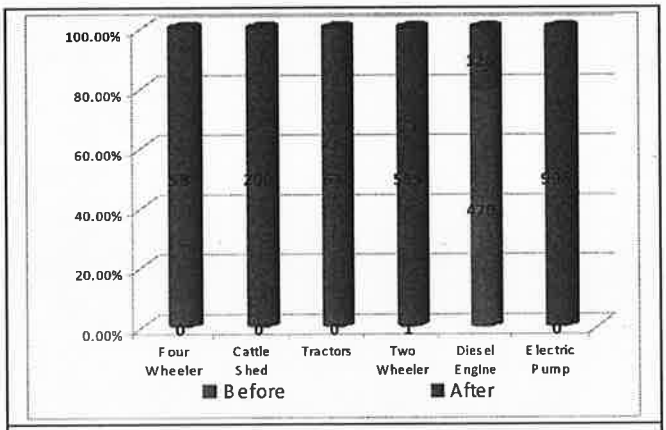


Figure no. 3.4 Before and After Status of Assets in Villages of Langdi River Basin

Table no. 3.20 Village Wise Before and After Status of Assets in Langdi River Basin

Type of Asset		Four Wheeler	Cattle Shed	Tractors	Two Wheeler	Diesel Engine	Electric Pump
Kukaswada	Before	0	0	0	1	50	0
	After	50	0	20	100	0	230
Budhecha	Before	0	0	0	0	150	0
	After	2	0	15	200	4	200
Langodra	Before	0	0	0	0	200	0
	After	0	0	2	35	10	250
Kholada	Before	0	0	0	0	0	0
	After	1	50	3	50	100	1
Arena	Before	0	0	0	0	70	0
	After	5	150	27	200	12	315
Total	**Before**	**0**	**0**	**0**	**1**	**470**	**0**
	After	**58**	**200**	**67**	**585**	**126**	**996**

Source: Field Survey, 2009

4. IMPACT ASSESSMENT OF KHADA BANDHARA

4.1 Characteristics of Khada Bandhara

As a part of salinity control activity, Khada Bandhara has constructed on Chhasi River near Khada village of Una taluka of Junagadh district. The bandhara is named by nearer village Khada. Physiographically the area around the Khada bandhara is generally flat with gentle eastward slope and then meets to sea. There are few sand dunes near submergence area of the bandhara. Approximate height of sand dunes is 6.15 m. These sand dunes are parallel to the waste weir section. Main geological formation is Miliolitic Limestone noticed in basin and periphery area. This limestone is overlain by recent deposits like silty sand and clayey soil. Some foraminifera and other fossils embedded in miliolite formation. This limestone contains numerous solution cavities of varying shapes. This is main aquifer of the area and groundwater is only source to fulfill water requirement especially for irrigation. Now a days groundwater is depleting due to over use and also affected due to salinity ingress. The affected villages are Khada, Khajudra, Dandi, Simar and Senjaliya. Under the study of impact assessment of Khada bandhara, these villages have been selected.

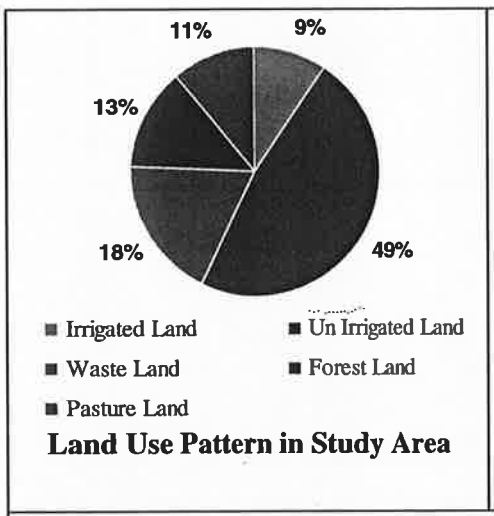
4.1.1 Land Use

The total land of studied villages around Khada bandhara is about 4120.82 Ha. Village Simar has maximum 1895 Ha land whereas village Khada has minimum land 297.2 Ha. (Table No. 4.1). 58% of total land is used for agriculture purpose that further divided into irrigated (9 %) and unirrigated land (49 %). The pasture and waste land cover area is spread over 18% and 11% respectively. Remaining 13 % is forest land. The maximum irrigation land (219 Ha) is in Simar village. More un-irrigated land is due to low groundwater potential in the area.

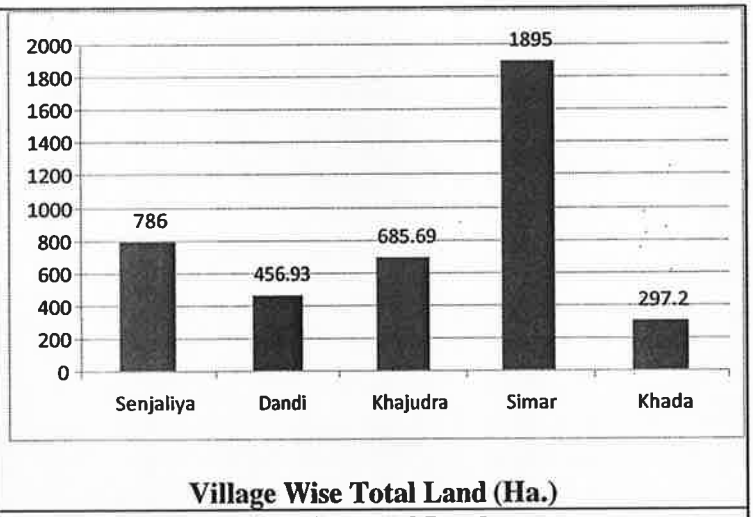
Table no. 4.1 Village Wise Land Use Around Khada Bandhara

Land Use (Ha.)	Senjaliya	Dandi	Khajudra	Simar	Khada	Total
Irrigated Land	75.4	19	34	218.99	40.32	**387.71**
Un Irrigated Land	199.24	266.35	327.6	1140.03	32.89	**1966.11**
Waste Land	225.26	115.3	121.41	282.37	16.3	**760.64**
Forest Land	283.28	0.00	0.00	137.1	129.5	**549.88**
Pasture Land	2.82	56.28	202.68	116.51	78.19	**456.48**
Total	**786**	**456.93**	**685.69**	**1895**	**297.2**	**4120.82**

Source: Census, 2001 and Field Survey, 2009



Land Use Pattern in Study Area



Village Wise Total Land (Ha.)

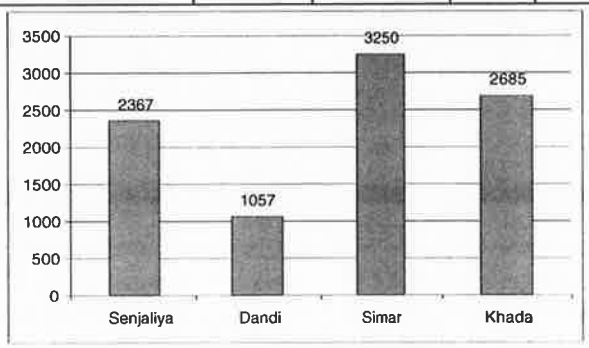
Fig. 4.1 Shows Land Use Pattern in Study Area and Village Wise Total Land

4.1.2 Demographic Status

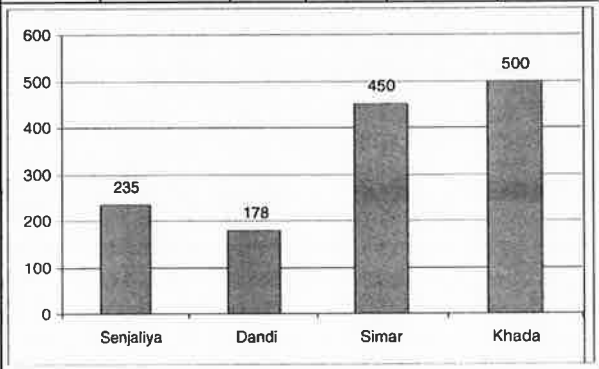
Total population of the study area is 9,359 persons distributed among 1363 households. Simar (3250 no.) has maximum population. (Table no. 4.2) The sex ration in the study area stands at 864 female against 1000 male. The general caste is a dominating category in all villages. ST community is absent in study area. Even SC population is only in Simar village. The general and OBC (other backward caste) together include Brahmins, Karadia Rajputs, Ahir, Patels, Lohana etc.

Table no. 4.2 Village Wise Household and Population (Caste Wise) in Study Villages

Sr. No.	Village	House Holds No.	Population								Total No.
			Men				Women				
			General	SC	ST	Total	General	SC	ST	Total	
1	Senjaliya	235	1278	00	00	**1278**	1089	00	00	**1089**	**2367**
2	Dandi	178	556	00	00	**556**	501	00	00	**501**	**1057**
3	Simar	450	1200	550	00	**1750**	1000	500	00	**1500**	**3250**
4	Khada	500	1438	00	00	**1438**	1247	00	00	**1247**	**2685**
Total		**1363**	**4472**	**550**	**00**	**5022**	**3837**	**500**	**00**	**4337**	**9359**



Total Population (No)



Households (No)

Source: Census, 2001 and Field Survey, 2009

4.1.3 Education Status

All villages have primary education systems, while Simar has higher secondary education facility also. Table 4.3 shows village wise education facilities and no of students. There are total 8 Anganwadi and 5 schools in study villages provide education to about 1169 student.

Table no. 4.3 Education Status in Study Villges of Khada Bandhara

Village	Type of School							
	Aanganwadi		1 to 7 Standard		8 to 10 Standard		11 to 12 Standard	
	No.	Students	No.	Students	No.	Students	No.	Students
Senjaliya	1	12	1	178	0	0	0	0
Dandi	1	13	1	85	0	0	0	0
Khajudra	1	30	1	180	0	0	0	0
Simar	4	100	0	0	0	0	1	325
Khada	1	8	0	0	1	238	0	0
Total	**8**	**163**	**3**	**443**	**1**	**238**	**1**	**325**

Source: Field Survey, 2009

4.2 Socio Economical Impact Assessment

Various Impact of Khada bandhara on surrounding villages have been assessed from social, livelihood, and natural resource point of view. These social and technical indicators are (01) Residing community and land holding; (02) Gender sensitization; (03) Impact on Livelihood; (04) drinking water; (05) Health and (06) Assets.

4.2.1 Residing Community and Landholding

To understand community wise impact all households were classified as per their landholdings such as (01) Landless; (02) Marginal farmers (< 2.50 Acre); (03) Small farmers (2.5 to 5 Acre); and (04) Big farmers (> 5 Acre). Table no. 4.4 shows big farmers in these villages are only 2.3 % and belongs to Khada village only. Whereas 11.5 % i.e. 200 families are landless in these area.

Table no. 4.4 Classification of Land holding in Study Villages Around Khada Bandhara

Landholding	Caste	Senjaliya	Dandi	Khajudra	Simar	Khada
Landless	General	0	10	90	20	200
	SC	0	0	0	50	0
	ST	0	0	0	0	0
	Total	0	**10**	**90**	**70**	**200**
Marginal Farmers < 2.50 Acre	General	0	103	210	200	150
	SC	0	0	0	80	0
	ST	0	0	0		0
	Total	0	**103**	**210**	**280**	**150**
Small Farmers 2.5 to 5 Acres	General	235	65	150	150	0
	SC	0	0	0	0	0
	ST	0	0	0	0	0
	Total	**235**	**65**	**150**	**150**	**0**
Big Farmers > 5 Acres	General	0	0	0	0	40
	SC	0	0	0	0	0
	ST	0	0	0	0	0
	Totals	**0**	**0**	**0**	**0**	**40**
Total		**235**	**178**	**450**	**500**	**390**

Source: Field Survey, 2009

If we see the village wise analysis, maximum landless families are in Khajudra (90 HH), Khada (200HH) and Simar (70 HH) villages, whereas maximum marginal farmers are belong to Simar village. Simar is the only village where all kinds of landholding category families staying.

Table no. 4.5 Caste Wise Landholding (No. of Households) in Study Area

Caste	Land Less	Marginal Farmers	Small Farmer	Big Farmer	Total
General	320	663	365	40	1388
SC	50	80	0	0	130
Total No.	**370**	**743**	**365**	**40**	**1518**
Percentage	**24.37**	**48.95**	**24.04**	**2.64**	**100.00**

Source: Field Survey, 2009

4.2.2 Gender Sensitization

As discussed in previous section total female population is 4337 persons and male: female ration stands at 864 female against 1000 male. To understand change taking place in gender sensitivity levels in the study villages, following questions were discussed with the villagers such as

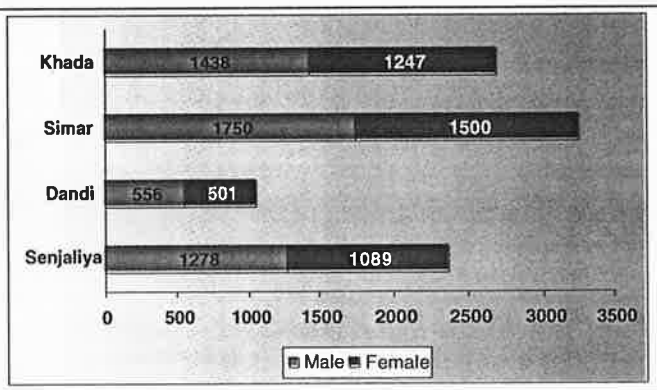


Fig. 4.2 Chart Shows Male Female Ration in Villages Around Khada Bandhara

Did the Bandhara help to save time of women for fetching DW? If yes where they utilize the time?
Do women take decision in your family?
Do women participate in community work?

Normally it is an assumption that, due to water harvesting/ groundwater recharge/ water conservation, groundwater quality and quantity improved at that level where every village can have their drinking water source at village level. And if the village has its drinking water source within the village, it decreases the time for women for fetching drinking water. Based on these two considerations, the first question was asked to the villagers. The people responses have clearly shown that in all villages women have to spend their time for fetching drinking water. Regarding decision making, only in Khajudra women are participating in *gramsabhas* but are not more than 30 %. Women of all villages involve into social activities. Involvement of women in household level decision making has restricted up to decision like marriage of children, purchase of jewelry etc. Table no. 4.6 shows the responses of the people of different villages.

Table no. 4.6 Village Wise Survey Results on Gender Sensitivity – Khada Bandhara

Village	Did the Bandhara Save Time of Women for Fetching DW (Y/N)	Do Women Take Decision inYour Family (Y/N)	Do Women Participate in Community Work
Senjaliya	No	Yes	Social activities
Dandi	No	No	Social activities
Khajudra	No	Yes	*Gramsabha*
Simar	No	No	Social activities
Khada	No	Yes	Social activities

Source: Field Survey, 2009

4.2.3 Livelihood Impact

The main occupation in the study villages are agriculture and animal husbandry. In addition to this several households have marginal labour option for income generation and in some people of the village like Khada are also engaged in fishing. Among different occupations agriculture is one of the most vulnerable occupation can directly influenced by degradation of soil and water quality. While other means of livelihoods like agriculture labour and animal husbandry have indirect impact of degradation of such natural resources. Such impacts can be assess through studying increase/decrease production, migration pattern, increase/decrease milk production, change in livestock etc. keeping this in mind, this section is discussing various impact on different aspects of agriculture and animal husbandry occupations along with village wise migration pattern in study area.

4.2.3.1 Agriculture

There are two agriculture seasons i.e. Kharif and Rabi, no summer crops practices in this area. Cotton, Bajra and Groundnut are main Kharif crop, whereas wheat is main crop of Rabi season. Priority wise Cotton is main Kharif crop and Bajra is second common crop. Farmers of Khajudra and Simar villages sow Groundnut as third crop, while in case of Khada Caster is third crop. Senjaliya and Dandi village farmers take only two crops in Kharif season. Survey data shows crop sown area has decreased from 9463 Bigha to 8750 Bigha in Kharif season whereas it increased from 1500 Bigha to 3900 Bigha in Rabi season. The reason of decrease is submerges of agriculture land in Bandhara water during monsoon.

Case Study: 4 Case of Bhagabhai Village: Khada

Due to submergence of agriculture land (3 acre out of 5.5 acre) Kharif and Rabi seasons are not utilized by Bhagabhai for agriculture purpose. While in case of summer hardly 2 bigha land can use for fodder crop. The main source of income of the family is through wege labour. Annual income is about 12,000 Rs. Bhagabhai annually borrows 30,000 to 40,000 Rs (@ 5 % interest) from private money lender.

Case Study: 5 Case of Malabhai Solanki Village: Simar

- Total land became irrigated land. (4.1 acre)
- Productivity of groundnut increase by 250 to 425 kg/bigha. He also earned Rs. 27000/- per year from coconut plantation.
- Due to ground water recharge the quality of water has improved.
- Income from agriculture has increased about Rs. 6,000/- per year. Now the family members are full time occupied with agriculture works.
- Repayment capacity has increased that can judge through before farmer was borrowing 1500 Rs for food, but now he borrows loan from bank of about 30,000 Rs. with 7 % interest rate for agriculture purpose.

Two significant changes have been observed in this area are (01) Decrease in rainfed (Kharif) crop sown area and (02) Increase in winter crop area. All most in all villages Kharif crop area has decreased, however it is maximum in Simar (2000 Bigha to 300 Bigha). This decrease is mainly due to submergence of land. Maximum increase in Rabi irrigation area is in Simar (900 Bigha) and Khada (1000 Bigha) villages.

Horticulture practice has still continued in most of the villages (except Dandi) even before bandhara construction. Plant species wise only Simar has mango plantation in 500 Bigha. No change has noticed in mango production even after Khada

bandhara. Normally coconut is planted on farm boundary. Case study data on coconut plant productivity shows huge decrease in per plant income up to Rs.75 from 200 Rs. per plant e.g. Khajudra. Same in Khada this decrease rate is up to Rs. 100 from Rs. 300. Overall impact of groundwater salinity in this area is very clearly reflected by reduction in number of horticulture species and increasing plantation of coconut and Sapota like salt tolerance species. For all the village irrigation source for horticulture is shallow groundwater and farmers prefer flood method for irrigation.

The vegetable plantation is very negligible and is not done as source of income but to fulfill the household requirements.

Table no. 4.7 Season Wise Crop Area and Unit Production (Before and After construction of Khada Bandhara

Season	Crop	Area (Bigha)		Production (Kg/Bigha)	
		Before	After	Before	After
Kharif	Cotton	5388	4775	2800	2800
	Bajra	1775	1675	1400	2200
	Castor	500	500	200	400
	Groundnut	1800	1800	400	400
Total		**9463**	**8750**	--	--
Rabi	Wheat	1375	3725	1800	1800
	Fodder	175	175	--	--
Total		**1550**	**3900**	--	--

Source: Field Survey, 2009

Table no. 4.8 Status of Horticultural plantation in the command area of Khada Bandhara (Before and After)

Village		Species	Plantation Area (Bigha)	Irrigation Source	Irrigation Method	Production Kg/Bigha	Income (Rs/ Plant)
Sejariya	Before	Coconut	Boundary	Well	Flood	-----	-----
	After	Coconut	Boundary	Well	Flood	-----	-----
Dandi	Before	-----	-----	-----	-----	-----	-----
	After	-----	-----	-----	-----	-----	-----
Khajudra	Before	Coconut	50	Well	Flood	-----	200
	After	Coconut	50	Well	Flood	-----	75
Simar	Before	Mango	500	Well	Flood	4000	-----
	After	Mango	500	Well	Flood	4000	-----
Khada	Before	Coconut	Boundary	Well	Flood	-----	300
	After	Coconut	Boundary	Well	Flood	-----	100
Total	**Before**		**550**				
	After		**550**				

Source: Field Survey, 2009

Soil quality of agriculture land has been assessed through analysis of soil sample. Therefore total 20 samples were collected from total five villages, where average 4 to 5 soil samples represent each village. Table no 4.17 gives details of sample location and chemical properties like Ec and pH. This analysis was carried out by Central Soil Salinity Research Institute based at Bharuch. According to this, only two samples of Shimar (4 Ec) and Khajudra (4.8 Ec) shows soil salinity, while other samples indicate normal soil quality in Ec point of view. Minimum Ec value shows in Khada Village (0.21). All the sampes indicate PH value more than 8 and less than 9.

Table no. 4.9 Before and After Field Crop Status in Surrounding Villages of Khada Bandhara

Village		Senjaliya		Dandi		Khajudra		Simar		Khada	
Season	**Crop Pattern**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Kharif	**Crop Name 1**	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
	Area (Bigha)	500	375	180	180	1700	1500	1500	100	1500	1000
	Production (Kg/Bigha)	800	800	400	400	600	600	600	600	400	400
	Crop Name 2	Bajra	Bajra	Bajra	Bajra	Bajra	Bajra	Bajra	Bajra	Caster	Bajra
	Area (Bigha)	125	125	750	500	300	100	500	200	500	750
	Production (Kg/Bigha)	400	800	600	400	200	200	200	200	200	600
	Crop Name 3	-----	-----	-----	-----	Groundnut	Groundnut	Groundnut	Groundnut	Bajra	Caster
	Area (Bigha)	-----	-----	-----	-----	300	500	1500	1300	100	500
	Production (Kg/Bigha)	-----	-----	-----	-----	200	200	200	200	600	400
Rabi	**Crop Name 1**	Wheat	-----	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)	125	-----	300	500	600	850	100	1000	250	1250
	Production (Kg/Bigha)	600	-----	400	400	200	200	200	200	400	400
	Crop Name 2	-----	-----	Fodder	Fodder	-----	-----	-----	-----	Fodder	Fodder
	Area (Bigha)	-----	-----	50	50	-----	-----	-----	-----	125	125
	Production (Kg/Bigha)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Source: Field Survey, 2009

4.2.3.2 Animal Husbandry

All type of livestock exists in villages around Khada bandhara. Population wise small animals (Goat and Sheep) are double than large cattle (Cow and Buffalo). Only Khada village has some poultry farms. The total numbers of birds in farm is about 500.

There is marginal but gradual increase in all kind of animal population. However in Khajudra and Khada village, cow population has slightly decreased from previous. Buffalo population has decreased in Simar (from 250 to 70) and Khada (from 250 to 135). (Table No 4.10, Figure No. 4.3)

The results of all villages are very clearly indicating about 22.5 % total increase in bullock population in all villages, but maximum increase is in Senjaliya village i.e. from 100 bullocks to 800 bullocks. It is interesting to point that except Senjaliya bullock population has decreased. The interaction with farmers during group discussion has revealed that this decrease is mainly due to increased use of tractor in agriculture practices.

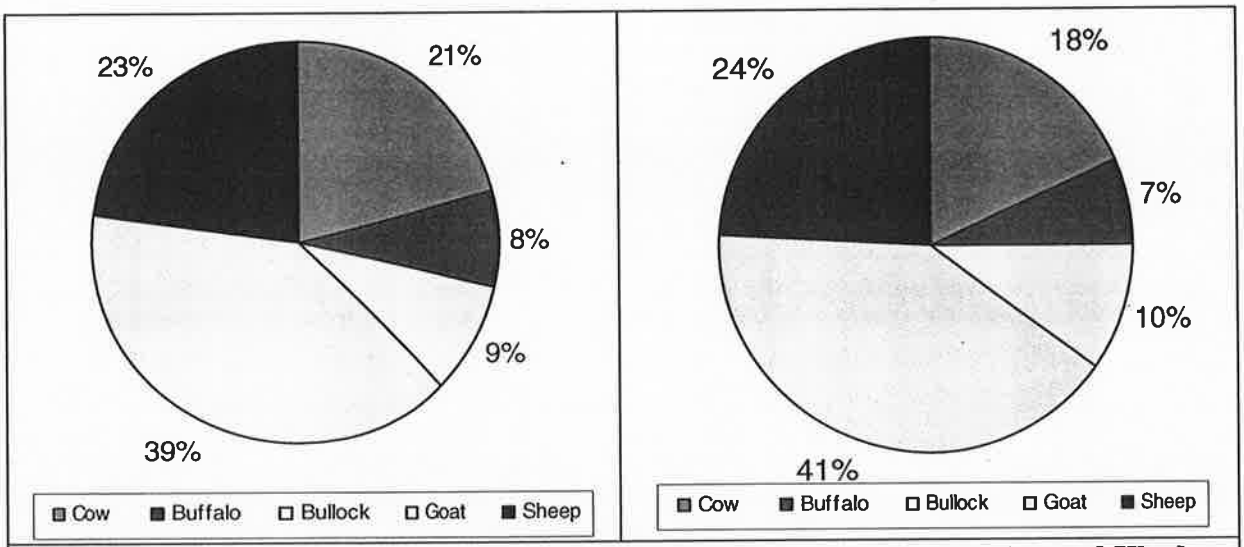


Fig. 4.3 Figure Show Change in Livestock Population in Study Villages Around Khada Bandhara (Before and After)

Goat and sheep population in these villages also show increasing trend. About 19.65 % and 23.57 % increase have been observed in goat and sheep population respectively. Population increase of small cattle in any area is an indicator of maintenance problem in large cattle due to fodder insecurity. According to village people following are the reasons

- Decrease in rainfed agriculture area due to submergence
- Reduction in grazing lands
- Change in cropping pattern more cash crop sowing in Kharif season
- Very limited fodder crop sowing
- Lack of milk selling facilities

Table No. 4.10 Change in Livestock Population in Command area of Khada Bandhara

Cattle Type	Senjaliya		Dandi		Khajudra		Simar		Khada		Total	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Cow	250	300	300	345	1500	1200	700	1000	300	235	**3050**	**3080**
Buffalo	20	50	100	87	500	800	250	70	250	135	**1120**	**1142**
Bullock	100	800	150	103	600	500	300	200	200	50	**1350**	**1653**
Goat	500	400	500	400	2500	3000	2000	2500	250	580	**5750**	**6880**
Sheep	250		300	278	1000	1500	1500	2000	250	300	**3300**	**4078**
Total	**1120**	**1550**	**1350**	**1213**	**6100**	**7000**	**4750**	**5770**	**1250**	**1300**	**14570**	**16833**

Source: Field Survey, 2009

Table no. 4.11 Details of Livestock and Milk Production in Villages around Khada Bandhara

Type	Details	Senjaliya		Dandi		Khajudra		Simar		Khada	
		Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Cow	No	250	300	300	345	1500	1200	700	1000	300	235
	Lactating Cattle	60	125	100	150	500	300	200	500	200	100
	Lactation Period (days)	240	200	240	240	200	200	240	200	240	240
	Milk Production Lit/day	2	2	2	3	2	3	2	2	2	2
Buffalo	Nos	20	50	100	87	500	800	250	70	250	135
	Lactating Cattle	16	25	75	65	350	500	200	50	100	100
	Lactation Period (days)	240	250	270	250	250	240	270	240	270	270
	Milk Production Lit/day	4	5	3	3	4	4	4	5	4	5
Bullock	No	100	800	150	103	600	500	300	200	200	50
Goat	No	500	400	500	400	2500	3000	2000	2500	250	580
Sheep	No	250		300	278	1000	1500	1500	2000	250	300
	Milk Production Lit/day										700
Poultry	No	1000								500	

Source: Field Survey, 2009

Lacting Cattle Ratio: Heard management in animal occupation is the main factor that maintains its economical sustainability of a family. Again heard management is dependent on number of lacting cattle in a heard. The ratio of lacting cattle against total numbers of cattle is mainly deciding factor of total livestock population especially in milk base animal husbandry.

Table no 4.12 Lacting Cattle Ratio in Villages of Khada Bandhara Area

Village	Type of Cattle	Ratio	
		Before	After
Sejariya	Cow	24 %	41 %
	Buffalo	80 %	50 %
Dandi	Cow	33 %	43 %
	Buffalo	75 %	75 %
Khajudra	Cow	33 %	25 %
	Buffalo	70 %	62.5 %
Simar	Cow	28 %	50 %
	Buffalo	80 %	71 %
Khada	Cow	66 %	42 %
	Buffalo	40 %	74 %

Source: Field Survey, 2009

Lacting cattle ratio in cow was ranging from 24% (Senjaliya) to maximum 66 % in Khada village before Bandhara but after bandhara this ratio has changed from minimum 25 % in Khajudra and maximum 50 % in Simar village. In case of buffalo the ratio has remained same more or less except high increase in village Khada from 40 % (before) to 74 % (after). This nominal change in ratio reflects fodder condition is still same as it was before bandhara.

Milk Production and Dairy Development: Facility of milk collection centers is in Simar and Khada villages only. In case of Simar the center has started after construction of Bandhara whereas in Khada it was exists even before Bandhara. Milk collection has decreased from 3.65 Lakh liters to 1.46 Lakh liters at Khada center. The average milk price per liter has increased from Rs. 18 to 20. This may be due to increase in fat in buffalo milk. Table no. 4.13 shows details of milk collection at center and respective income from this.

Table no. 4.13 Details of Milk Selling at Milk Collection Centers

Details	Simar		Khada	
	Pre	Post	Pre	Post
Total Household Selling Milk	----	12	250	170
Daily Milk Collection (Lit)	----	150	1000	400
Annual Milk Collection (Lit)	----	54750	365000	146000
Average Rate Rs/lit	----	20	18	20
Total Income from Milk Rs. in Lakh	**----**	**10.95**	**65.7**	**29.2**

Source: Field Survey, 2009

The interaction with farmers during group discussion revealed that

- Increase in buffalo is mainly due to enhancement in fodder securities through improvement in water resources. Another reason for increasing buffalo population is its average milk production and increased market opportunity through dairy development in this area.
- Increase in irrigation opportunity during winter and summer seasons is the main reason for increasing population of bullock in this area.
- In spite of all development till farmers have to face difficulties to rear large animals and therefore people still prefers small animals. So that they can easily migrate with them. Another reason for small cattle in majority of households is landless, marginal and small farmer. For them big cattle is not affordable.

4.2.3.3 Migration and Labour

Increase in wage labour and migration are indicators of degradation of natural resources. It is already discussed that salinity ingress in groundwater has badly impacted traditionally backboned occupation of agriculture. Before and after bandhara Migration pattern in villages around Khada bandhara is presented in Table no. 4.14. The migration pattern in villages around Khada bandhara can be expressed as follow.

- People of all villages migrating for their livelihood and to rear small cattle.
- Khajudra, Simar and Khada people migrate for fishing, whereas Senjaliya and Dandi people migrates for labor work.
- Migration places are different for all villages i.e.
    - Khajudra people migrate for labour in Porbandar area. They migrate for whole the year.
    - Dandi people migrates in Una for labour and migration seasons are winter and summer.
    - For fishing, people go to Veraval. The migration period is for eight months of winter and summer seasons.
- Before and after bandhara numbers of migratory people were 450 that increased up to 965 from all villages. Maximum numbers are increasing in Simar, Khada and Dandi villages.
- So far the income is concerned migration is additional source of income for all the villages but after bandhara income has increased in Senjaliya village whereas in remaining villages it remains same as it was before bandhara.

Table no. 4.14 Migration Trend in Study Villages Around Khada Bandhara

Village		Migration	No. of Person	Work	Place	Season	Days/Year	Income Rs./Yr
Senjaliya	Before	Yes	40	Labor	Porbandar	Year	365	54750
	After	Yes	40	Labor	Porbandar	Year	365	73000
Dandi	Before	Yes	20	Labor	Una	Winter and Summer	240	24000
	After	Yes	125	Labor	Una	Winter and Summer	240	24000
Khajudra	Before	Yes	300	Fishing	Veraval	Winter and Summer	240	24000
	After	Yes	300	Fishing	Veraval	Winter and Summer	240	24000
Simar	Before	Yes	80	Fishing	Veraval	Winter and Summer	240	24000
	After	Yes	200	Fishing	Veraval	Winter and Summer	240	24000
Khada	Before	Yes	10	Fishing	Veraval	Winter and Summer	240	40000
	After	Yes	300	Fishing	Veraval	Winter and Summer	240	40000

Source: Field Survey, 2009

4.2.4 Impact on Water Resources

There were two methods adopted to assess impact on ground water resources of the study area. The methods are study of changes in groundwater level and quality mainly based on secondary data recorded by SIPC and availability of water for different uses. In these cases only drinking and irrigation uses have considered for assessment.

4.2.4.1 Change in Groundwater

Salinity Ingress and Prevention Circle, Government of Gujarat is a responsible department for implementation of coastal salinity related programme in any coastal areas of state. In addition to implementation, impact assessment and long term monitoring of different water resource

related parameters like groundwater level, water quality (status as well fluctuation) are also their responsibilities. Therefore, department has establish their own observation network of well. In Khada bandhara area, department has monitored 16 wells in study villages. Besides these wells there is no any long term monitoring well in upper catchment areas of the basin. In any watershed area, any intervention carried out in upper reaches has their definite implications in lower catchment. The scale and type of impacts absolutely depends on specific characteristics of the particular watershed or basin. Keeping this in mind the analysis of monitoring wells had carried out to understand fluctuation trends in water level and water quality in lower reaches (coastal parts) of Khada bandhara area. Cavernous limestone is a major aquifer in this area. Village wise well hydrograph were prepared to understand secular and seasonal changes taking place in groundwater levels in last several years.

Random well inventory and sample collection carried out in each village during this study. Total 21 samples collected from these villages including bandhara surface water also. Table no 4.17 shows details of sample collection. Analyses of these samples were done by Central Soil Salinity Research Institute, Bharuch. Based on well inventory data, major aquifers are limestone and sand in these villages. This survey was carried out in month of June, year 2009.

It is important to clarify that the conclusions regarding the water level fluctuation and quality have following limitations.

- Analysis were based on secondary data recorded by SIPC
- Data were of only pre monsoon seasons therefore, seasonal changes in water level, due to rainfall was not possible to carry out

Water Level Fluctuation: The trends of water level in all the wells shows rise in water level taking place from 1991 to 2008. (Table no. 4.15) Out of sixteen monitoring wells hydrographs of KBU 5 and HLC 213 (for Simar) KBU 6 (for Khajudra); KBU 11 for Senjaliya and KBU 10 (for Khada) have prepared to understand water level fluctuation. (Figure No 4.4)

Hydrographs of Simar, Khajudra and Senjaliya villages clearly show rise in water level after construction of bandhara, while well hydrographs of village Khada show uneven fluctuations in water level during period from 2001 to 2008. There was a rise in water about 1.5 during year 2004 but afterward it has reduced and again it started rising.

Based on well inventory data (Table no 4.17), maximum depth of water table is surveyed in Dandi (14 m) and Khajudra (10.6 m). Most of the wells have shallow depth water table from 2 m to 7 m from surface. Minimum depth water table is seen in Khada village (1.5 m).

Water Quality: Changing trends in groundwater quality has been understood by preparing well hydrographs of Total Dissolved Solids value in groundwater as well as changes in ratio of chloride carbonate ration.

Figure no. 4.5 shows hydrographs of TDS value of monitoring wells. All hydrographs of all the villages clearly show gradual rise in total dissolved solids in groundwater except KBU 10 well of Khada village. That means over the period salinity has increased in most of the well represented aquifer area. Village wise in Simar village the average TDS values have increased up to 3000 ppm, same in case Khajudra is 4000 ppm. In case of Khada village, water quality has improved from before bandhara stage. Here TDS concentration in groundwater was about 4500 ppm, which has decreased and now a days it is less than 2000 ppm. Again in case of Senjaliya it shows rising trend but even till the values remain less than 2000 ppm.

Based on well inventory data (Table No. 4.17), it can interpret that out of total 21 samples, only 5 water sample are falls under potable limit it means more than 2.8 Ec (1800 ppm TDS). Other wells are having saline water. Most of the wells are indicate high Ec value which indicate salinity problem in this area. Surface water of Khada bandhara shows 6.1 Ec indicates highly salinity water. In groundwater, maximum salinity observed in Khajudra village (13.2Ec). PH range in these wells is falls between 7.6 to 9.1 pH range. Beyond 8.5 value pH also indicate not potable water.

In addition to TDS concentration Chloride and Carbonate + Bicarbonate ration in groundwater of the study area was computed. (Table no.4.16) If the ratio is more than 6, it indicates salinity ingress in groundwater. As per the data, almost all the wells shows ration more than 6 in some years of monitoring which indicate contamination of groundwater by salinity ingress. Here some well indicate very low affected by salinity intrusion especially in wells HLC 209, HLC 213 and HLC 271 of Simar village.

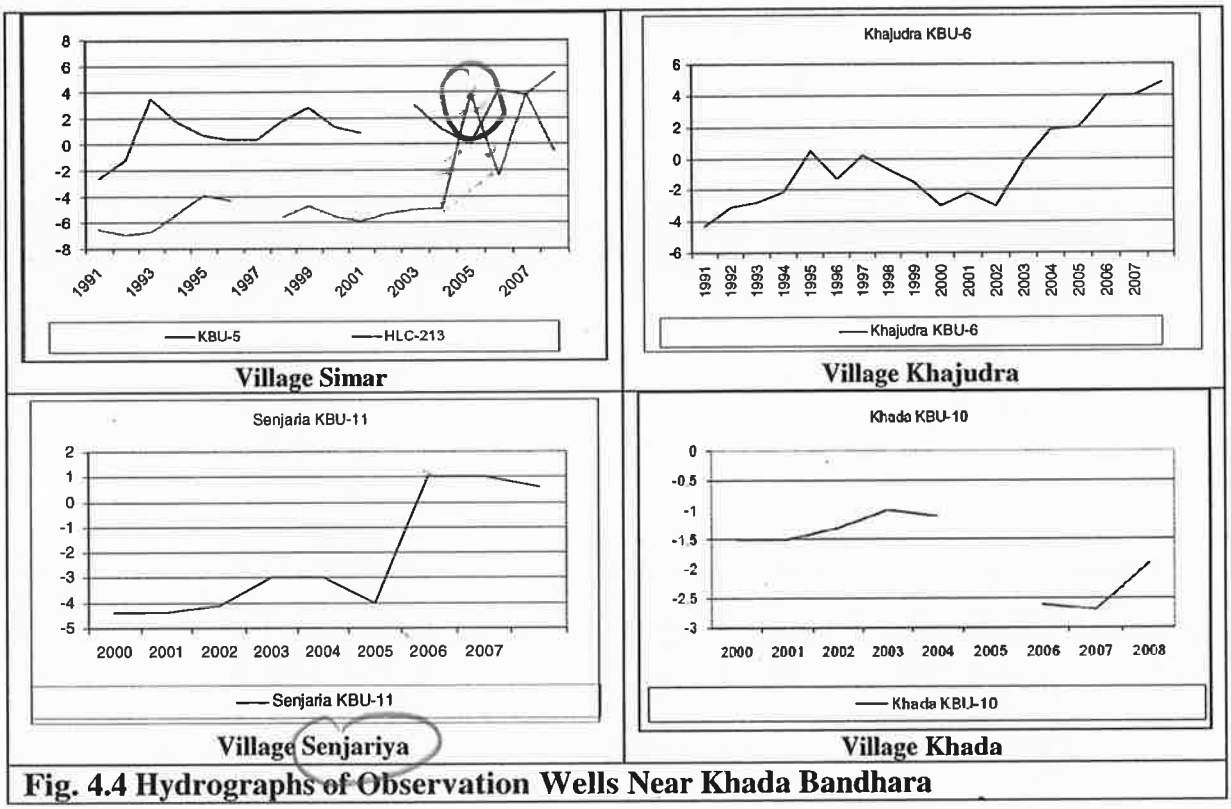


Fig. 4.4 Hydrographs of Observation Wells Near Khada Bandhara

Source: SIPC, 2009

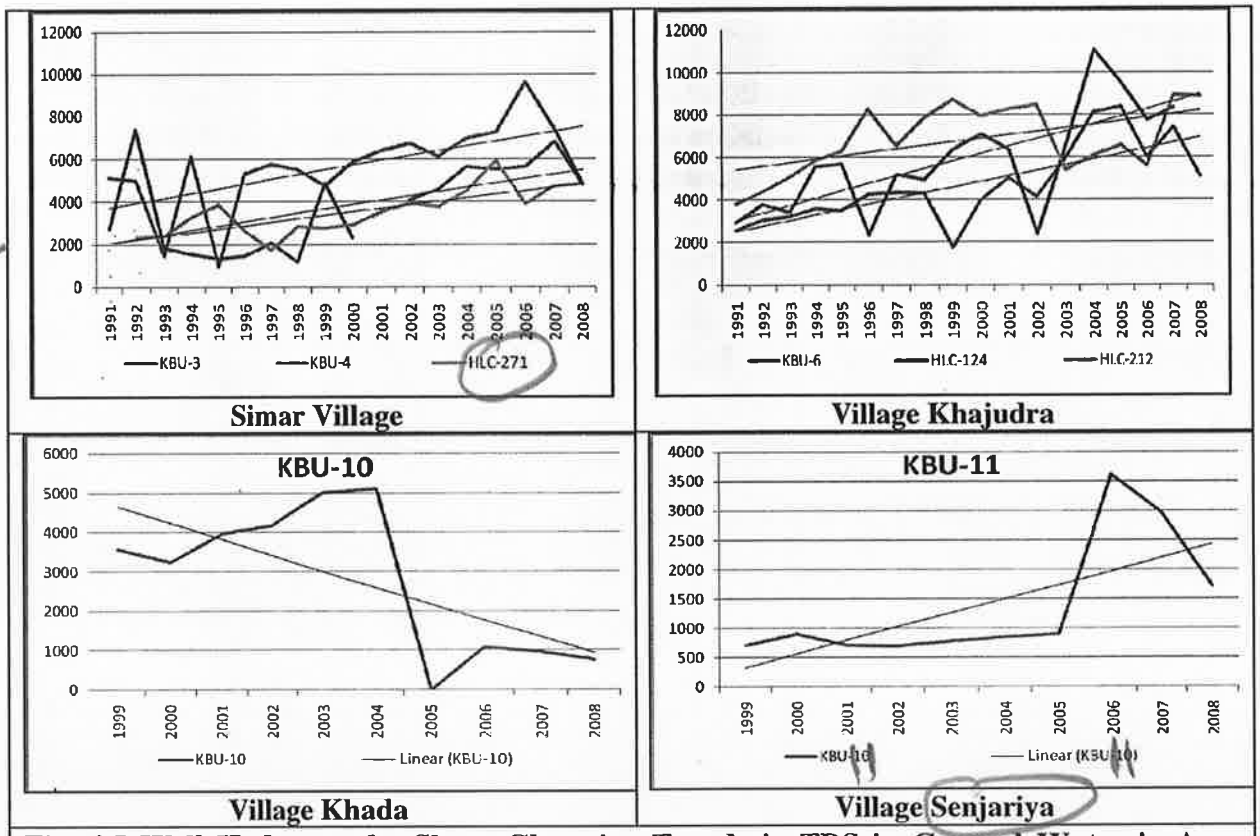


Fig. 4.5 Well Hydrographs Show Changing Trends in TDS in Ground Water in Area Around Khada Bandhara

Source: SIPC, 2009

Table no. 4.15 Pre Monsoon Water Level Fluctuation in Observation Wells of Villages around Khada Bandhara (Years from 1991 to 2008)

O.B.Well		KBU-1	KBU-3	KBU-4	KBU-5	HLC-209	HLC-211	HLC-213	HLC-271	KBU-6	KBU-9	HLC-124	HLC-212	KBU-8	KBU-10	KBU-7	KBU-11
Village		Simar Ban.	Simar.							Khajudra					Khada	Senjalia	
R.L.(m)		1.67	5.35	5.23	8.84	6.62	8.16	1.84	7.13	9.79	6.94	10.11	8.85	8.16	3.5	7.72	5
Pre Monsoon R.W.L (m)	1991	-1.93	-3.46	-8.97	-2.61	2.33	-1.24	-6.45		-4.31	2.34	-2.28	-0.05			1.72	
	1992	-1.53	-2.85	-9.7	-1.16	2.12	1.66	-6.86	7 (swl)	-3.11	-1.06	-0.19	-0.65	5.06		4.32	
	1993	-2.23	-1.95		3.54	2.12		-6.65	6.2 (swl)	-2.81	-0.66	-3.18	-1.65	3.46		4.22	
	1994	-1.73	-3.85		1.74	2.32	0.36	-5.35	5.4 (swl)	-2.11	-1.56	-3.18	-0.35			3.42	
	1995	-2.53	-0.15	-11.77	0.69	3.12		-3.85	4.5 (swl)	0.49	1.44	-0.08	1.95			2.92	
	1996	-2.73	-0.65	-12.77	0.34	1.72	0.06	-4.25	2.13	-1.31	0.64	-0.88	1.05	3.56	-	3.22	-
	1997	-2.33	-0.05	-11.27	0.34					0.19	1.04	12.69					
	1998	-2.33	0.15	-12.97	1.84	2.62	2.26	-5.46		-0.71	0.74	-1.49	1.95			2.92	
	1999	-2.33	-0.85	-12.77	2.84	2.32		-4.66		-1.51	-0.06	1.71	0.35				
	2000	-2.63	-1.05	-13.27	1.34	2.02	-0.94	-5.46	-0.27	-3.01		-3.39	-1.65		-1.5		-4.4
	2001	-2.73	-1.65		0.84		1.16	-5.86		-2.21		-3.89	-1.95		-1.5		-4.4
	2002	-2.73	-0.95	-13.17		2.42		-5.26	0.83	-3.01	-4.06	-0.99	1.85		-1.3		-4.1
	2003	-2.83	-0.65	-14.05	2.94			-4.96	-1.83	-0.21		-1.79	0.85		-1		-3
	2004	-2.33	0.35	-10.77	1.14		3.16	-4.86	1.13	1.79		0.71	1.85		-1.1		-3
	2005	-3.03	0.35	-11.07	N.A.	-0.74	3.46	-3.86	3.40	1.99	N.A.	1.61	3.85	N.A.	-	N.A.	-4
	2006	-1.53	0.85	-9.17	4.14	Dry	5.06	-2.36	4.40	3.99	2.14	3.21	3.05	6.26	-2.61	2.32	1
	2007	-1.13	-5.67	-5.67	3.84	3.51	3.22	3.85		3.99	3.74		4.96	2.96	-2.7	2.62	1
	2008	-0.43	2.65	-3.67	5.44	3.62	5.96	-0.46		4.79	2.84	5.01	4.45		-1.9	3.02	0.6

Source: SIPC, 2009

Table no. 4.16 Water Quality in Observation Wells of Villages Around Khada Bandhara in Pre Monsoon Season (1991 to 2008, SIPC - 2009)

O.B.Well		KBU-1	KBU-2	KBU-3	KBU-4	KBU-5	KBU-6	KBU-7	KBU-8	KBU-9	HLC-124	HLC-209	HLC-211	HLC-212	HLC-213	HLC-271
Village		Simar Ban.	Nakii Ban	Simar	Simar	Simar	Khajudra	Senjalia	Khada	Khajudra	Khajudra	Simar	Simar	Khajudra	Simar	Simar
1991	T.D.S.ppm	4121	1865	5114	2737	1715	2587	872		9626	2933	5582	12816	3816	2649	
	Cl ppm	1640	680	2320	1080	648	1160	240		5120	1120	1720	7360	1840	800	
	Cl:CO3 Ratio	2.8	2.79	12.26	2.3	3.6	7.61	1.11		45	2.67	6.55	54.55	18.51	1.6	
1992	T.D.S.ppm	7120	1082	5012	7405	4215	3076	1025	940	1111	3786	7280	4426	4368	2796	2330
	Cl ppm	3680	288	2040	3960	2000	1400	312	280	224	1680	2320	2040	2120	880	800
	Cl:CO3 Ratio	8.93	1.12	6.76	12.33	7.36	5.73	1.76	1.64	0.6	6.39	5.44	11.5	12.44	1.34	1.84
1993	T.D.S.ppm	7120	1509	1452	1823	4956	3247	2421	4898	1082	3418	4756		5069	3019	2421
	Cl ppm	3720	464	440	664	2520	1560	1040	2480	232	1400	1160		2400	1000	880
	Cl:CO3 Ratio	7.53	0.92	0.95	2.87	38.28	9.16	8.58	34.9	0.5	3.79	3.02		17.77	1.43	1.87
1994	T.D.S.ppm	5960	1321	6144	1536	3564	3594	1260		1198	5562	6115	5824	5824	2097	3320
	Cl ppm	2640	424	1720	592	1680	1720	328		312	2640	1800	3040	3120	560	1080
	Cl:CO3 Ratio	5.68	1.35	4.61	3.6	15.76	12.12	0.86		0.83	8.45	4.96	20.4	40.06	0.73	3.61
1995	T.D.S.ppm	919	1726	974	1364	6682	3508	2450		1420	5696	5069		6266	3361	3873
	Cl ppm	272	552	104	464	3240	1560	960		392	2760	1400		3320	1120	1200
	Cl:CO3 Ratio	1.66	1.43	0.24	2.2	17.57	8.28	7.5		1.12	11.26	5.32		19.11	3	0.9
1996	T.D.S.ppm	2854		5300	1456	5358	4310	1689	5183	1165	2364	2848	8544	8259	5646	2620
	Cl ppm	1280		2120	584	2640	2000	488	2160	440	840	720	4440	4480	2200	720
	Cl:CO3 Ratio	15		7.65	3.91	21.94	7.03	1.25	7.51	2.69	10.75	2.2	21.2	45	5.75	2.8
1997	T.D.S.ppm	732	3220	5756	2071	11005	4387			1458	5202	4613		6506	2125	1769
	Cl ppm	208	1040	2400	960	6080	2160			416	2600	1480		3440	1000	392
	Cl:CO3 Ratio	1.25	1.04	7.11	5.09	27.58	6			1.17	12.2	5.21		14.91	7.64	1.43
1998	T.D.S.ppm	833	2857	5535	1190	2797	4345	1190		1250	4950	3145	2854	7862	5708	2854
	Cl ppm	264	1280	2080	368	1160	2040	328		368	2440	680	1120	4120	2400	960
	Cl:CO3 Ratio	1.37	6.2	12.2	1.09	3.62	5.75	0.84		1.15	7.8	1.34	3.71	31.4	14.07	2.73

Table no. 4.16 Water Quality in Wells of Villages Around Khada Bandhara in Pre Monsoon Season (1991 to 2008) contd...

O.B.Well		KBU-1	KBU-2	KBU-3	KBU-4	KBU-5	KBU-6	KBU-9	KBU-10	KBU-11	HLC-124	HLC-209	HLC-211	HLC-212	HLC-213	HLC-271
Village		Simar Ban	Nakii Ban	Simar	Simar	Simar	Khajudra	Khajudra	Khada	Senjalia	Khajudra	Simar	Simar	Khajudra	Simar	Simar
1999	T.D.S.ppm	1101	3303	4762	4881	2331	1786	1190	3571	714	6369	4107		8690	5178	2797
	Cl ppm	368	1600	2400	2000	960	648	328	1760	144	3320	960		4640	2000	960
	Cl:CO3 Ratio	2.08	10.22	9.52	6.95	3	1.62	1.03	12.03	0.57	22.78	1.64		45.2	5.03	2.6
2000	T.D.S.ppm	15100	4632	5836	2346	7219	4031		3249	902	7099	4753	4211	7941	5174	2948
	Cl ppm	8520	2280	2520	1120	3760	2000		1440	152	3680	1800	1760	4200	2360	1080
	Cl:CO3 Ratio	88.88	20.7	15.1	11.25	35.33	9.22		13.06	0.61	45.04	12.36	4.46	25.71	8.31	2.82
2001	T.D.S.ppm	60472	2500	6428		6488	5059		3988	714	6369		6607	8273	1905	3571
	Cl ppm	32160	1080	2680		2880	2520		1800	112	3320		3040	4280	640	1320
	Cl:CO3 Ratio	3.02	5.63	10.63		11	6.76		22.04	0.58	17		12.22	26.8	1.68	3.91
2002	T.D.S.ppm	45427	5183	6756	4135		4193	8095	4193	699	2392	2213	3203	8445	757	3960
	Cl ppm	24360	2600	3040	2000		2120	4240	2040	128	920	680	1200	4360	192	1640
	Cl:CO3 Ratio	686.19	36.61	28.63	33.33		24.87	306.2	24.98	0.62	3.45	2.55	2.75	56.07	1.50	5.37
2003	T.D.S.ppm	35914	4120	6125	4621	2116	6013		5011	780	6550			5411	968	3786
	Cl ppm	19400	2160	2680	2360	840	3000		2400	144	3360			2760	208	1600
	Cl:CO3 Ratio	109.51	11.7	7.54	20.83	2.03	7.41		18.77	0.71	12.29			32.4	0.45	5.37
2004	T.D.S.ppm	34893	5174	6979	5655	9024	8122		5114	842	11066		2916	6071	2202	4523
	Cl ppm	18880	2600	3160	2840	4600	4200		2440	160	5960		960	3120	800	1840
	Cl:CO3 Ratio	94.96	28.16	14.35	32.12	16.4	32.86		26.43	0.75	55.96		2.23	15.15	3.13	10.16
2005	T.D.S.ppm	50534	4813	7279	5535	N.A.	8422	N.A.	-	902	9523	Dry	3393	6543	5952	3393
	Cl ppm	28240	2320	3480	2760	N.A.	4480			184	5000	Dry	1200	3200	2560	1080
	Cl:CO3 Ratio	159.41	14.55	19.21	48.58		7.01			0.87	15.64	Dry	2.81	15.02	9.24	2.92

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Table no. 4.16 Water Quality in Wells of Villages Around Khada Bandhara in Pre Monsoon Season (1991 to 2008) contd...

O.B.Well		KBU-1	KBU-2	KBU-3	KBU-4	KBU-5	KBU-6	KBU-7	KBU-8	KBU-9	KBU-10	KBU-11	HLC-124	HLC-209	HLC-211	HLC-212	HLC-213	HLC-271
Village		Simar Ban	Nakii Ban	Simar	Simar	Simar	Khajudra	Senjalia	Khada	Khajudra	Khada	Senjalia	Khajudra	Simar	Simar	Khajudra	Simar	Simar
2006	T.D.S. ppm	1985	3790	9626	6016	2406	6016	5595	433	2226	1083	3610	7738	N.A.	1964	5595	3928	4643
	Cl ppm	720	1640	4520	3000	1000	3000	2840	72	920	248	1480	4080		720	2720	1440	2160
	Cl:carb ratio	2.7	13.58	28.35		4.62	6.6	3.2	0.53			7.59	16.67		3.16	24.71	5.88	7.15
2007	T.D.S. ppm	1937	3702	7405	6835	3987	7462	8544	2962	2278	968	2962	8352	3007	3953	8909	N.A.	4788
	Cl ppm	720	1640	3161	3560	1760	3800	4400	1200	800	200	1200	1080	4440	1000	1720	4680	
	Cl:carb ratio	2.98	8.24	10.61	14.32	5.63	6.86	13.48	2.64	2.04	1	4.44	4.47	28.47	5.42	4.84	32.95	
2008	T.D.S .ppm	1196	2962	4842	4785	2449	5126	2620		2108	769	1709		3816	4557	8886	1823	4842
	Cl ppm	384	1200	1920	2440	1040	2400	1080		720	152	440		1480	1720	4640	600	2000
	Cl:carb ratio	1.75	6.76	7.73	18.07	5.23	4.57	2.98		1.81	0.86	1.29		9.49	3.97	26.14	1.96	5.63

Source: SIPC, 2009

Table No. 4.17 Details of Water and Soil Samples Collected in Study Villages of Khada Bandhara

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min	Sec	Deg	Min	Sec				EC	PH	EC	PH
1	Simar	KhadaBandhara	20	45	56.1	71	8	46.7				6.1	8.4		
2	Simar	Malabhai Gigabhai Babr	20	46	56.7	70	8	53.4	5.9	2.9	Limestone	6.6	7.7	2.1	8.2
3	Simar	Dayabhai Palabhai Ahir	20	46	44.1	71	8	39.8	3	2.5	Sand	4.8	8.8	2	8.4
4	Simar	Vagha Macharibhai Panchng	20	47	19.6	70	8	53	5	4.3	Sand	5.7	8.2	2	8.2
5	Simar	Shamat Nathubhai Makvana	20	47	23.2	71	8	6.8	4.4	2.9	Limestone	6.9	7.8	4	8.1
6	Khajudara	Lakha varjangbhai bambharia	20	47	30.1	71	7	33.1	4.4	2	Limestone	13.2	7.9	1.87	8.2
7	Khajudara	Vasrambhai rambhai parmar	20	47	39.1	71	6	43.6	14.2	5.1	Limestone	13.2	7.6	2.2	8.2
8	Khajudara	Nanjibhai madam	20	47	43.8	71	6	21.4	12.2	6.2	Limestone	6.6	8.3	1.32	8.3
9	Khajudara	Dana vala parmar	20	47	44.1	71	5	55.2	19.6	10.6	Limestone	6.3	8.7	4.8	8.2
10	Senjaliya	Naran bhikha solanki	20	46	9.3	71	6	41	3.3	2.9	Sand	1.26	8.9	0.42	8
11	Senjaliya	Bhikhabhai rambhai	20	46	10.6	71	6	54.5	7.4	2	Sand	2.2	8	0.33	8.6
12	Senjaliya	Govindbhai malabhai vansh	20	46	3.1	71	6	21.9	3.1	2.85	Sand	2.6	8.5	0.31	8.8
13	Senjaliya		20	46	1.2	71	7	15.4	7.75	3.1	Sand	2.1	8.5	0.35	8.4
14	Khada	Bholaata bholaram bambhania	20	45	53.7	71	7	46.8	4.2	1.5	Limestone	5.5	8	1.62	8.4
15	Khada	Khodubhai bogha bambhania	20	45	29.8	71	7	21.6	5.4	4.2	Limestone	2.7	8.9	0.21	8.2
16	Khada		20	45	31.4	71	7	16.7	7.2	5.85	Limestone	4.2	8.1	0.34	8.2
17	Khada	Bhalaram bambhania	20	45	34.6	71	8	2.5	7.9	6.85	Limestone	4.2	9.1	0.46	8.4
18	Dandi	Rajabhai karsnbhai bambhania	20	47	15.7	71	5	28.3	17	14	Limestone	3.1	8.1	1.15	8.5
19	Dandi	Savdasbhai ramshibhai majethia	20	46	46.1	71	5	22	3.3	3.1	Sand	4.5	7.6	0.28	8.1
20	Dandi	Kumbhabhai kanabhai majethia	20	46	57.3	71	5	34.2	8.3	7.1	Limestone	2.1	8.3	0.87	8.3
21	Dandi	Punjabhai ranabhai majethia	20	47	2.9	71	5	50.9	15.7	6.4	Limestone	3.3	8.9	0.38	8

Source: Field Survey, 2009

4.2.4.2 Impact on Drinking and Irrigation Water

Impact of Khada bandahra on water resource have also been assessed by village opinion during group discussion. In this process detailed discussion with villagers have hold on before and status of water resource from utilization (drinking and irrigation water use) point of view. This analysis was made based on primary information collected through group discussion and case study in study area.

Drinking Water: Table no. 4.18 shows villagers responses on before and after status of drinking in respective village. The gist of the same are listed below…

- Except Senjaliya and Khada village, other three villages have drinking water problem even after bandhra. However, Senjaliya and Khada villages didn't have drinking water problem even before bandhara.
- Except Shejaria and Khada village, other three villages are facing problem of insufficient quantity of drinking water.
- Dam and Open well are main drinking water source in all the villages.
- All the villages have insufficient water for cattle

Table no. 4.18 Pre and Post Status of Drinking Water in Study Villages

Village		Problem of Drinking Water	Source of Drinking Water	Quantity of Water	Accessibility of DW	Quality of Water	Availability of DW for Livestock
Senjaliya	Before	No	Well	Sufficient	0 Km	Sweet	Yes
	After	No	Well	Sufficient	0 Km	Sweet	Yes
Dandi	Before	Yes	Rawal Dam	Insufficient	0 Km	Sweet	Yes
	After	Yes	Rawal Dam	Insufficient	0 Km	Sweet	Yes
Khajudra	Before	Yes	Rawal Dam	Insufficient	25 KM	Saline	Yes
	After	Yes	Rawal Dam	Insufficient	25 KM	Sweet	Yes
Simar	Before	Yes	Rawal Dam	Insufficient	25 KM	Sweet	Yes
	After	Yes	Rawal Dam	Insufficient	25 KM	Sweet	Yes
Khada	Before	No	Well	Sufficient	0 Km	Sweet	Yes
	After	No	Well	Sufficient	0 Km	Sweet	Yes

Source: Field Survey, 2009

Irrigation Water: To understand availability of irrigation water in study area a set of questions were asked during group discussion. Such question were focused on availability of water for all or individual season/seasons; type of water source; an introduction of water saving technologies etc. The responses from villagers are as follow

- Open wells are till major water resource for irrigation.
- The wells were not able to provide water for support irrigation during all seasons. Farmers get sufficient water only for Kharif and Rabi seasons. The source can not provide sufficient water for full crop except Khada village.
- No farmers in these villages have adopted micro irrigation system for irrigation.
- Salinity in groundwater is the main reason for very limited reception of micro irrigation techniques by farmers.

Major conclusion from above discussion can be draw as

- Even after taken by so much of care villages are not self dependent their own drinking water management.
- Improvement in groundwater quality is not reached up to the point that do not encourage farmer for large scale acceptance of micro irrigation technologies.

4.2.5 Impact on Health

It is already proven that 90 % of human health issues are related to water. Since the study area has a water quality threat due to salinity ingress the impact on health is assessed in study villages. Following can be said the impact of water resources on health.

- Due to poor quality, the malarial infection is seen in the all villages except Simar.
- Vector borne diseases (excluding Dandi and Khada) and stones in kidney (Khajudra and Simar) are seen in study villages. The major agent of this kind of diseases is water.
- Fluorosis disease and gastric problem are not present in the study area.
- There is presence of skin disease only in Senjaliya village.

4.2.6 Assets

Number of typical kinds of asset is an indirect indicator of overall socio-economic development of area. Considering this information on assets like four wheelers, two wheelers, tractors, water lifting devices were collected during village group discussion.

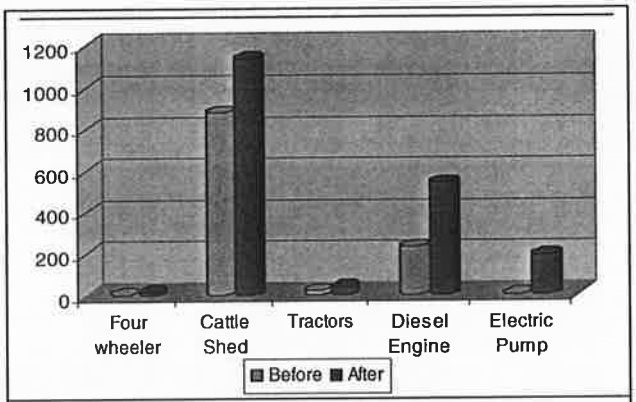


Fig. 4.6 Before and After Status of Assets in Study Villages

Table no. 4.19 gives detail accounts of assets in villages around Khada bandhara. It is very clear that before bandhara there was no single electric pump, which increases up to 189 no after bandhara. There is also high increase in number of diesel engine which is almost double then before. No of four wheeler also increased up to 14 no which was only 2 before bandhara. There is also increase in no of tractors and cattle sheds.

Table no. 4.19 Village Wise Before and After Status of Assets in Study Villages

Type of Asset		Four wheeler	Cattle Shed	Tractors	Diesel Engine	Electric pump
Sejariya	Before	0	150	1	15	0
	After	1	185	6	40	6
Dandi	Before	0	178	2	35	0
	After	2	178	9	110	5
Khajudra	Before	1	300	3	80	0
	After	1	300	10	150	40
Simar	Before	1	200	12	90	0
	After	7	350	4	200	135
Khada	Before	0	50	1	10	0
	After	3	125	7	40	3
Total	**Before**	**2**	**878**	**19**	**230**	**0**
	After	**14**	**1138**	**36**	**540**	**189**

Source: Field Survey, 2009

5. ASSESSMENT IN PANCHPIPALVA BANDHARA

5.1 Characteristic of Panchpipalva Bandhara

The Panchpipalva bandhara is constructed on Sangawadi and Rupen River and located near village Panchpipalva of Kodinar taluka. The site is located SSW Dolasa village on the Kodinar-Una state highway. The bandhara is implemented with aim to obstacle tidal water which enters through the creek and to harvest rain water. The bandhara has 4760 m long earth dam with a 700m long waste weir. Four kilometer approach road leads from Dolasa village to Chikhali village at the site.

Terrain around Panchpipalva bandhara site is flat land with some small size hillocks having gentle slope towards the sea. In surrounding land use pattern, most of the areas get covered by water. Part of remaining land is under use for agricultural purpose, where other is barren land. Main rock formation is limestone with clay of Gaj formation covered with top soil in some area.

Total seven surrounding villages get benefit from this bandhara which are Nanavada, Malgam, Advi, Panchpipalva, Dolasa, Velva and Chikhali. Except Chikhali villages all five villages are belong to Kodinar taluka, where Chikhali village belongs to Una taluka. These villages are located in area of 10 kilometer radius of the site. Main occupation of these villages is seasonal agriculture which totally dependent on this bandhara for water. Along with this, the structure provides drinking water to these villages.

Table No 5.1 Salient Features of Panchpipalva Bandhara

1	**Project name**	**Sangvada Rupen Water Basin Project**		
2	Project Location	A	District	Junagadh
		B	Taluka	Kodinar
		C	Village	Panchpipalva
		D	River	Sangvadi Rupen
3	Surface Structure	A	Catchment area	522.24sq.km.
		B	Total water capacity	16.70m.cubic ft
		C	Full tank level	2.50 meters
		D	High flood level	1.50 meters
		E	Wasteware length	700 meters
		F	Bodywall top level	2.50 meters
4	Bund Length	A	Right bank	3000 meters 3990
		B	Left bank	9224 meters
		C	Top of bund level	6.80 meters

Source: SIPC, 2009

5.1.1 Land Use

Total land of beneficiary villages of Panchpipalva bandhara is 7,736.78 Ha, distributed in seven villages. Village Chikhali has maximum land 2252.58 Ha, while Velava has minimum land 543 Ha. (Table No. 5.2 and Figure No. 5.1)

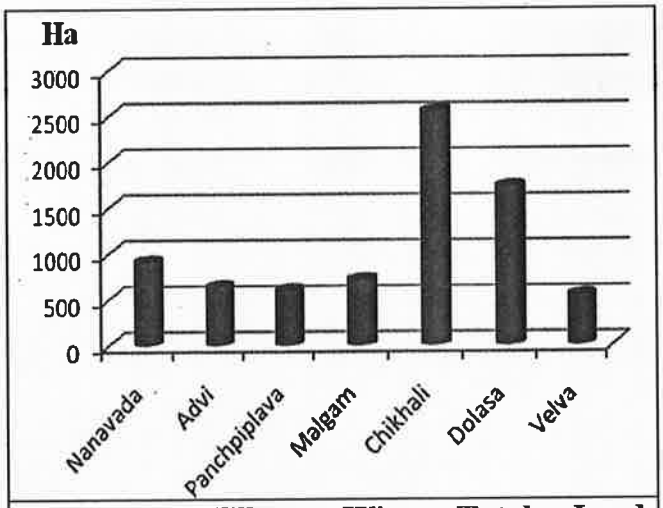


Fig. 5.1: Village Wise Total Land Distribution in Panchpiplava Bandhara

Landuse wise rainfed area is 35% of total land, while irrigated agriculture land is 25%. Agriculture land as whole constitutes 60 % of total land while pasture land and forest land area are 19% and 13% respectively. Only 8 % land is waste land. (Table No. 5.3)

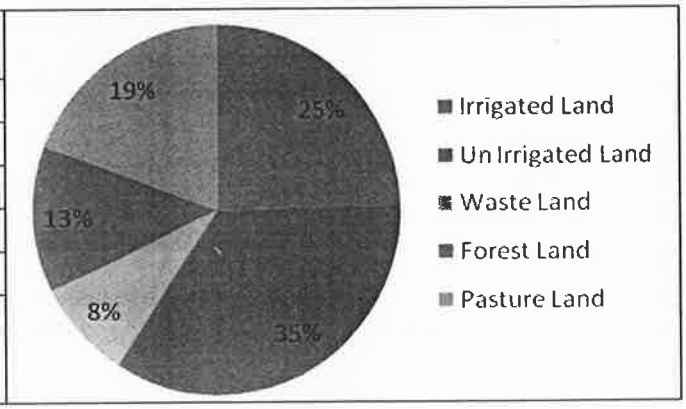
Maximum unirrigated land is in Dolasa village (1006.7 Ha). Reason of increase in unirrigated land is due to degradation in water quality. Minimum unirrigated land is in Panchpipalva village (88.2 Ha). Maximum irrigated area is in Dolasa village which is 600 Ha and minimum in Chikhali (24.59 Ha.) and Panchpipalva (85.4 Ha.). Forest land is only in village Chikhali (985.01 Ha.). All villages have pasture land that Dolasa (30 Ha.) and Malgam (46.3 Ha.) have minimum while Chikhali has maximum (675.78 Ha.).

Table no. 5.2 Village Wise Land Use of Panchpipalva Bandhara

Village	Irrigated Land (Ha.)	Un Irrigated Land (Ha.)	Waste Land (Ha.)	Forest Land (Ha.)	Pasture Land (Ha.)	Total Land (Ha)
Nanavada	294	503.3	56.2	0	116.8	**907.3**
Advi	344	154.7	1	0	134.8	**634.5**
Panchpiplava	85.4	88.2	97.9	0	326.6	**598.1**
Malgam	320.3	300	43	0	46.3	**709.6**
Chikhali	24.59	496.2	371	985.01	675.78	**2552.6**
Dolasa	600	1006.7	92.2	0	30	**1728.9**
Velva	233.9	141.9	0.9	0	166.3	**543**
Total	**1902.2**	**2691**	**662.2**	**985.0**	**1496.6**	**7736.8**

Table no. 5.3 Land Use Pattern in Panchpipalva Bandhara Area

Land Use Type	Area Ha.
Irrigated Land	1902.19
Un Irrigated Land	2691
Waste Land	662.2
Forest Land	985.01
Pasture Land	1496.58
Total	**7736.78**



Source: Census, 2001 and Field Survey, 2009

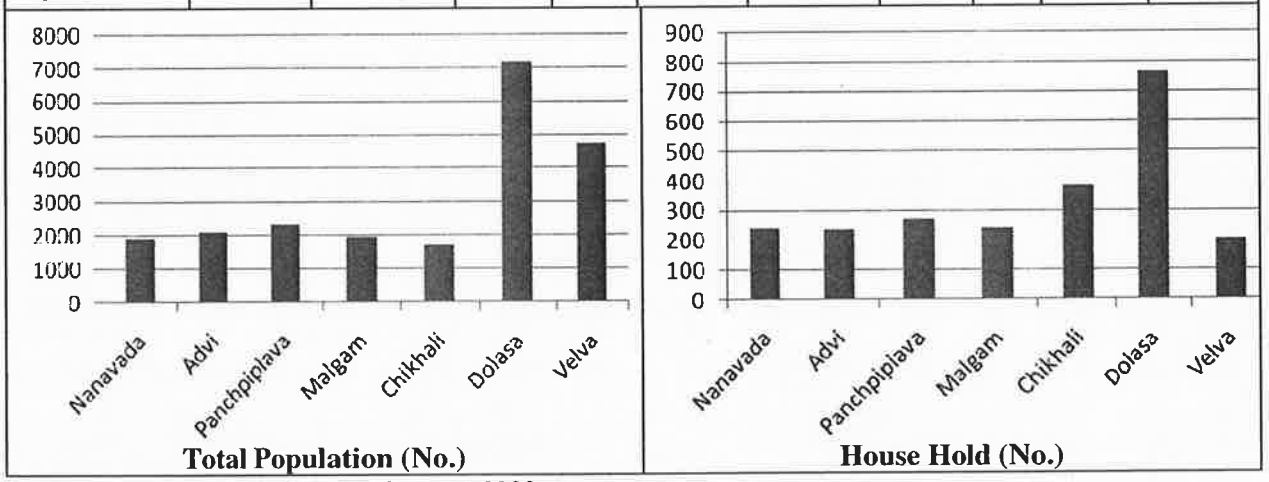
5.1.2 Demographic Status

Total population of studied villages of Panchpipalva bandhara is about 21,894 distributed in 2,334 households. Highest population is in Dolasa (7217 no), while lowest population is in Chikhali (1694). Population in other villages are 4,734 (Velava), 2,309 (Panchpipalva), 2,085 (Advi), 1945 (Malgam) and 1910 (Nanavada). The sex ratio stands at 1175. (Table no 5.4)

The General category is a dominating category in study villages. The general and OBC (other backward caste) together constitute 80 % of total population. These include Karadiya Rajputs, Brahmins, Ahirs, Patels, Lohana etc. Caste belong to SC community are Kolis, Harijans, Muslims. The Rabari in this area are ST community and are very less (< 1%) in numbers. In most of the villages, Karadia Rajputs and Ahir are at the top position in comparison to other.

Table no. 5.4 Caste Wise Household and Population in Villages-Panchpipalva Bandhara

Village	Total No. of House holds	Population in No.								Total No.
		Men				Women				
		General	SC	ST	Total	General	SC	ST	Total	
Nanavada	238	181	799	0	980	173	757	0	930	1910
Advi	237	736	321	11	1068	715	294	8	1017	2085
Panchpiplava	272	1098	63	7	1168	1073	63	5	1141	2309
Malgam	241	710	266	0	976	694	275	0	969	1945
Chikhali	381	827	25	0	852	826	16	0	842	1694
Dolasa	768	3189	431	0	3620	3176	421	0	3597	7217
Velva	197	1073	327	0	1400	3002	332	0	3334	4734
Total	**2334**	**7814**	**2232**	**18**	**10064**	**9659**	**2158**	**13**	**11830**	**21894**



Source: Census, 2001 and Field Survey, 2009

5.1.3 Education Status

All the villages are facilitated by primary education systems. Total 11 schools provide primary education and 04 schools provide secondary education. Out of total secondary school, two are in Dolasa, while Malgam and Chikhali have one in each. Table 5.5 shows village wise education status in term of number of school and students studying. In case of Anganwadi, maximum children are in Dolasa village, while minimum are in Nanavada village (20). Total 2,000 students go for primary education in Dolasa which is maximum, while in Malgam village this is minimum i.e. 100. About 1050 students are going for secondary education in schools of Malgam, Chikhali and Velva villages. Communities of Velva village are getting

education facility from nearby Kotada village of Kodinar taluka. There is no education facility in Velva village. There is no college and higher secondary school facility in any village.

Table no. 5.5 Village Wise Education Status in Villages of Panchpipalva Bandhara

Village	Type of School					
	Aanganwadi		1 to 7 standard		8 to 10 standard	
	Number	Student	Number	Student	Number	Student
Nanavada	2	20	1	300	0	0
Advi	2	50	1	400	0	0
Panchpiplava	2	100	2	500	0	0
Malgam	2	50	1	100	1	500
Chikhali	2	120	1	200	1	300
Dolasa	5	200	5	2000	2	250
Velva	0	0	0	0	0	0
Total	**15**	**540**	**11**	**3500**	**4**	**1050**

Source: Field Survey, 2009

5.2 Socio Economical Impact Assessment

Impact of Panchpiplava Bandhara has been assessed from social, livelihood, and natural resource point of view. The indicators through those assessment was undertaken were (01) Residing community and land holding; (02) Gender sensitization; (03) Impact on Livelihood; (04) drinking water; (05) Health and (06) Assets.

5.2.1 Residing Community and Landholding

To understand community wise impact, all the households have classified as per their landholdings such as (01) Landless; (02) Marginal farmers (< 2.50 Acre); (03) Small farmers (2.5 to 5 Acre); and (04) Big farmers (> 5 Acre). Table no. 5.6 shows caste wise land holding categorization. About 15.48 % of the total households are landless. Maximum landless family belongs to general caste (15.67% of total general), while 9% SC of total caste have no land. This clearly pinpoint that any agriculture benefit of Panchpiplava bandhara cannot help directly to 15.48 % landless families. Maximum 55 % of total household are marginal farmers, where general and SC caste constitute 95.11 % and 5.37 % of total households. Only 2.08% of total household are big farmers, while 27.43% are small farmers. Total 30.41% household of general caste are small and big farmers.

Landless families of general category are maximum in Dolasa (290 HH) whereas the same of SC communities is only in Panchpipalva (8 HH). (Table no. 5.7) Maximum marginal farmers are in Chikhali (419HH), while small farmers are in Nanavada (249HH) and Panchpipalva (204HH). Big farmers are belongs to Malagam (42 HH) and Advi (20HH) of general caste. No clear data is available of Velva village.

Table no. 5.6 Caste Wise Landholding (No. of Household) of Study Area

Caste	Land Less	Marginal Farmers	Small Farmer	Big Farmer	Total
General	453	1558	817	62	**2890**
SC	8	80	0	0	**88**
ST	0	0	0	0	**0**
Total No.	**461**	**1638**	**817**	**62**	**2978**
Percentage	**15.48**	**55.00**	**27.43**	**2.08**	**100**

Source: GOG, 2001

Table no. 5.7 Caste Wise Classification of Land holding in Study Villages

Land Holding	Caste	No. of Households						
		Nanavada	Advi	Panch piplava	Malgam	Chikhali	Dolasa	Total
LL	General	0	65	52	46	0	290	453
	SC	0	0	8	0	0	0	8
	ST	0	0	0	0	0	0	0
	Sub Total	**0**	**65**	**60**	**46**	**0**	**290**	**461**
MF <2.5 Acre	General	380	130	271	48	419	310	1558
	SC	0	0	80	0	0	0	80
	ST	0	0	0	0	0	0	0
	Sub Total	**380**	**130**	**351**	**48**	**419**	**310**	**1638**
SF 2.5 to 5 Acre	General	249	14	204	48	164	138	817
	SC	0	0	0	0	0	0	0
	ST	0	0	0	0	0	0	0
	Sub Total	**249**	**14**	**204**	**48**	**164**	**138**	**817**
BF > 5 Acre	General	0	20	0	42	0	0	62
	SC	0	0	0	0	0	0	0
	ST	0	0	0	0	0	0	0
	Sub Total	**0**	**20**	**0**	**42**	**0**	**0**	**62**
Total		**629**	**229**	**615**	**184**	**583**	**738**	**2978**

Source: GOG, 2001

5.2.2 Gender Sensitivity

As discussed in previous section female population in these villages are 11,830 persons and male: female ratio stands at 1175 female against male. To understand change taking place in gender sensitivity levels in the study villages due to salinity prevention activities following questions were asked to villagers.

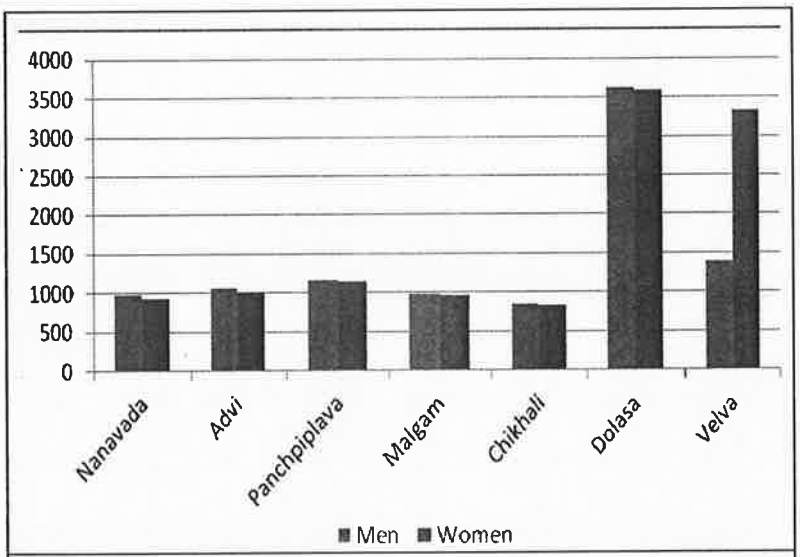


Fig. 5.2 Chart Shows Male Female Ration in study villages of Panchpipalva Bandhara

Did the Bandhara help to save time of women for fetching drinking water? If yes, where they utilize the time?
Do women take decision in your family?
Do women participate in community work?

Normally it is an assumption that, due to water harvesting/ groundwater recharge/ water conservation, groundwater quality and quantity improved at that level where every village can have their drinking water source at village level. And if the village has its drinking water source within the village, it decreases the time for women for fetching drinking water. Based on these two considerations, the first question was asked to the villagers. Table no 5.8 shows the people's responses from different villages. Except Panchpipalva village, all village people have told that there is no such impact of bandhara than time can save of women from drinking

water fetching. As per response of Panchpipalva village, women use their saved time in household activities like to care the children. In case of involvement of women in household level decision making, village people apart from Nanavada and Panchpipalva have responded negatively. However type of decisions even in these villages hardly women involves in occupation level decisions. While the response on inquiry regarding women's involvement in different kinds of community level work, people have said that women remains present in the *gramsabha*. In Malgam village, people responded that women participated in Panchayat also. Some villages like Nanavada and Advi, women are also involved in social activities. In Dolasa and Velva, women are also participating in group meetings (*Sakhi Mandals*).

Table no. 5.8 Responses of People on Gender Aspects in Panchpipalva Bandhara Area

Village	Did Bandhara Help to Save Time of Women for Fetching DW? (Y/N)	If Yes, Than Where They Use Their Time	Do Women Take Decision in Your Family? (Y/N)	Do Women Participate in Community Work?
Nanavada	No		Yes	Social Activity
Advi	No		No	Social Activity
Panchpipalva	Yes	Household activities	Yes	*Gramsabha*
Malgam	No		No	Panchayati Act
Chikhali	No		No	*Gramsabha*
Dolasa	No		No	Group Meeting
Velva	No		No	Group Meeting

Source: Field Survey, 2009

5.2.3 Livelihood Impact

The main occupations in the study area are agriculture and animal husbandry. In addition several households are managing their income through wage labor. Among different occupations agriculture is one of the most vulnerable occupation can directly influenced by degradation of soil and water quality. While other means of livelihoods like agriculture labor and animal husbandry have indirect impact of degradation of such natural resources. Such impacts can be assess through studying increase/decrease production, migration pattern, increase/decrease milk production, change in livestock etc. Keeping this in mind, this section is discussing various impacts on different aspects of agriculture and animal husbandry occupations along with village wise migration pattern in study area.

5.2.3.1 Agriculture

As seen in landholding, 85.5% of total families are engaged with agriculture. According to census record of government of Gujarat, 2001 about 35 % (2691 Ha) of total land is characterizes as rainfed (unirrigated) land, while 25 % (1902.2 Ha) of total land is irrigated agriculture land. Therefore total about 60 % of total land (4593 Ha) is under agriculture. (Table no. 5.3) Sea water intrusion leads groundwater salinization, has badly affected this backbone economy of the area. Impacts of salinity ingress on agriculture before construction of bandhara was assessed through changes taking place in different agriculture type from cropping pattern, increase / decrease in irrigated area, and rise and fall in production point of view. All these assessment have made seasonally Table no. 5.10 shows village wise season wise, before and after agriculture status in term of crops, crop sown area, and production in case of field crops.

In case of field crops groundnut in Kharif and wheat in Rabi seasons are remain dominant crop in all the villages even now (after bandhara construction). Two villages Malgam and Dolasa have Sugarcane as main Kharif crop. In case of second crop Bajra and Sugarcane are common. Farmers of Malgam and Velva villages sow cotton also as third crop while in Chikhali village third crop is Til. In Rabi season second crop is Bajara. In summer crop, farmers of Chikhali sow Bajara and Farmers of Dolasa sow Groundnut and Bajara.

Table no. 5.9 shows before and after status of crop wise unit production. After bandhara total Kharif field crop area and production have decreased which is because of agriculture land of some farmer occupied by water as submergence area of Bandhara especially in Panchpipalva village. But in Rabi season, field crop area and production have increased. In Kharif season field crop decrease in groundnut crop while area increases in Bajara, Cotton and Til.

Table no. 5.9 Cropped area and productivity of command area of Study Villages

Season	Crop	Area (Bigha)		Production Kg/ Bigha	
		Before	After	Before	After
Kharif	Groundnut	9637	7537	2500	960
	Bajra	1125	725	3500	1700
	Sugarcane	500	900	400	800
	Cotton	122	1022	1200	2550
	Til	300	300	400	400
	Total	**11684**	**10484**	**8000**	**6410**
Rabi	Wheat	2500	3050	4000	4800
	Bajra	100	100	400	400
	Sugarcane		50		200
	Total	**2600**	**3200**	**4400**	**5400**
Summer	Bajra	600	937	1400	1700
	Groundnut	1800		500	
	Total	**2400**	**937**	**1900**	**1700**
Total		**16684**	**14621**	**14300**	**13510**

Source: Field Survey, 2009

Concerning horticulture, farmers of Panchpipalva village are practicing Mango horticulture even after bandhara. Water source is well where flood irrigation system adopted. Per bigha income has increased from 30,000 Rs to 45,000 Rs after the bandhara. There is no horticulture practice in other villages. Also there is very negligible vegetable cropping in these villages.

To assess soil quality of agriculture land in study villages, total 33 soil samples were collected from 8 villages. The sampling was carried out in month of June, year 2009. Average 4 to 5 samples collected from each study village. Table no 5.17 gives details of sample location and chemical properties like Ec and pH. The chemical analysis of the samples was carried out by Central Soil Salinity Research Institute based at Bharuch. According to this, only three samples show soil salinity more than normal range. These samples are of Nanavada (4.2 Ec), Jantrakhadi (2.8 Ec) and Chikhali (3.2) villages. Other samples show Ec in normal range. PH range is from 7 to 9 values, but one sample of Chikhali villages show 9.1 pH.

Table no. 5.9 Before and After Field Crop Status in Study Villages of Panchpipalva Bandhara

Village		Nanavada		Advi		Panchpipalva		Malgam	
Season	Crop	Before	After	Before	After	Before	After	Before	After
Kharif	Crop Name 1	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Sugarcane	Groundnut	Groundnut
	Area (Bigha)	700	700	1200	1200	300	100	700	700
	Production (Kg/Bigha)	600	60	200	200	500	200	300	300
	Crop Name 2	Bajra	Bajra	Sugarcane	Sugarcane	Bajra		Sugarcane	Sugarcane
	Area (Bigha)	100	100	400	400	100		100	100
	Production (Kg/Bigha)	400	400	200	200	800		200	200
	Crop Name 3		Cotton		Cotton			Cotton	Cotton
	Area (Bigha)		500		400			50	50
	Production (Kg/Bigha)		900		450			600	600
Rabi	Crop Name 1	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)	600	600	400	400	300	300	600	600
	Production (Kg/Bigha)	800	800	500	500	600	600	600	600
Summer	Crop Name 1				Bajra				
	Area (Bigha)				400				
	Production (Kg/Bigha)				500				

Source: ACT Field Survey, 2009

Case Study: 6 Case of Bachubhai Village: Chikhali

Total land became waste land after bandhara due to increased soil salinity. Only 3 bigha land rarely utilize for cotton sowing. Due to this, Bhachubhai losses about 1.8 lakh Rs annually from agriculture. Before bandhara he regualarly borrow loan from bank, but now due to decreased repay capacity he does not borrow money from bank.

Table no. 5.9 Before and After Field Crop Status in Study Villages of Panchpipalva Bandhara Contd...

Village		Chikhali		Dolasa		Velva	
Season	Crop	Before	After	Before	After	Before	After
Kharif	**Crop Name 1**	Groundnut	Groundnut	Groundnut	Sugarcane	Groundnut	Groundnut
	Area (Bigha)	4500	4500	1800	300	437	437
	Production (Kg/Bigha)	200	200	500	200	200	200
	Crop Name 2	Bajra	Bajra	Bajra		Bajra	Bajra
	Area (Bigha)	500	500	300		125	125
	Production (Kg/Bigha)	300	300	1000		1000	1000
	Crop Name 3	Til	Til			Cotton	Cotton
	Area (Bigha)	300	300			72	72
	Production (Kg/Bigha)	400	400			600	600
Rabi	**Crop Name 1**	Wheat	Wheat	Wheat	Wheat		Wheat
	Area (Bigha)	350	350	300	300		500
	Production (Kg/Bigha)	300	300	1200	1200		800
	Crop Name 2	Bajra	Bajra				Sugarcane
	Area (Bigha)	100	100				50
	Production (Kg/Bigha)	400	400				200
Summer	**Crop Name 1**	Bajra	Bajra	Groundnut			Bajra
	Area (Bigha)	300	100	1800			437
	Production (Kg/Bigha)	400	400	500			800
	Crop Name 2			Bajra			
	Area (Bigha)			300			
	Production (Kg/Bigha)			1000			

Source: Field Survey, 2009

5.2.3.2 Animal Husbandry and Livestock

Before bandhara livestock of the area was dominated by goat then followed by cow and buffalo, but in present case cow and buffalo are dominant animals. The drastic change in goat population has seen in Chikhali village (3000 to 200 population of goat). In other livestock type, population increased such as 35% in buffalo, 25% in cow and 16% in bullock category. (Table no. 5.11)

The survey results show gradual increase in all types of big animal such as cow (2880 to 3605), buffalo (2030 to 2745) and bullock (2500 to 2900). According to farmers of the area cow and buffalo increased because of increased fodder securities due to improvement in water resources. Another reason is market opportunity through dairy development. Increase in irrigation opportunity during winter and summer seasons are reasons in this area for increasing population of bullock in this are. There are no sheep and camels population.

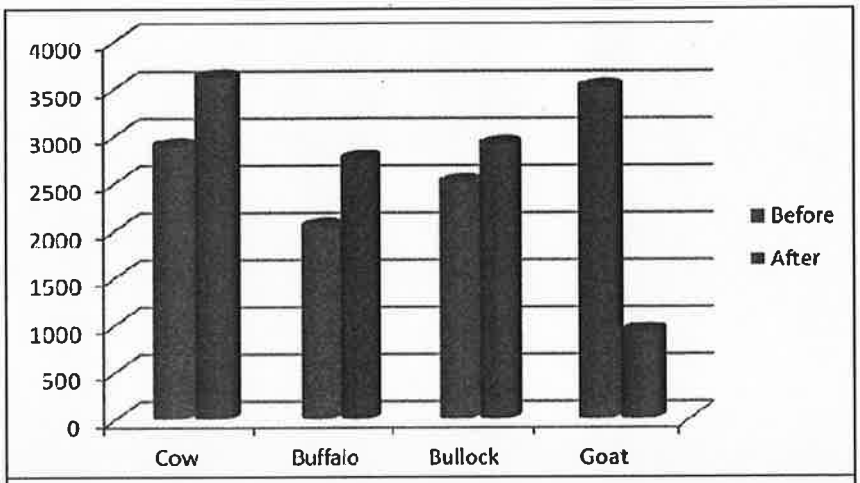


Fig. 5.3 Before and After Bandhara Livestock Population Around Panchpipalva Bandhara

Table No. 5.11 Before and After Bandhara Change in Livestock Population in Study Villages Around Panchpipalva Bandhara

Village		Cow	Buffalo	Bullock	Goat	Total
Nanavada	Before	100	100	400	0	600
	After	90	150	400	0	640
Advi	Before	600	600	500	0	1700
	After	800	800	500	20	2120
Panchpipalva	Before	380	350	300	0	1030
	After	400	400	100	0	900
Malgam	Before	150	200	500	0	850
	After	400	400	50	0	850
Chikhali	Before	225	60	500	3000	3785
	After	290	75	550	200	1115
Dolasa	Before	1300	600	0	0	1900
	After	1500	800	1000	200	3500
Velva	Before	125	120	300	500	1045
	After	125	120	300	500	1045
Total	**Before**	**2,880**	**2,030**	**2,500**	**3,500**	**10,910**
	After	**3,605**	**2,745**	**2,900**	**920**	**10,170**

Source: Field Survey, 2009

Table no. 5.12 Livestock and Milk Production Details in Study Villages

Cattle Type	Detail	Nanavada		Advi		Panchpipalva		Malgam	
		Before	After	Before	After	Before	After	Before	After
Cow	Nos	100	90	600	800	380	400	150	400
	Lactating Cattle	35	30	400	400	50	50	50	200
	Lactation Period (days)	210	210	210	210	210	210	210	210
	Milk Production Lit/day	3	3	4	4	3	3	3	3
Buffalo	Nos	100	150	600	800	350	400	200	400
	Lactating Cattle	70	50	500	400	50	50	100	200
	Lactation Period (days)	270	270	270	270	270	270	270	270
	Milk Production Lit/day	7	7	4	5	5	5	4	5
Bullock	Nos	400	400	500	500	300	100	500	50
Goat	Nos	0	0	0	20	0	0	0	0

Source: Field Survey, 2009

Table no. 5.12 Livestock and Milk Production Details in Study Villages Contd...

Cattle Type	Detail	Chikhali		Dolasa		Velva	
		Before	After	Before	After	Before	After
Cow	Nos	225	290	1300	1500	125	125
	Lactating Cattle	120	145	800	700	80	80
	Lactation Period (days)	210	210	210	210	210	210
	Milk Production Lit/day	4	4	2	2	2	2
Buffalo	Nos	60	75	600	800	120	120
	Lactating Cattle	30	40	280	350	80	80
	Lactation Period (days)	270	270	270	270	270	270
	Milk Production Lit/day	5	5	3	3	5	5
Bullock	Nos	500	550	0	1000	300	300
Goat	Nos	3000	200	0	200	500	500

Source: Field Survey, 2009

A lacting cattle in heard is main deciding factor of total cattle in heard. Looking towards the numbers of lacting cattle during before and after bandhara construction, a clear relationship with cattle wise daily average milk production comes out from table no 5.12. As the production increases total numbers of cattle decrease and ratio with lacting cattle also goes down. Daily average milk production of cow in this area was ranging from 2 liter to 4 liter before bandhara times, which till same even after bandhara. In case of buffalo in Advi and Malgam the average milk per day has seen to increased about 1 liter. In rest of the case it does not show any change. However, it varies in different villages from 3 lit to 7 lit.

Milk Production and Dairy Development

After bandhara facility of milk collection centers is available in all the study villages except Chikhali. The collection centers are of NDDB. An average rate of milk ranges from Rs 15 to Rs 22 per liter. Minimum milk price is fetched by Panchpipalva animals i.e. of Rs. 15. Table

no 5.12 also reflects reason for that i.e. ratio of lacting cattle is very low and daily milk production is also low. However price of milk is depends on fat. Generally the fats of the buffalo milk are higher than the cow milk. Table no 5.13 shows village wise details of milk economy. Maximum milk collection is in Advi village (1,82,500 lit) and Dolasa village (1,46,00 lit). Minimum milk collection is in Malgam village (29,200 lit) where there is no milk collection in Chikhali village.

Table no. 5.13 Details of Milk Selling at Milk Collection Centers in Study Villages of Panchpipalva Bandhara

Village		Total Household Selling Milk	Daily Milk Collection (Lit)	Annual Milk Collection (Lit)	Average Rate Rs/lit	Total Income from Milk Rs. in Lakh
Nanavada	Pre	0	0	0	0	0.0
	Post	350	150	54,750	22	12.04
Advi	Pre	0	0	0	0	0.0
	Post	100	500	1,82,500	22	40.15
Panchpiplava	Pre	0	0	0	0	0.0
	Post	200	320	1,16,800	15	17.52
Malgam	Pre	0	0	0	0	0.0
	Post	40	80	29,200	22	6.42
Chikhali	Pre	0	0	0	0	0.0
	Post	0	0	0	0	0.0
Dolasa	Pre	0	0	0	0	0.0
	Post	100	400	1,46,000	18	26.28
Velva	Pre	0	0	0	0	0.0
	Post	70	160	58,400	22	12.85
Total	**Pre**	**0**	**0**	**0**	**0**	**0**
	Post	**860**	**1610**	**5,87,650**	**121**	**115.27**

Source: Field Survey, 2009

5.3.3 Migration and Labor

Increase in wage labour and rate of migration are indicators of degradation and low carrying capacity of natural resources. Because of these, it becomes main source of income especially for landless families. In study area issue of salinization of groundwater is already discussed which has affected badly traditional occupations of the area. Table no. 5.14 shows village wise details of migration pattern. It clearly shows that migration has started even before bandhara. People of Chikhali and Dolasa villages were used to migrate before bandhara constructed, but now there is a migration practice in all villages.

Una and Surat are the main places where people were migrating before bandhara for labor work and skill work in diamond industries. After bandhara construction, main place for migration are Veraval, Surat and Una for labour work, work in diamond industries and fisheries occupation. Major migration seasons are winter and summer. Only people of Chikhali migrate during whole year. There is gradually increase in the numbers of migrating persons from 1400 to 2490. The village Dolasa has maximum number of migrating people (1000), while minimum migratory people in Nanavada village (150). (Table no.5.14)

Table no. 5.14 Migration Trend in Villages of Panchpipalav Bandhara

Village	Migration		Persons No.		Migration season		No. of days (Annual)		Income Rs. in lakh (annual)	
	Before	After	Before	After	Before	After	Before	After	Before	After
Nanavada	No	Yes		150		Winter, Summer		240		21600
Advi	No	Yes		500		Winter, Summer		240		24000
Panchpiplava										
Malgam		Yes		440		Winter, Summer		240		16800
Chikhali	Yes	Yes	400	400	All seasons		365	365	45625	45625
Dolasa	Yes	Yes	1000	1000	Winter, Summer		240	240	24000	24000
Velva	No									

Source: Field Survey, 2009

5.2.4 Impact in Water Resource

Impact of the bandhara on water resources has been predicted by two methods viz., (01) Analysis of SIPC well monitoring data (for groundwater level fluctuation and water quality) and (02) Seasonality analysis of pre and post periods of construction of bandhara including irrigation and drinking water point of view.

5.2.4.1 Change in Groundwater

Salinity Ingress and Prevention Cell (SIPC), Government of Gujarat is the main authorized department for implementation of coastal salinity related programme. Impact of such activities is also regularly monitored by the department. Total 21 wells are monitored by them around bandhara. These wells are distributed in 11 villages. There is representative monitoring well in all the villages of panchpiplava bandhara study area. Maximum no of monitoring wells are in Panchpipalva village. Analysis of all the monitoring wells had carried out to understand fluctuation in water level and water quality. Well hydrograph were prepared to understand secular and seasonal changes taking place in groundwater levels in last several years. Village wise monitoring well have been analyzed through hydrographs of reduced water level.

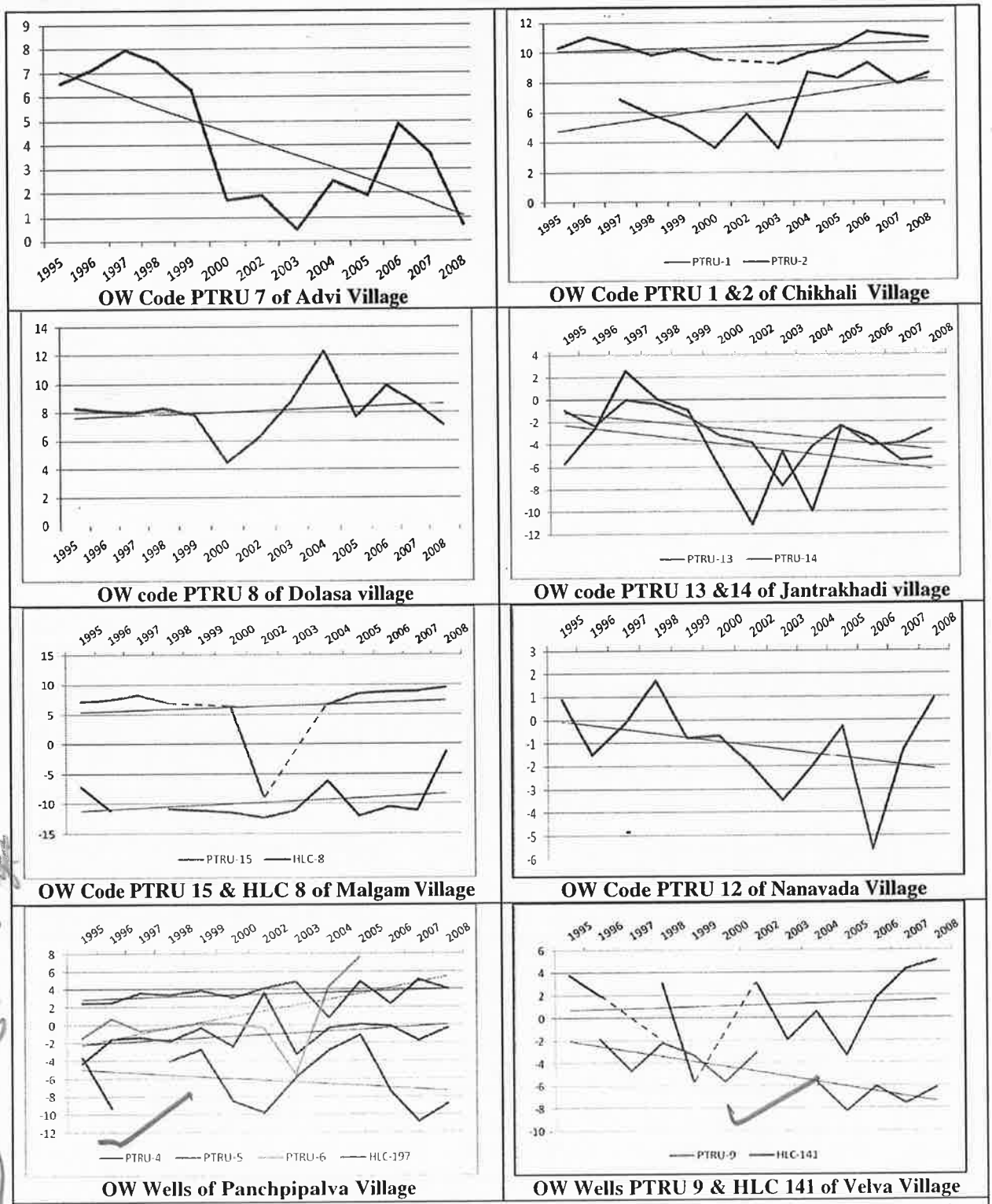
It is important to clarify that the conclusions regarding the water level fluctuation and quality have following limitations.

- Secondary data recorded by SIPC
- Due to lack of successive season's data seasonal changes in water level due to rainfall was not possible to carry out. Data is provided.

Random well inventory and sample collection carried out in each village during this study. Total 34 samples collected from these villages including bandhara surface water also. Table no 5.17 shows details of sample collection. Analyses of these samples were done by Central Soil Salinity Research Institute, Bharuch. Well inventory data shows Limestone is main aquifer of this area. This survey was carried out in month of June, year 2009.

Water Level Fluctuation: Year wise pre monsoon reduced water level of each monitoring well is given in table no 5.15. The present analysis is done through hydrographs of 15 monitoring well of eight villages. Hydrographs of six wells show that RWL is going down in

this area, while other 9 wells show it is rising. (Figure no 5.4) Water level of Advi, Jantrakhadi and Nanavada is going down. In case of Jantrakhadi and Nanavada, water level has gone down below sea level. Observation wells of Panchpipalva village shows raised in water level except well code HLC 197. Maximum water level draft of about 6 m has seen in well PTRU 7 of Advi village and same for PTRU 9 of Velva village is 3.5 m, while maximum rise has shown in well PTRU 6 of Panchpipalva and PTRU 1 of Chikhali village. This rising trend clearly shows rise of water level in this area due to bandhara construction.



OW Code PTRU 7 of Advi Village

OW Code PTRU 1 &2 of Chikhali Village

OW code PTRU 8 of Dolasa village

OW code PTRU 13 &14 of Jantrakhadi village

OW Code PTRU 15 & HLC 8 of Malgam Village

OW Code PTRU 12 of Nanavada Village

OW Wells of Panchpipalva Village

OW Wells PTRU 9 & HLC 141 of Velva Village

Fig. 5.4 Well Hydrographs Show Change in Reduced Water Level (RWL) in Observation Wells of Villages Around Panchpipalva Bandhara

Based on above discussions following impacts on groundwater level can be listed

- Most of the area got benefit of groundwater recharge through the Panchpipalva Bandhara
- Maximum water level rise is 9.1 m (Well code PTRU 6).
- Recharge benefit didn't show in Advi, Naanvada and Jantrakhadi villages.

Based on well inventory data (Table no 5.17), it can say that in Nanavada, Jantrakhasi, Advi and Malgam, water level is more deep than other villages. Maximum depth water level is seen in Velava village, while shallow depth water level seen in Chikhali village.

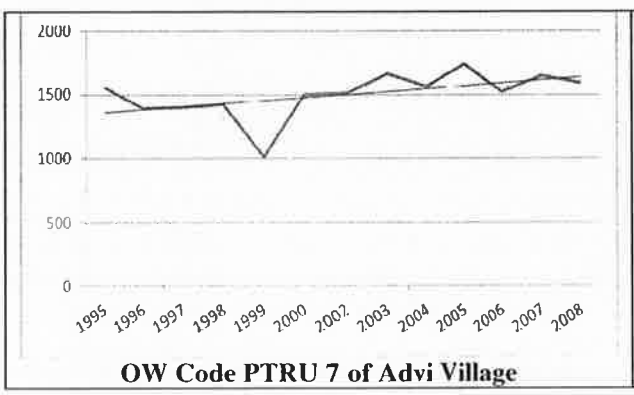
Water Quality: Changing trends in groundwater quality has been understood by preparing well hydrographs of fluctuating values of Total Dissolved Solids and changes in ratio of Chloride: Carbonate ration.

Total 10 (out of 17) wells hydrographs have prepared for measured TDS values of monitoring wells from year 1995 to 2008. (Figure No. 5.5) Hydrographs of observation well no PTRU 7, PTRU 8, PTRU 13, PTRU 15, HLC 8, PTRU 12 and HLC 142 show very little change or negligible change in TDS over the period, while two well hydrographs of observation wells no PTRU 1 and PTRU 2 (Chikhali) show degradation in TDS value. Total 5 well hydrographs shows measurably high increase in TDS, such wells are PTRU 14 (Jantrakhadi), PTRU 9 and HLC 141 (Velva), PTRU 4 (Panchpiplava) and HLC 284 (Sokhada). Monitoring wells of Chikhali village shows salinity dilution is about 2000 ppm to 2500 ppm in year 2008 in compare to year 1995. Maximum TDS value increased in well code PTRU 4 (2660 ppm), PTRU 6 (2964 ppm) of Panchpipalva and PTRU 9 (1994 ppm), HLC 141 (2079ppm) of Velva in year 2008 in compare to year 1995.

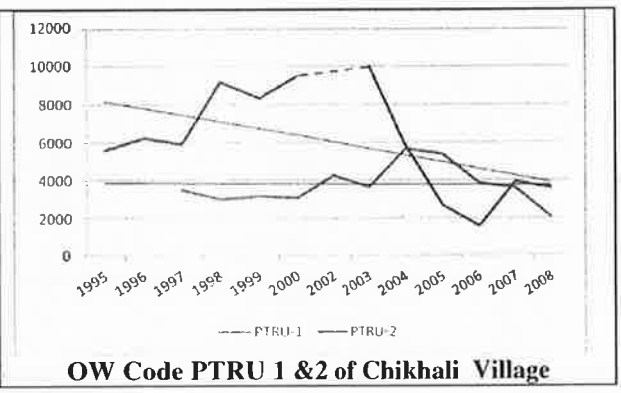
Compare & PTRU-4

Total 34 water samples have been collected from well including bandhara surface water. Based on well inventory data (Table No. 5.17), it can interpret that out of total 44 samples, only six samples are belongs potable water limit. Bandhara surface water is sweet water having 2.3 Ec means 1472 ppm TDS. Other well samples show high TDS/Ec than normal or potable water range it means more than 2.8 Ec (1800 ppm TDS). Maximum salinity observed in Velva (17.8 Ec). Higher Ec values in most of the well samples indicate salinity intrusion in groundwater, while pH range seems normal rage in all the samples.

In addition to TDS concentration Chloride and Carbonate + Bicarbonate ration in groundwater of the study area was computed. (Table no.5.16) If the ration is more than 6, than it indicate sea water intrusion. Among total monitoring wells, 13 monitoring wells show no sea water intrusion over the years while the ration in six wells of Chikhali (PTRU 1 &2), Panchpipalva (PTRU 4), Jantrakhadi (PTRU 14), Nanavada (PTRU 12) and Sokhada (HLC 284) indicate sea water intrusion in all the years. Interesting interpretation of well code HLC 284 of Sokhada village is salinity increase in last three years drastically.



OW Code PTRU 7 of Advi Village



OW Code PTRU 1 &2 of Chikhali Village

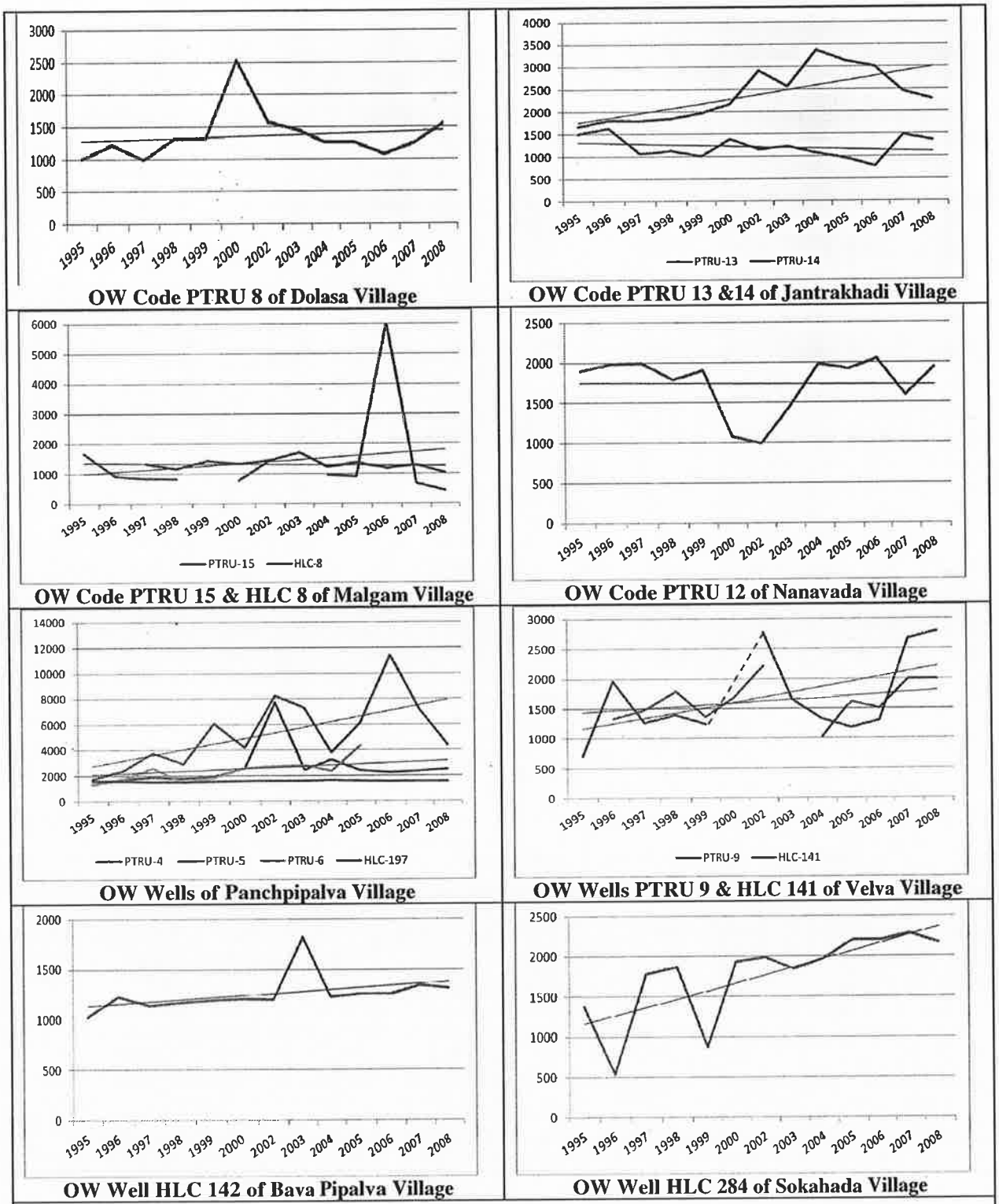


Fig. 5.5 Well Hydrographs Show Change in TDS in Observation Wells of Villages Around Panchpipalva Bandhara contd...

Following conclusion can be draw based on this behavior of the wells

- The stable concentration of TDS during year 1991 to 2001.
- Abrupt salinity increased in most of the well during year 2006-2007 may be due to over exploitation of groundwater and low rainfall during these years.
- Most of the wells show salinity decrease in year 1996 and year, 2008

Table no. 5.15 Pre Monsoon Reduced Water Level (RWL) in Study Villages (Year 1995 to 2008)

Village	Well code	R.L.(m)	Reduced Water Level in m												
			1995	1996	1997	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008
Advi	PTRU-7	19.47	6.57	7.17	7.97	7.47	6.27	1.67	1.87	0.47	2.47	1.87	4.87	3.67	0.67
Chikhli	PTRU-1	13.64	6.04		6.84	5.84	5.14	3.64	5.84	3.54	8.64	8.24	9.24	7.84	8.54
	PTRU-2	14.92	10.32	11.02	10.52	9.82	10.22	9.5		9.22	9.92	10.32	11.32	11.12	10.92
	PTRU-3	13.73													
Dolasa	PTRU-8	19.28	8.28	8.08	7.98	8.28	7.78	4.48	6.28	8.78	12.28	7.68	9.88	8.68	7.08
Jantrakhadi	PTRU-13	9.32	-0.88	-2.28	0.02	-0.38	-1.48	-3.18	-3.78	-7.68	-4.18	-2.28	-4.08	-3.88	-2.68
	PTRU-14	12.57	-5.63	-2.53	2.57	0.07	-0.93	-6.13	-11.13	-4.63	-9.93	-2.43	-3.43	-5.43	-5.23
Malgam	PTRU-15	16.55	7.25	7.53	8.35	7.05		6.05	-8.65		6.75	8.55	8.85	8.95	9.55
	HLC-8	12.9	-7.2	-11.1		-10.8	-11.1	-11.4	-12.3	-11.1	-6.1	-12	-10.5	-11.1	-1.3
Nanavada	PTRU-12	12.01	0.89	-1.49	-0.19	1.71	-0.79	-0.69	-1.99	-3.49	-1.99	-0.29	-5.59	-1.29	0.91
Panchpipalva	PTRU-4	7.88	2.48	2.53	3.58	3.38	3.88	3.08	4.18	4.88	0.88	4.88	2.38	5.08	4.08
	PTRU-5	9.71	-4.29	-1.59	-1.39	-1.79	-0.29	-2.39	3.61	-3.29	-0.29	0.11	-0.09	-1.69	-0.29
	PTRU-6	10.68	-1.42	0.68	-0.62	-0.32	0.18	0.18	-0.32	-5.52	4.38	7.68			6.98
	PTRU-10	8.56	3.56		-5.24	-5.44	-5.14						2.86	0.16	1.96
	HLC-196	9.59	-5.51			Dry					-3.41		Dry		-10.7
	HLC-197	11.18	-3.63	(-)9.33		-4.02	-2.72	-8.52	-9.82	-5.82	-2.82	(-)1082	-7.42	-10.8	-8.82
Pipalva-Bava	HLC-142	21.2	4.1	6.9		6.9	7.2	4.4	1.9	-2.8	-0.8	0.7	4.2	0.2	5.2
Sokhada	HLC-284		7 swl	16.2 swl		10 (swl)		12.9(swl)					16.80swl		BH
Velva	PTRU-9	9.36		-1.84	-4.64	-2.14	-3.24	-5.64	-3.04		-5.64	-8.24	-6.04	-7.54	-6.14
	HLC-141	14.09	3.79	1.99		3.08	-5.61		3.09	-1.91	0.59	-3.31	1.79	4.29	5.09

Source: SIPC, 2009

-9.13

-10.82

Table no. 5.16 Water Quality in Monitoring Wells of Study villages of Panchpipalva Bandhara (1995 to 2008)

Village	Well Code	Parameter	Year of Pre monsoon Monitoring												
			1995	1996	1997	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008
Chikhli	PTRU-1	TDS	4510	----	3470	2976	3155	3068	4252	3619	5655	5354	3850	3532	2051
		CL.	2000	----	1560	1160	1360	1240	1840	1520	2720	2600	1720	1440	880
		Ratio	15.65	----	9.57	3.04	3.16	3.49	6.25	5.64	25.62	19.84	3.13	4.31	8.26
	PTRU-2	TDS	5568	6232	5901	9166	8333	9505	----	10022	5836	2647	1564	3930	3588
		CL.	2760	3200	3000	4840	4440	5080	----	5320	2880	1280	656	1760	1520
		CL:HCO3 Ratio	48.29	53.33	42.46	48.57	89.92	102.87	----	149.85	45.06	14.43	2.84	0.91	6.91
Panchpipalva	PTRU-4	TDS	1726	2388	3738	2916	6071	4211	8270	7294	3790	6136	11430	7234	4386
		CL.	664	1000	1800	1160	3080	1960	4240	3720	1760	3120	5960	3800	2120
		CL:HCO3 Ratio	4.16	4.62	8.32	3.54	22.89	10.61	26.59	33.8	12.4	41.75	69.95	24.38	15.7
	PTRU-5	TDS	1336	1747	1881	1786	1964	2587	7746	2450	3249	2406	2287	2392	2506
		CL.	384	584	720	640	800	1080	3960	1040	1400	1040	1000	880	1000
		CL:HCO3 Ratio	1.55	1.56	2.67	1.83	2.89	4.11	22.35	5.14	13.14	3.86	3.16	2.06	3.13
	PTRU-6	TDS	1308	1747	2589	1428	1845	2587	2737	2840	2346	4332	N.A.	N.A.	4272
		CL.	384	576	1000	472	760	1040	1200	1160	960	2000	----	----	1840
		CL:HCO3 Ratio	1.59	1.56	3.79	1.7	2.67	3.96	4.12	4.42	4.66	5.74	----	----	5.76
	PTRU-10	TDS	1281	----	3452	1428	1428	----	----	----	----	----	1684	1538	872
		CL.	392	----	1560	504	496	----	----	----	----	----	592	480	256
		CL:HCO3 Ratio	1.94	----	11.01	2.4	2.64	----	----	----		----	3.2	1.82	1.24
	HLC-196	TDS	1595	----	3351	Dry	----	----	----	----	3928	----	----	----	1196
		CL.	504	----	1480	Dry	----	----	----	----	1800	----	----	----	488
		CL:HCO3 Ratio	2.6	----	12.29	----	----	----	----	----	22.02	----	----	----	2.98
	HLC-197	TDS	1623	1623	1504	1514	1548	1624	1631	1595	1667	1613	1548	1559	1538
		CL.	520	512	496	512	468	552	544	520	680	560	496	600	560
		CL:HCO3 Ratio	2.32	2.36	2.32	2.21	2.03	2.54	2.64	2.28	5.18	4.52	2.25	2.64	2.63
Advi	PTRU-7	TDS	1558	1398	1405	1428	1012	1504	1514	1670	1564	1745	1524	1652	1595
		CL.	448	440	432	488	312	440	464	576	536	632	504	560	560
		CL:HCO3 Ratio	1.5	1.48	1.38	2.09	1.79	1.77	1.59	1.93	1.86	3.24	1.63	131.41	1.92
Dolasa	PTRU-8	TDS	1002	1223	988	1309	1309	2527	1572	1448	1263	1263	1083	1253	1538
		CL.	288	432	304	432	464	1120	632	504	424	448	376	400	600
		CL:HCO3 Ratio	1.56	2.72	1.82	2.57	3.11	9.88	4.82	3.84	2.59	3.23	1.68	2.16	7.69

Table no. 5.16 Water Quality in Monitoring Wells of Study villages of Panchpipalva Bandhara (1995 to 2008) Contd....

Village	Well Code	Parameter	Year of Pre monsoon Monitoring												
			1995	1996	1997	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008
Velva	PTRU-9	TDS	----	1340	1476	1786	1369	1684	2213	----	1023	1624	1504	1994	1994
		CL.	----	400	448	624	432	512	920	----	296	568	488	680	680
		Cl:CO3 Ratio	----	1.32	1.22	1.88	1.33	1.38	4.25	----	0.95	2.43	1.59	2.51	3.3
	HLC-141	TDS	712	1965	1268	1398	1244	----	2771	1652	1340	1190	1309	2673	2791
		CL.	120	760	416	440	392	----	1080	592	448	400	434	1080	1160
		Cl:CO3 Ratio	0.41	3.35	1.83	1.69	1.47	----	3.2	2.73	2.18	1.71	1.9	5.43	5.45
Nanavada	PTRU-12	TDS	1893	1980	1988	1786	1905	1083	990	1448	1985	1925	2045	1595	1937
		CL.	800	840	840	760	840	376	352	544	920	856	396	600	880
		Cl:CO3 Ratio	7.27	8.45	6.76	7.37	8.79	3.11	4.71	4.94	11.83	12.75	25.23	3.38	12.39
Jantrakhadi	PTRU-13	TDS	1503	1631	1059	1131	1012	1384	1165	1336	1083	963	782	1481	1367
		CL.	376	448	232	304	312	336	424	308	232	184	128	520	480
		Cl:CO3 Ratio	1.01	1.11	0.65	0.86	2.58	0.83	3.74	0.78	0.5	0.44	0.34	1.87	2.29
	PTRU-14	TDS	1670	1805	1786	1845	1964	2166	2912	2561	3369	3128	3008	2446	2278
		CL.	656	712	728	776	840	960	1320	1200	1600	1480	1360	1000	1000
		Cl:CO3 Ratio	8.8	7.18	9.36	15	6.97	8.46	13.27	21.12	25.03	34.84	38.85	5.86	20.22
Malgam	PTRU-15	TDS	1670	932	851	833	----	782	1456	----	963	902	6016	684	438
		CL.	640	152	136	136	----	112	496	----	200	168	3120	88	72
		Cl:CO3 Ratio	6.91	0.28	0.34	0.3	----	0.25	3.25	----	0.44	0.36	87.88	0.29	0.41
	HLC-8	TDS	1196	----	1327	1165	1440	1324	1447	1709	1223	1369	1190	1281	1025
		CL.	400	----	416	400	480	448	512	624	448	440	408	448	320
		Cl:CO3 Ratio	1.94	----	1.78	2.08	2.08	2.3	2.67	3.38	2.93	2.48	3.29	9.07	1.88
Pipalva-Bava	HLC-142	TDS	1025	1225	1137	1165	1190	1203	1196	1823	1223	1250	1250	1336	1310
		CL.	312	360	352	392	384	384	408	640	392	440	448	480	456
		Cl:CO3 Ratio	1.99	1.45	1.68	2.83	2.3	2.16	2.55	2.4	1.9	2.88	3.95	4.5	2.92
Sokhada	HLC-284	TDS	1367	530	1781	1864	869	1925	1980	1837	1964	2202	2202	2283	2164
		CL.	408	88	568	640	168	680	800	640	600	720	960	1000	960
		CL:HCO3 Ratio	1.82	0.42	2.13	2	0.57	2.99	3.04	2.77	1.56	2.07	27.04	12.85	7.11

Source: SIPC, 2009

Table No. 5.17 Details of Water and Soil Samples Collected in Study Villages of Panchpipalva Bandhara

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min.	Sec.	Deg.	Min.	Sec.				EC	PH	EC	PH
1	Chikhali	Panchapipalva Bandhara	20	47	1.8	70	50	47.8				2.3	8.2		
2	Chikhali	Amad Isamail Jat Fakirani	20	46	42.3	70	51	39	5.1	3.7	Limestone	5.6	8.2	3.2	9.1
3	Chikhali	Palabhai Mandalbhai Varjan	20	46	45	70	51	55.4	6.3	4.35	Limestone	6.8	7.3	1.82	7.9
4	Chikhali	Bambhniya Ukabhai Bhanabhai	20	47	15.8	70	51	7.9	9.4	6.4	Limestone	5.2	7.9	1.74	8.3
5	Chikhali	Bachu Misari Solanki	20	47	30.3	70	51	42.8	13	12.2	Limestone	9.6	7.6	1.14	8.1
6	Dolasa		20	47	56.2	70	51	7	11.6	7.8	Limestone	5.9	7.5	1.63	8
7	Dolasa	Prakashbhai Devabhai Rathod	20	48	13.2	70	51	8.5	13	11.1	Limestone	3.5	7.6	0.73	8.3
8	Dolasa	Jodhabhai Kalabhai Mori	20	48	43	70	51	43.7	9.65	7.55	Limestone	3.4	7.6	2.1	7.9
9	Dolasa	Balubhai Danabhai Rathod	20	49	5.2	70	51	17.7	13.65	11.7	Limestone	3.9	7.7	0.89	8
10	Dolasa	Malabhai Virambhai Mori	20	49	9	70	50	4.4	20	18	Limestone	1.71	8.5	1.08	7.8
11	Adavi	Chinabhai Govindbhai Dodiya	20	50	6.8	70	49	27.4	19.2	17.9	Limestone	3.5	8.4	0.67	8.4
12	Adavi	Dodiya Jaysingbhai Ranabhai	20	48	56.4	70	50	8	17.8	17.4	Limestone	3	8.4	1.8	8.1
13	Adavi	Hamirbhai Masaribhai Vada	20	45	5.5	70	49	52.3	20.6	18.5	Limestone	2.8	7.9	2.1	8
14	Adavi	Pravinbhai Hajabhai Dodiya	20	48	51.4	70	49	51.9	18.1	13	Limestone	2.4	7.8	0.46	8.2
15	Panchpipalva	Devdanbhai Hajabhai Solanki	20	48	5.5	70	49	55.9	15.5	14.5	Limestone	6	7.8	0.71	8.3
16	Panchpipalva	Bhagavan Virjanbhai Dodiya	20	47	55	70	49	59	13.25	7	Limestone	7.4	7.6	1.65	8.2
17	Panchpipalva	Jeevabhai Karsanbhai Dodiya	20	47	43.6	70	50	33.9	13.4	7.6	Limestone	5.8	8.2	2.2	8.1
18	Panchpipava	Bhagvanbhai Naranbhai Dodiya	20	47	49.8	70	49	40.6	5	3.9	Limestone	7.1	7.8	1.43	8
19	Velva	Ramabhai Varjangbhai Dodiya	20	48	6	70	48	46.7	22.5	19.3	Limestone	2.9	7.9	2.6	8.3
20	Velva	Kanabhai Govindbhai Koli	20	48	40	70	49	32.2	21.9	20.4	Limestone	17.8	7.6	0.46	8.4
21	Velva	Sadabhai Parbatbhai Harijan	20	48	34.6	70	49	18.3	11.7	11.1	Limestone	8.5	7.9	0.89	8.2
22	Velva	Naranbhai Meramanbhai Vada	20	48	21.4	70	48	55.1	19.3	16.6	Limestone	6.6	7.2	1.3	8.1
23	Malgam	Bhachubhai Jodhabhai Parmar	20	47	38.9	70	48	38.1	14.35	13	Limestone	3.9	7.8	0.94	8.5

Table No. 5.17 Details of Water and Soil Samples Collected in Study Villages of Panchpipalva Bandhara Contd....

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min	Sec	Deg	Min	Sec				Ec	pH	Ec	pH
24	Malgam	Mahesbhai Ranabhai Darji	20	47	28.6	70	48	39.8	12.5	11.2	Limestone	6.4	7.9	1.7	7.8
25	Malgam	Raja karsan Dodiya	20	47	30.3	70	48	5.7	15.25	14.15	Limestone	2.4	8.5	2.5	7.7
26	Malgam	Raghabhai Mandanbhai Parmar	20	47	29.3	70	48	18.4	19.3	14.6	Limestone	3.3	8.5	0.64	7.9
27	Jantrakhadi	Subhashbhai Virbhanbhai Dodiya	20	47	12.1	70	48	25.9	23.6	19.2	Limestone	3.8	8.3	1.94	8
28	Jantrakhadi	Balubhai Mulabhai Vada	20	46	52.4	70	48	4	25.7	20.8	Limestone	3.3	8.8	1.46	8
29	Jantrakhadi	Dudabhai Danabhai Jankat	20	47	4	70	47	38.3	36.3	24.8	Limestone	3.5	8.3	2.8	7.5
30	Jantrakhadi	Gogabhai Balubhai Parmar	20	47	20.6	70	47	41.4	26.2	24.2	Limestone	2.2	8.4	1.9	8.2
31	Nanavada		20	46	23.7	70	48	24.9	14.5	14.2	Limestone	3.4	7.7	4.2	7.5
32	Nanavada	Ravsingbhai Ranabhai Vada	20	46	1.2	70	48	25.1	18.3	16	Limestone	7.1	8.2	2.2	7.8
33	Nanavada	Bhagavanbhai Masaribhai Sosa	20	45	44.6	70	48	15.4	20.1	15.5	Limestone	3.4	7.6	1.22	8
34	Nanavada		20	45	30	70	48	6.4	21.1	16.2	Limestone	6.5	7.4	1.96	7.7

Source: Field Survey, 2009

5.2.4.2 Impact on Drinking and Irrigation Water

Impact of Panchpipalva Bandhara on water resource has also been assessed through holding group discussion on uses of water. In this process detailed discussion with villagers have hold based on before and after status of water resource from use (drinking and irrigation water use) point of view.

Drinking Water: Table no. 5.18 shows villagers responses on before and after status of drinking in respective village. The gist of the same are listed below

- All the villages were having drinking water problem before bandhara, which also continue even after Bandhara. However, the nature of problem has changed, before bandhara water quality was the major issue, while after bandhara distribution and insufficient quantity are issue.
- Drinking water source in some villages has been changed after bandhara like in Nanavada, Panchpipalva, Chikhali and Dolasa which are dam and tank base sources.
- Except Panchpipalva, all the villages are facing problem for insufficient quantity of drinking water, while Advi and Malgam also face problem of poor water quality.
- Open well was the main drinking water source in all the villages before, while tank and dams are additional drinking water source after bandhara.
- All the villages have sufficient water for cattle.

Table no. 5.18 Before and After Drinking Water Status in Villages of Panchpipalva Bandhara

Village		Problem of Drinking Water	Source of Drinking Water	Quantity of Water	Accessibility of DW	Quality of Water	Availability of DW for Livestock
Nanavada	Before	Yes	Well	Insufficient	0 KM	Saline	No
	After	Yes	Jamvala Dam	Insufficient	35 KM	Sweet	Yes
Advi	Before	Yes	Well	Insufficient	0 KM	Turbid	No
	After	Yes	Well	Insufficient	0 KM	Turbid	Yes
Panch pipalava	Before	Yes	Well	Sufficient	0 KM	Sweet	No
	After	Yes	Jamvala Dam	Sufficient	0 KM	Sweet	Yes
Malgam	Before	Yes	Well	Insufficient	0 KM	Saline	Yes
	After	Yes	Well	Insufficient	0 KM	Saline	Yes
Chikhali	Before	Yes	Well	Insufficient	700 M	Sweet	Yes
	After	Yes	Dam Pipelne	Insufficient	700 M	Sweet	Yes
Dolasa	Before	Yes	Well	Insufficient	0 KM	Sweet	Yes
	After	Yes	Jamvala Dam	Insufficient	22 KM	Sweet	Yes
Velva	Before	Yes	Well	Insufficient	0 KM	Sweet	Yes
	After	Yes	Well	Insufficient	0 KM	Sweet	Yes

Source: Field Survey, 2009

Irrigation Water: To understand availability of irrigation water in study area a set of questions were asked during group discussion. Such questions were focused on availability of water for all or individual in season/seasons; type of water source; an introduction of water saving technologies etc. The responses from villagers are as follow

- Open wells are till major water resource for irrigation.
- Before bandhara, wells were able to provide water for support irrigation during Kharif season and in case of Rabi irrigation it was only in two villages. After bandhara except one village all village get sufficient water for both the seasons.
- Even in present situation, water in some of the villages is not sufficient for crop during Rabi season.
- Before status, farmers were not using water saving technology. After bandhara, some farmers of Advi, Nanavada and Dolasa village have started using water saving technologies for irrigation. Salinity in groundwater is the main reason for very limited reception of micro irrigation techniques by farmers.

Major conclusion from above discussion can be draw as

- Even after taken by so much of care, villages are not fully self dependent for their own drinking water management.
- There is a definite increase in Rabi season agriculture but the sufficient quantity of water is till major issue in some of the villages.
- Improvement in groundwater quality is not reached up to the point that can encourage farmer for large scale acceptance of micro irrigation technologies.

5.2.5 Impact on Health

Since human health is directly concerned with good water quality an assessment from health point of view was also carried out in study area. Looking to health aspect, there are many water borne diseases exist in the villages around Panchpipalva bandhara. Following can be said the impact of water on health.

- The seasonal malarial is seen in the villages like Advi, Malgam, Chikhali Dolasa and Velva. The malarial infection is not seen in the villages like Panchpipalva and Nanavada.
- Vector borne diseases and stones in kidney are seen in almost all the villages of the Noli river basin. The major agent of this kind of diseases is water.
- Fluorosis which is caused due to excess of fluoride in water is seen Arena village. The skin diseases caused due to poor quality of water which seen in Chikhali and Velva villages.
- The gastric problem is also major villages of the Panchpipalva bandhara. The major cause of this problem is water.

5.6 Assets

Number of typical kinds of asset is an indirect indicator of overall socio-economic development of area. Considering this, information on assets like four wheelers, two wheelers, tractors, water lifting devices were collected during village group discussion.

Table no. 5.19 give detail accounts of assets in villages around Panchpipalva Bandhara. It indicates that electric pump has replaced diesel engine that has reduced input cost in irrigated

agriculture. Two wheelers have increased after bandhara construction from 306 to 1062. Usage of tractors has also increased in agriculture practices after the bandhara.

Table no. 5.19 Before and After Status of Assets in Villages Around Panchpipalva Bandhara

Village		Four Wheeler	Cattle Shed	Tractors	Two Wheeler	Diesel Engine	Electric Pump
Nanavada	Before			0		100	
	After	0	100	5	100		60
Advi	Before			0		0	
	After	10	0	70	250		200
Panchpipalva	Before	10		40	100	100	
	After	10	30	60	150	10	
Malgam	Before			0		100	
	After	5		10	17	8	75
Chikhali	Before			2	6	20	4
	After	2		15	125	2	30
Dolasa	Before			150	200	400	
	After	6		200	400	50	400
Velva	Before		3	5		0	
	After	3		16	20	45	80

Source: Field Survey, 2009

Overall these changes have resulted into reduction of bullock population in some of the villages. Increased numbers of vehicle also indicates improvement in transportation. In Nanavada and Advi villages, there was not a single two wheeler before bandhara.

6. ASSESSMENT OF SPREADING CHANNEL OF SODAM BANDHARA

6.1 Characteristic of Sodam Bandhara

Sodam bandhara is located at New Velan village on Khadi River. This Sodam bandhara is linked with Panchpipalva bandhara by a spreading channel with aim to receive water from Panchpipalva bandhara. The salient features of the spreading channel are mentioned in Table no 6.1. This spreading channel provides artificial recharge to aquifer through surface water spreading along a narrow but elongated stretched canal. This structure was suggested by the high level committee 1. This canal is 4.45 Km long. From this length, 2715 m canal passes through waste land, 1340 m passes through cultivated land of Kaj village and 400m passes through cultivate land of Nanawada village of Kodinar taluka. The surrounding area has gentle slope towards sea. Main geological formations are clay and limestone of Gaj formation.

Assessment in of this channel has been carried out in three villages Kaj, Sarakhadi and Velan around spreading channel of Kodinar Taluka to fulfill the aim. These villages are located within of 10 km diameter. Agriculture is the main occupation in these villages. The seasonal agricultural is practiced in most of the villages.

Table No 6.1 Salient Features of Spreading Channel

1	Length of spreading channel	4455 meter
2	Bottom width of channel	5.00 meter
3	Inside slope of channel	1:1 in soil & hard murrum 1:0.5 in soft rock 1:0.25m in Hard rocks
4	C.D.work on spreading channel	7 Nos.
5	Top width of service roa	3.60 meter
6	Top width of Inspection path	1.80 meter
7	Side Slope of earth work	1:1
8	C.C.A. of spreading channel	270 Ha.
9	Benefited villages	Nanavada, Kaj, Velan
10	Water required for life irrigation	30.79 Mcft.
11	Total available storage	783.61 Mcft.
12	Estimated cost	Rs.62,07,600

Source: SIPC, 2009

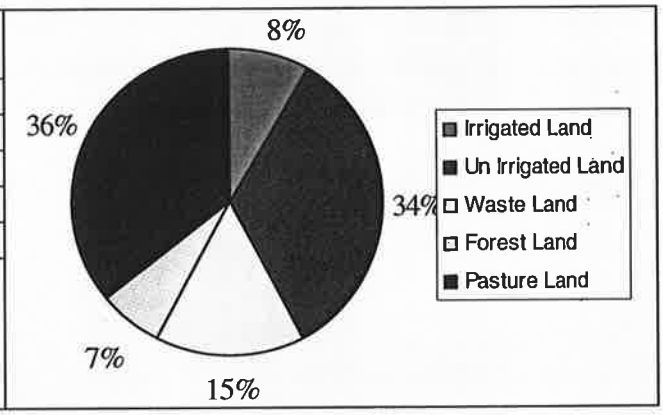
6.1.1 Land Use

All the villages together acquire about 6959.5 Ha of land. Velan has maximum 3936.5 Ha of land, while Sarakhadi and Kaj occupy 1583.1 Ha and 1439.9 Ha respectively. (Table no.6.2)

Land use pattern in these villages shows maximum land is used for agriculture purpose (42%). Total pasture land is 36% (2492.2 Ha) next to agriculture, while forest land is only 7% (470.4Ha). Total waste land is 15% (1036.6 Ha) of total land. (Table No 6.2)

Table no. 6.2 Land Use Pattern in Study Area (Spreading Channel of Sodam Bandhara)

Landuse Type	Area Ha.
Irrigated Land (Ha.)	586.4
Un Irrigated Land (Ha.)	2373.9
Waste Land (Ha.)	1036.6
Forest Land (Ha.)	470.4
Pasture Land (Ha.)	2492.2
Total land	**6959.5**



Source: Census, 2001 and Field Survey, 2009

Maximum irrigated land is in Velan village (294.7 Ha.), while Kaj has minimum (48 Ha.). Sarakhadi village has more rainfed areas (1047.2 Ha.) in compare to irrigated area. Only Velan has forest land in study area. There is no pasture land in Sarakhadi village. Kaj and Velan together occupy 551.9 Ha and 1940.3 Ha pasture land respectively. Maximum waste land is in Velan village (674.4 Ha). (Table No 6.3)

Table no. 6.3 Land Use of Study Villages (Spreading Channel of Sodam Bandhara)

Village	Irrigated Ha.	Un Irrigated Ha.	Waste Land Ha.	Forest Ha.	Pasture Land Ha.	Total Ha
Kaj	48	770	70	0	551.9	**1439.9**
Velan	294.7	556.7	674.4	470.4	1940.3	**3936.5**
Sarakhadi	243.7	1047.2	292.2	0	0	**1583.1**
Total	**586.4**	**2373.5**	**1036.6**	**470.4**	**2492.2**	**6959.5**

Source: Census, 2001 and Field Survey, 2009

6.1.2 Demographic Status

Total population of study villages is about 22593 distributed in 1401 households. Velan has the highest population i.e. 13781 people while Kaj has minimum population i.e. 4326 peoples. The men: women sex ratio stands at 1021 female against male. Population of general group is dominant in compare to other two groups (SC and ST). (Table no. 6.4)

Category wise general and OBC categories consist of Karadiya Rajputs, Brahmins, Ahirs, Patels and Lohana communities. The general category is in the dominating position. SC category consists of Kolis, Harijans and Muslims communities, while ST category consists of only Rabaris.

Table no. 6.4 Village Wise Household and Population (Caste Wise) in Study Villages

Village	Men				Women				Total
	General	SC	ST	Total	General	SC	ST	Total	
Kaj	1637	522	0	2159	1623	544	0	2167	4326
Velan	6151	645	5	6801	6306	666	8	6980	13781
Sarakhadi	1559	658	0	2217	1615	654	0	2269	4486
Total	**9347**	**1825**	**5**	**11177**	**9544**	**1864**	**8**	**11416**	**22593**

Source: Census, 2001 and Field Survey, 2009

6.1.3 Education Status

All villages have education facilities up to secondary schools. Table 6.5 shows village wise status of education units and students. Maximum no of Anganwadis are in Velan. All these villages have one primary and one secondary school. Total student in primary and secondary schools are 1625 and 650 respectively. Maximum 1000 student are going for primary education in Velan village, while maximum no of secondary school student are in Kaj village. No college or higher secondary school facility in any villages.

Table no. 6.5 Village Wise Education Status in Study Villages

Village	Education					
	Aanganwadi		1 to 7 Standard		8 to 10 Standard	
	Number	Student	Number	Number	Student	Number
Kaj	4	150	1	425	1	250
Velan	7	210	1	1000	1	200
Sarakhadi	2	45	1	200	1	200
Total	**13**	**405**	**3**	**1625**	**3**	**650**

Source: Field Survey, 2009

6.2 Socio Economical Impact Assessment

Various impacts of Spreading Channel of Sodam Bandhara have assessed from social, livelihood and natural resource point of view. The social and technical indicators through those assessment had undertaken are (01) Residing community and land holding; (02) Gender sensitization; (03) Impact on Livelihood; (04) drinking water; (05) Health and (06) Assets point of view.

6.2.1 Residing Community and Landholding

To understand which community is gaining most benefit by this activity all households were classified as per landholding such as (01) Landless; (02) Marginal farmers (< 2.50 Acre); (03) Small farmers (2.5 to 5 Acre); and (04) Big farmers (> 5 Acre). Table no. 6.6 shows 49.96 % household are landless. Big farmer are only 14.27 % of total household. The landless families are maximum in general and ST community which are 500 and 200 HH respectively. (Table no 6.6)

Based on this analysis broadly it may be stated that out of total household 50 % household (landless) may not have direct benefit by this activity.

Table no. 6.6 Caste Wise Landholding (No. of Households) (Spreading Channel of Sodam bandhara)

Caste	Land Less	Marginal Farmers	Small Farmer	Big Farmer	Total
General	500	175	176	200	1051
SC	200	75	75	0	350
ST	0	0	0	0	0
Total No.	700	250	251	200	1401
Percentage	49.96	17.84	17.91	14.27	**100**

Source: Field Survey, 2009

6.2.2 Gender Sensitization

As discussed in previous section female population in these villages are 11416 persons and male: female ratio stands at 1021. To understand change taking place in gender sensitivity levels in the study villages due to salinity prevention activities following questions were asked to villagers.

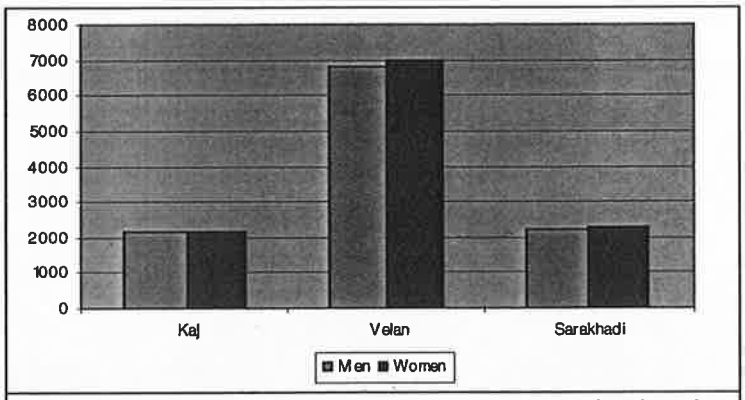


Figure no. 6.1 Chart Shows Male Female Ration in Study Villages

Did the Bandhara help to save time of women for fetching drinking water? If yes, where they utilize the time?
Do women take decision in your family?
Do women participate in community work?

The responses of these questions are described in table no 6.7.

Table no. 6.7 Village Wise Survey Results on Gender Sensitivity

Village	Did the Bandhara Help to Save Time of Women for Fetching DW (Y/N)	If yes Than Where They Use Their Time	Do Women Take Decision in Your Family (Y/N)	Do Women Participate in Community Work
Kaj	No	-----	No	*Gramsabha*
Velan	No	-----	Yes	*Gramsabha*
Sarakhadi	No	-----	No	*Gramsabha*

Source: Field Survey, 2009

Normally it is an assumption that, due to water harvesting/ groundwater recharge/ water conservation, groundwater quality and quantity improved at that level where every village can have their drinking water source at village level. And if the village has its drinking water source within the village, it decreases the time for women for fetching drinking water. Based on these two considerations, the first question was asked to the villagers. In all villages responses of people regarding saving time from drinking water were negative that reflecting till the drinking water in these villages have not secured. Besides these indicators, the straight question regarding role of women in household level decision making has asked during group discussion. In Kaj and Sarakhadi villages, people have responded as no role except Velan village where women take decision in family. While the response on inquiry regarding women's involvement in different kinds of meetings, people have said that women remains present into the *gramsabha* but they are not actively participate in discussion.

6.2.3 Livelihood Impact

The main occupations in the study area are agriculture and animal husbandry. In addition several households are managing their income through wage labor. Among different occupations agriculture is one of the most vulnerable occupation can directly influenced by degradation of soil and water quality. While other means of livelihoods like agriculture labor and animal husbandry have indirect impact of degradation of such natural resources. Such

impacts can be assess through studying increase/decrease production, migration pattern, increase/decrease milk production, change in livestock etc. Keeping this in mind, this section is discussing various impacts on different aspects of agriculture and animal husbandry occupations along with village wise migration pattern in study area.

6.2.3.1 Agriculture

As we seen in land use pattern, total 42 % of total land is under agriculture use. Sea water intrusion and groundwater salinization has badly affected this backbone economy of the area by degrading soil productivity. Impacts of salinity ingress on agriculture before construction of spreading channel for Sodam bandhara were assessed through discussion with village people on type of cropping pattern, increase / decrease in irrigated area, and rise and fall in production. All these assessment have made seasonally. Table no. 6.9 shows village wise season wise before and after status of agriculture in term of crops, crop sown area, and production in case of field crops.

Table no. 6.8 Season Wise Before and After Status Crop Area and Respective Unit Production in Surrounding Villages of Spreading Channel

Season	Crop	Area (Bigha)		Production (Kg/ Bigha)	
		Before	After	Before	After
Kharif	Groundnut	4980	1200	4980	840
	Bajra	1047	1047	2300	2300
	Cotton	3987	3987	2100	2100
Total		10014	6234	9380	5240
Rabi	Wheat	2201	2201	2000	2000
	Castor	1781	1781	600	600
Total		3982	3982	2600	2600

Source: Field Survey, 2009

Case Study: 7 Case of Ramsinhbhai Vanja Village: Velan

- After bandhara irrigated agriculture area in Rabi season decreased from 2.5 bigha to 1 bigha under wheat crop production, while in summer crop replaced from bajari to jovar.
- In coconut based horticulture, little change in area from 1.25 bigah to 1.35 bigha after bandhara, but there is decrease in annual income of about 1,000 Rs.
- Before bandahra the farmer borrowed 4000 Rs with 11 % interest rate from lander for agriculture purpose, while after bandhara he borrowed 8,000 Rs with 8 % interest rate from bank especially for fertilizers.

In case of field crop groundnut in Kharif and wheat in Rabi seasons are still dominant crops in all villages. In Kharif season Bajra and cotton are common as second crops. Table no. 6.8 shows before and after status of crop wise unit production. There is no summer cropping in any village. As per before and after bandhara status, major change is in area decrease in groundnut crop in Kharif season.

Table no. 6.9 Before and After Field Crop Status in Villages of Spreading Channel

Village	Crop	Kaj		Velan		Sarakhadi	
Season		Before	After	Before	After	Before	After
Kharif	Crop Name 1	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut	Groundnut
	Area (Bigha)	4275	4275	375	375	330	330
	Production (Kg/Bigha)	400	400	400	400	400	400
	Crop Name 2	Cotton	Cotton	Bajara	Bajara	Bajara	Bajara
	Area (Bigha)	2137	2137	225	225	110	110
	Production (Kg/Bigha)	1000	1000	1000	1000	500	500
	Crop Name 3	Bajara	Bajara	Cotton	Cotton	Cotton	Cotton
	Area (Bigha)	712	712	100	100	1750	1750
	Production (Kg/Bigha)	800	800	600	600	500	500
Rabi	Crop Name 1	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
	Area (Bigha)	1781	1781	200	20	220	220
	Production (Kg/Bigha)	800	800	600	600	600	600
	Crop Name 2	Castor	Castor	Cotton	Cotton	-----	-----
	Area (Bigha)	1781	178	-----	-----	-----	-----
	Production (Kg/Bigha)	600	600	-----	-----	-----	-----

Source: Field Survey, 2009

Horticulture practiced only in Velan village. Here plant species is coconut and irrigation sources are till open wells. Flood irrigation is popular practice. Income per bigha is decreased after bandhara from Rs. 12,000 Rs to 5,000/-.

The vegetable plantation is very negligible in these villages. Mainly kitchen garden is practiced in these villages. There is no plantation of the vegetables as a source of income

Table no. 6.9 Horticulture Crop in Velan Village Before and After Bandhara Status

Village	Velan	
	Before	After
Name of tree species	Coconut	Coconut
Area under plantation Bigha	125	125
Source of irrigation	Open well	Open Well
Methods of irrigation	Flood	Flood
income (per Bigha)	12000	5000

Source: Field Survey, 2009

To assess soil quality of agriculture land in study villages, total 12 soil samples were collected from three study villages. Average 4 to 5 samples collected from each study village. Table no 6.16 gives details of sample location and chemical properties like Ec and pH. This analysis was carried out by Central Soil Salinity Research Institute based at Bharuch. According to this, total 5 samples show high Ec value than normal range. This land shows more salinity than other land. Maximum Ec value shows in Velan (8.5) and Kaj (8.0). Minimum value is 0.6 in Sarakhadi village. PH range shows normal value from 7 to 8.5.

6.2.3.2 Animal Husbandry and Livestock

All villages have small and large size animals. The main livestock composition is dominated by large size animal like buffalo and cattle (cow and bullock). Goat is dominant small animal

in this area. The total livestock population in these villages is 5575, which was about 4220 before bandhara. There are no sheep and camel population of sheep and camel in study villages. (Table no. 6.11) The survey results in the study area show high increase in buffalo (1195 to 1950) and goat (300 to 1400) population whereas gradual decrease in cow (1825 to 1725) and bullock population (900 to 500). (Figure no 6.2)

According to farmers buffalo have increased mainly due to availability of fodder due to improvement in water resources. Another reason is more average milk production by buffalo. Market opportunity through dairy development has also played significant role in buffalo population. Increase in irrigation opportunity during winter and summer seasons is the main reason for increasing population of bullock in this area. Village wise details of livestock and milk production in study villages have given in table no 6.12.

Table No. 6.11 Change in Livestock Population Villages Around Sodam Spread Channel

Village		Cow	Buffalo	Bullock	Goat
Kaj	Before	700	775	200	100
	After	800	800	150	400
Velan	Before	125	120	200	200
	After	125	150	50	1000
Sarakhadi	Before	1000	300	500	0
	After	800	1000	300	0
Total	**Before**	**1825**	**1195**	**900**	**300**
	After	**1725**	**1950**	**500**	**1400**

Source: Field Survey, 2009

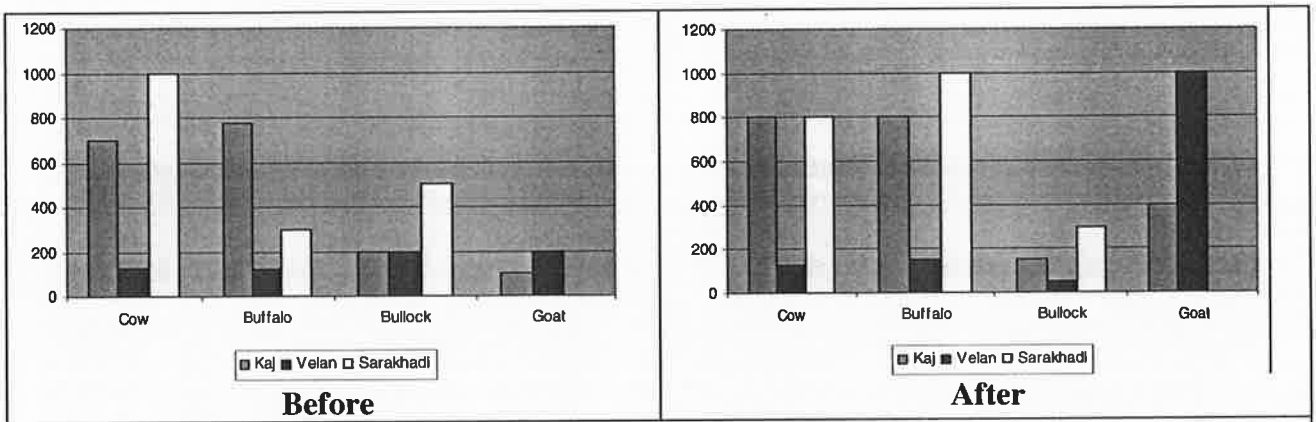


Figure no 6.2 Charts Shows Total Livestock population in the area of Spreading Channel of Sodam bandhara (pre and post)

Out of total animals, people prefer about 50 % of total as lacting cattle to maintain production. Average milk production by cow was 2 lit/day in village Sarakhadi before bandhara, which is 5 lit/day now. In present days average production by a cow is varies from 3 lit/day in village Kaj to maximum 5 lit in village Sarakhadi. Similarly in case of buffalo average milk production before bandhara was 6 lit which has increased up to 7 lit, which is till maximum among other villages.

Table no. 6.12 Livestock Population and Milk Production in the area of Spreading Channel of Sodam Bandhara

Cattle Type	Details	Kaj		Velan		Sarkhadi	
		Before	After	Before	After	Before	After
Cow	Nos	700	800	125	125	1000	800
	Lactating Cattle	350	400	55	56	500	400
	Lactation Period (days)	210	210	210	210	210	210
	Milk Production lit/day	3	3	4	4	2	5
Buffalo	Nos	775	800	120	150	300	1000
	Lactating Cattle	375	400	100	100	150	400
	Lactation Period (days)	270	210	270	270	270	270
	Milk Production lit/day	3	3	6	7	5	5
Bullock	Nos	200	150	200	50	500	300
Goat	Nos	100	400	200	1000		

Source: Field Survey, 2009

Milk Production and Dairy development

Milk collection center facility is in all study villages have started after the construction of the bandhara. All are of NDDB. The average price of the milk is varies from Rs 15 to Rs 20 per liter. The price mainly depends on the fats of the milk. Generally buffalo milk fetches higher rate than the cow milk. The milk collection at Kaj is higher than other villages also highest number of houses selling the milk at this center.

Table no. 6.13 Details of Milk Selling at Milk Collection Centers in Study Village Around Spreading Channel of Sodam Bandhara

Village		Total Household Selling Milk	Daily Milk Collection (Lit)	Annual Milk Collection (Lit)	Average Rate Rs/lit
Kaj	Pre	0	0	0	-----
	Post	400	800	292000	15
Velan	Pre	0	0	0	-----
	Post	22	50	18250	20
Sarakhdi	Pre	0	0	0	-----
	Post	20	200	73000	18

Source: Field Survey, 2009

6.2.3.3 Migration and Labour

Increasing wage labours and rate of migration are indicators of degradation of natural resources. It is already discussed that salinization of groundwater has badly impacted back bone traditional occupation i.e. agriculture. Table no. 6.14 shows village wise details of migration pattern. Sarakhadi people have started migration after bandhara, whereas Kaj and Velan people were migrating even before bandhara. The families migrate to nearby villages and Veraval, Mangrol and Porbandar areas for labour work in agriculture and fish catching occupation. People of all villages engaged in fishery occupation during migration time, while people of Velan also worked as labor in agriculture.

In Sarakhadi migration was not preferred before the construction of the bandhara. About 1000 people migrate from this village. People of Velan migrate in all seasons, while of Kaj and

Sarakhadi used to migrate in winter and summer seasons. There is no change in income before and after status. by spreading channel status.

Table no. 6.14 Migration Trend in Study Villages of Spreading Channel

Village	Migration		Persons No.		Migration Season		No. of days (Annual)		Income Rs. in Lakh (Annual)		
	Before	After	Before	After	Before	After	Before	After	Before	After	Change
Kaj	Yes	Yes	300	300	Winter, Summer		240	240	0.40	0.04	**-0.36**
Velan	Yes	Yes	800	1200	All seasons		365	365	0.20	0.20	**0.0**
Sarkhadi	No	Yes	----	1000	----	Winter, Summer	----	240	0.0	1.0	**1.0**
Total			**1100**	**2500**			**605**	**845**	**0.80**	**1.24**	**0.64**

Source: Field Survey, 2009

6.2.4 Impact on Water Resources

There were two methods adopted to assess impact on ground water resources of the study area. The methods are study of changes in groundwater level and quality mainly based on secondary data recorded by SIPC and availability of water for different uses. In these cases only drinking and irrigation uses have considered for assessment.

6.2.4.1 Change in Groundwater

Salinity Ingress and Prevention Cell, Government of Gujarat is a responsible department for implementation of coastal salinity related programme in any coastal areas of state. In addition to implementation, impact assessment and long term monitoring of different water resource related parameters like groundwater level, water quality (status as well fluctuation) are also their responsibilities. Therefore, department has establish their own observation network of well. In study area around spreading channel of Sodam Bandhara, only one well of Kaj villages has monitored by the department. Besides this well, there is no any long term monitoring well in other villages of study area or in upper catchment areas of the basin. In any watershed area, any intervention carried out in upper reaches has their definite implications in lower catchment. The scale and type of impacts absolutely depends on specific characteristics of the particular watershed or basin. Keeping this in mind the analysis of monitoring well had carried out to understand fluctuation trends in water level and water quality. Well hydrograph were prepared to understand secular and seasonal changes taking place in groundwater levels in last several years.

Random well inventory and sample collection carried out in each village during this study. Total 13 samples collected from these villages including bandhara surface water also. Table no 6.16 shows details of sample collection. Analyses of these samples were done by Central Soil Salinity Research Institute, Bharuch. Limestone is main aquifer for this area. This survey was carried out in month of June, year 2009.

It is important to clarify that the conclusions regarding the water level fluctuation and quality have following limitations.

- Analysis were based on secondary data recorded by SIPC
- Only one monitoring well in study area.

Data were of only pre monsoon seasons therefore, seasonal changes in water level, due to rainfall was not possible to carry out

Water Level Fluctuation: Well hydrograph of reduced water level in pre monsoon season was prepared to understand secular and seasonal changes taking place in groundwater levels in last several years. The trends of water level in the well shows negligible rise in water level over the years. (Figure no 6.3) Water level of the well shows maximum recharge in year 1999 and 2004.

Based on well inventory data (Table no 6.16), area have shallow depth ground water table up to 14 m from surface. Maximum depth water level is seen in Kaj (13.9 m), while minimum in Velan (1.9 m).

Year	RWL m PTRU-11
1995	1.11
1996	1.81
1997	3.21
1998	4.71
1999	5.31
2000	6.01
2002	1.71
2003	4.71
2004	6.71
2005	2.11
2006	1.11
2007	2.51
2008	3.71

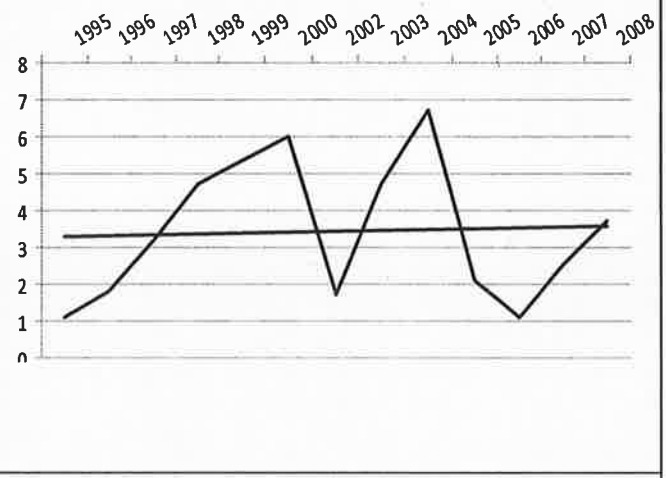


Fig. 6.3 Hydrograph of RWL in Observation Well PTRU 11 of Kaj Village

Water Quality: Changing trends in groundwater quality has been analyzed by preparing well hydrographs of fluctuating values of Total Dissolved Solids in groundwater as well as changes in ratio of chloride carbonate ration.

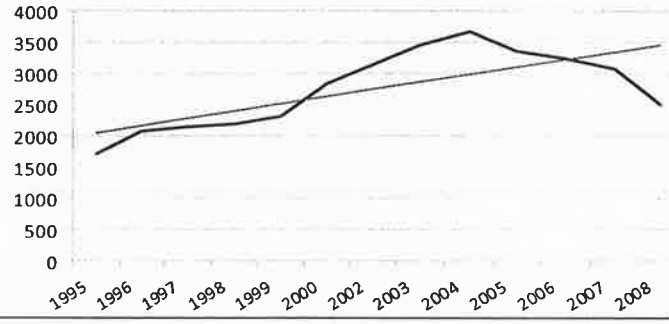


Fig. 6.4 Well Hydrograph Showing Changing Trends in Total Dissolved Solids in Well Code PTRU 11 of Kaj Village

Figure no. 6.4 shows well hydrographs prepared for TDS values measured in monitoring well of Kaj village. It clearly shows from year 1991 to 2001 values of TDS were nearly same up to year 1999. Then it has started increase during years 2000 to 2004. After this year again TDS value decreased. The peak values of TDS (3670 ppm) were observed in year 2004. Minimum TDS value is observed in year 1995 which was 1726 ppm.

Based on well inventory data (Table No. 6.16), it can interpret that only one sample of Kaj village have potable limit of Ec mean less than 2.8 Ec (1800 ppm TDS). Other all the samples indicate higher salinity than normal range. This indicates sea water intrusion in groundwater. Maximum Ec value observed in Kaj (13) and Sarakhadi (11) villages. PH value seems normal in all the samples.

Table no. 6.15 Water Quality in Well code PTRU 11 of Kaj Village (Pre monsoon of year 1995 to 2008)

Year	TDS ppm	Chloride ppm	Cl:CO3 Ratio
1995	1726	744	12.96
1996	2068	920	31.58
1997	2131	1000	10
1998	2202	1040	20.71
1999	2321	1160	36.3
2000	2828	1320	16.97
2002	3145	1480	52.11
2003	3452	1600	32.42
2004	3670	1800	42.6
2005	3369	1680	58.91
2006	3249	1520	42.81
2007	3076	1440	13.52
2008	2506	1120	22.64

Source: SIPC, 2009

In addition to TDS concentration Chloride and Carbonate + Bicarbonate ration in groundwater of the study area was computed. (Table no.6.14) Almost in all the years well shows ratio much more than 6 that again clearly indicates injurious contamination of groundwater by sea water. After year 2002 the ratio increased highly which again decrease in year 2007. Following conclusion can be draw based on this behavior of the wells

- The stable concentration of TDS during year 1995 to 2001
- Abrupt salinity increased in the area after year 2000 may be due to over exploitation of groundwater and low rainfall during these years.

Table No. 6.16 Details of Water and Soil Samples Collected from Study Villages of Spreading Channel of Sodam Bandhara

Sr. No.	Village	Name of Owner	Latitude			Longitude			Total Depth (m)	Water Level (m)	Aquifer Type	Water Analysis		Soil analysis	
			Deg	Min.	Sec.	Deg	Min	Sec				EC	PH	EC	PH
1	Velan	Sodam Bandharo	20	42	38.9	70	49	46.5				10.1	6.2		
2	Kaj	Bhavsing Arajanbhai Parmar	20	45	13.1	70	47	39.1	14.5	13.1	Limestone	6.9	7.8	8	7.3
3	Kaj	Jodhabhai Rajabhai Dodiya	20	45	1.1	70	47	17.1	11.8	8.4	Limestone	7	7.3	1.26	8.2
4	Kaj	Hamirbhai Bhathabhai	20	44	43.8	70	47	35.8	8.75	7.5	Limestone	2.4	8.2	2.3	7.4
5	Kaj	Balubhai Arajanbhai Parmar	20	44	21.3	70	47	59.3	5.4	4.8	Limestone	13.4	7.95	2.1	7.8
6	Velan	Arajan Bechar Vagela	20	43	9.2	70	50	19.5	5.15	3.5	Limestone	7.4	7.6	1.4	7.8
7	Velan	China Daya Vagela	20	43	0	70	44	42	4.45	3.6	Limestone	5.4	7.8	8.5	7.5
8	Velan	Asavibhai Chudasma	20	43	10.6	70	49	24.7	6.1	1.9	Limestone	17.8	7.6	2.8	8.5
9	Velan	Varzang Jesa Bambhaniya	20	43	23.2	70	44	8.6	4	3.2	Limestone	8.5	7.9	7.6	7.7
10	Sarkhadi	Rambhai Bhikhabhai	20	45	48.9	70	45	8.2	15.9	12.9	Limestone	6.6	7.2	0.61	8.2
11	Sarkhadi		20	45	31.1	70	45	5.8	11.9	10.7	Limestone	6.7	7.2	1.5	7.7
12	Sarkhadi	Parmar Abhesinh Bhikhabhai	20	45	9.3	70	45	1.6	10.2	8.2	Limestone	9.9	7.2	1.9	7.6
13	Sarkhadi	Bhikha Haja Vada	20	44	35.4	70	45	19.9	8.3	4.9	Limestone	10.6	7.2	6.4	7.5

Source: Field Survey, 2009

6.2.4.2 Impact on Drinking and Irrigation Water

Impact of spreading channel of Sodam bandhara on water resource have also been assessed by village opinion during group discussion. In this process detailed discussion with villagers have hold on before and status of water resource from utilization (drinking and irrigation water use) point of view. This analysis was made based on primary information collected through group discussion and case study in study area.

Drinking Water: Table no. 6.17 shows villagers responses on before and after status of drinking in respective village. The gist of the same are listed below…

- Except Velan, Kaj and Sarkhadi villages have problem of drinking water problem before and after bandhara.
- All the villages are facing problem of insufficient quantity of drinking water.
- Dam and Open well are main drinking water source in all the villages.
- Except Velan, other two villages have insufficient water for cattle

Table no. 6.17 Before and After Drinking Water Status in Villages Around Spreading Channel of Sodam Bandhara

Village		Problem of Drinking Water	Source of Drinking Water	Quantity of Water	Accessibility of DW	Quality of Water	Availability of DW for Livestock
Kaj	Before	Yes	Dam	Insufficient	0 Km	Sweet	No
	After	Yes	Dam	Insufficient	0 KM	Sweet	No
Velan	Before	No	Well	Insufficient	1 Km	Sweet	Yes
	After	No	Jamwala Dam	Insufficient	1 KM	Sweet	Yes
Sarkhadi	Before	Yea	Well	Insufficient	0 KM	Saline	No
	After	Yes	Jamwala Dam	Insufficient	30KM	Sweet	No

Source: Field Survey, 2009

Irrigation Water: To understand availability of irrigation water in study area a set of questions were asked during group discussion. Such question were focused on availability of water for all or individual season/seasons; type of water source; an introduction of water saving technologies etc. The responses from villagers are as follow

- Open wells are till major water resource for irrigation.
- The wells were not able to provide water for support irrigation during all seasons. Except Kaj village, farmers of Velan and Sarkhadi didn't get sufficient water for Rabi season.
- No farmers in these villages have adopted micro irrigation system for irrigation.
- Salinity in groundwater is the main reason for very limited reception of micro irrigation techniques by farmers.

Major conclusion from above discussion can be draw as

- Even after taken by so much of care villages are not self dependent their own drinking water management.
- Rabi season agriculture has till question in front of farmers for sufficient quantity of water.

- Improvement in groundwater quality is not reached up to the point that do not encourage farmer for large scale acceptance of micro irrigation technologies.

6.2.5 Impact on Health

It is already proven that 90 % of human health issues are related to water. Since the study area has a water quality threat due to salinity ingress the impact on health is assessed in study villages. Following can be said the impact of water resources on health.

- The malarial infection is seen in the all villages the main reason is due to poor quality of water.
- Similarly vector borne diseases and stones in kidney are seen in almost all the study villages. The major agent of this kind of diseases is water.
- Fluorosis which is caused due to excess of fluorine in water is seen Velan village. The skin diseases caused due to poor quality of water. The skin disease is mainly seen in Velan.
- The gastric problem is also major villages of the Sodam. The major cause of this problem is water.
- There is also presence of skin daises

6.2.6 Assets

Number of typical kinds of asset is an indirect indicator of overall socio-economic development of area. Considering this information on assets like four wheelers, two wheelers, tractors, water lifting devices were collected during village group discussion.

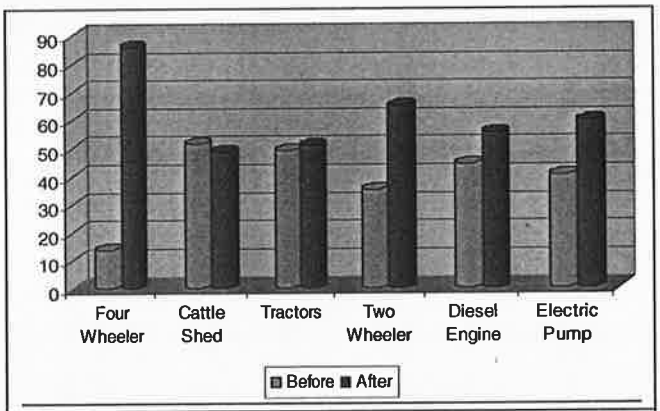


Figure no. 6.5 Before and After Status of Assets in Study Villages

Table no. 6.18 gives detail accounts of assets in villages around spreading channel of Sodam bandhara. It is very clear that large increase in numbers of diesel engine after bandhara. High increase in number of four wheeler has shown in Kaj and Sarakhadi village. No of electric pump increased in Sarakhadi village.

Table no. 6.18 Village Wise Before and After Status of Assets in Study Villages Around Spreading Channel of Sodam Bandhara

Type of Asset		Four Wheeler	Cattle Shed	Tractors	Two Wheeler	Diesel Engine	Electric Pump
Kaj	Before	5	800	50	180	80	200
	After	5	800	60	200	100	200
Velan	Before	1	150	2	1	200	7
	After	25	100	16	35	200	7
Sarakhadi	Before	0	0	60	0	0	0
	After	7	0	40	100	50	100
Total	**Before**	**6**	**950**	**112**	**181**	**280**	**207**
	After	**37**	**900**	**116**	**335**	**350**	**307**

Source: Field Survey, 2009

ANNEXURE

Annexure I : Village Wise Survey Format

Socio Economic Impact Assessment Study of the Salinity Prevention Structures in Saurashtra Region

Village level Information:

Village: Panchayat: Taluka: District:

Demography

Parameter	General	SC	ST	Total
Landless Households				
Marginal Farmers (less than 2.5)				
Small Farmers (2.5 to 5 acres)				
Big Farmers (more than 5 acres)				
Total households				

Parameter	General	SC	ST	Total
Men				
Women				
Total Population				

Sr. No.	Type of Land	Area in Hectares
1	Irrigated land	
2	Un irrigated land	
3	Waste land	
4	Forest land	
5	Pasture land	
6	Total	

Is there any change in the extent of waste lands pre and post, additional area brought under cultivation, area under submergence etc.

Cropping pattern:

Information regarding the crops produced during *kharif, rabi* and *summer*

	Before Bandhara			After Bandhara		
Season	**Crop**	**Area in bigha**	**Production (kg)**	**Crop**	**Area in bigha**	**Production (kg)**
Kharif						
Rabi						
Summer						

Horticulture plantation:

Particulars	Before Bandhara	After Bandhara
Name of tree species		
Area under plantation (bigha)		
Source of irrigation		
Methods of irrigation		
Average production (plantation)		
Income (per vigha)		

Vegetable Cultivation:

Crop	Before Bandhara		After Bandhara	
	Area	**Production**	**Area**	**Production**
1				
2				
3				

Is there any increase in land area under cultivation after the construction of bandhara?

(YES/ NO)

If yes, give details _____

Livestock Information:

Sr. No.	Live stock	No	Lactating Cattle	Lactation period (days)	Milk lit/Day	No	Lactating Cattle	Lactation period (days)	Milk lit/Day
		Before Bandhara				After Bandhara			
1	Cow								
2	Buffalo								
3	Ox								
4	Goat								
5	Sheep								
6	Poultry								
7	Camel								
8	Other								

Milk Collection Center (Pre Bandhara)

No. of Household selling Milk	Daily Milk collection in Ltrs.	Total yearly collection of milk	Average rate per litre	Total income from Milk

Milk Collection Center (Post Bandhara)

No. of Household selling Milk	Daily Milk collection in Ltrs.	Total yearly collection of milk	Average rate per litre	Total income from Milk

Assets in village:

Sr. No	Assets	Before Bandhara	After Bandhara
1	Four wheeler		
2	Cattle Shed (separately)		
3	Tractor		
4	Two Wheeler		
5	Diesel Engine		
6	Electric pump		
7	Other		

No. of farmers directly benefited by the bandhara / scheme / system (irrigation): _____

Availability of drinking water

Availability of drinking water	Before bandhara	After bandhara
Problem of drinking water		
Source of drinking water (open well, HP, tube well, pond, river etc.)		
Quantity of water (Sufficient / Insufficient)		
Accessibility of DW (distance of source)		
Quality of water (Sweet/Fresh, Saline,Turbid, With Chemical)		
Availability of drinking water for livestock		

Availability of water for irrigation:

Sr. No.	Availability of water	Before Bandhara	After Bandhara
1	Source of Irrigation*		
2	Sufficient for all three season crop		
3	Sufficient for kharif crop		
4	Sufficient for rabi crop		
5	Sufficient to irrigate full crop (season)no of irrigation		
6	Use of water saving devices for irrigation (Drip/ sprinklers)		

*Open well, Tube wells, LI, Canal, Other source.

Migration information:

Sr. No.		Before Bandhara	After Bandhara
1	Migration (Y/N)		
2	No. of persons those migrated		
3	Type of work		
4	Place of Migration		
5	Migration season		
6	No. of Days (annual)		
7	Income Rs. (annual)		

Health related Information:

(Water related problems)

Majority of illness reported diseases

Sr. No.	Name of disease	Seasonal	Through out year	Reason
1	Malaria			
2	Vector born diseases			
3	Stone in kidney			
4	Flourosis			
5	Skin disease			
6	Gastric problems			
7	Others_____			

Education Related Information:

Sr. No.	Institution	Number	Number of Students
1.	Aanganwadi		
2.	1st to 4th Standard school		
3.	5th to 8th Standard school		
4.	8th to 10th Standard school		
5.	11th to 12th Standard school		
6.	College		

Gender Issues:

1. Did the bandhara help to save time of women for fetching drinking water (Y/N)
   If yes, where do they utilize the time?
2. Do the women take decision in your family? Yes/ No
   If yes, specify_____
3. Do women participate in community work?
   - Gramsabha
   - Group meeting (SHG, Mahila mandal)
   - Social activities
   - Panchayati activities
4. Did the Bandhara help in creating new employment opportunities in the village? (Y/N)

Annexure II: Case Study Format

Name of the Farmer:

Village / Panchayat / Taluka / District:

Caste:

Date of Survey:

Educational Status:

Sr. No.	Name of the person	Relationship with Head of the family	Age	Educational Qualification
1				
2				
3				
4				
5				

Type of Land:

Sr. No.	Type of Land	Area (Hectares)	
		Before Bandhara	After Bandhara
1	Irrigated land		
2	Un irrigated land		
3	Waste land		
4	Forest land		
5	Pasture land		
	Total		

Cropping Pattern:

Season	Before Bandhara			After Bandhara		
	Crop	Area (Hectares)	Production (kg)	Crop	Area (Hectares)	Production (kg)
Kharif						
Rabi						
Summer						

Is there any change in the Cropping Pattern (New Crops)? Y / N

Horticulture Plantations	Before Bandhara	After Bandhara
Name of tree species		
Area under plantation (Hectares)		
Source of irrigation		
Methods of irrigation		
Average production		

Vegetable cultivation:

Crop	Before Bandhara		After Bandhara	
	Area (Hectares)	Production (kg)	Area (Hectares)	Production (kg)
1				
2				
3				
4				
5				

Is there increase in Crop Production after the construction of Bandhara? (Y/N)

Have you started growing crops or putting increased area under fruit crops after the construction of Bandhara?

If yes, Please give details:

Livestock Information:

Sr. No.	Livestock	Nos.	Lactating Cattle	Lactation period (days)	Milk Production/ Day	Fodder requirement
1	Cow					
2	Buffalo					
3	Ox					
4	Goat					
5	Sheep					
6	Poultry					
7	Camel					
8	Other					

Availability of drinking water

Availability of drinking water	Before bandhara	After bandhara
Problem of drinking water		
Source of drinking water (open well, HP, tube well, pond, river etc.)		
Quantity of water (Sufficient / Insufficient)		
Accessibility of DW (distance of source)		
Quality of water (Sweet/Fresh, Saline, Turbid, With Chemical)		
Availability of drinking water for livestock		

Availability of water for irrigation:

Sr. No.	Availability of water	Before Bandhara	After Bandhara
1	Source of Irrigation*		
2	Sufficient for all three season crop		
3	Sufficient for kharif crop		
4	Sufficient for rabi crop		
5	Sufficient to irrigate full crop (season)no of irrigation		
6	Use of water saving devices for irrigation (Drip/ sprinklers)		

*Open well, Tube wells, LI, Canal, Other source

Information on Household Income (annual):

Sr. No.	Source of income	Before Bandhara (Rs.)	After Bandhara Rs.)
1	Agriculture		
2	Animal husbandry (dairy)		
2	Job/ Business		
4	Wage Labor		
6	Livestock/. Dairy		
7	Sale of Fodder		
8	Others		
	Total		

Debt status:

Sr. No.	Particulars	Before Bandhara	After Bandhara
1	Money borrowed (Y/N)		
2	Amount borrowed		
3	From Where		
4	Rate of interest		
5	Reason		

Is there any change in the quality of ground water in your wells? (Y/N)

If yes, how?

Asset with the farmer

Sr. No.	Assets	Before Bandhara	After Bandhara
1	House		
2	Two wheeler		
3	Four wheeler		
4	Tractor		
5	Diesel engine		
6	Electric pump		

Observations of the surveyor (Please give a brief write up on the following):

- Your overall observations for fulfilling the objective of case study
- Farmer's opinion about bandhara
- Change in economic, agrarian life

Name and Signature of surveyor:_____

Date:_____