IMPACT ASSESSMENT OF WATER RESOURCE MANAGEMENT (WRM) STRUCTURES UNDER COASTAL AREA DEVELOPMENT PROJECT IN SAURASHTRA COASTAL AREAS

Final Report

Prepared By

Arid Communities and Technologies
Bhuj-Kachchh

COASTAL SALINITY PREVENTION CELL
Kharash Vistarotthan Yojana

Submitted To

Coastal Salinity Prevention Cell
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Study Team

Dr. Jadeja Yogesh, (M.Sc., Ph.D. Geology, Team Leader)
Ms. Bhimani Sezina (M.Sc., Ph.D. Geology)
Mr. Gorasiya Jayantilal (Civil Engineer)
Mr. Vadher Manubhai (BRS-Agriculture)
Mr. Sodha Karshanji (Para Worker-PARAB)
Mr. Siju Ravji (Para Worker-PARAB)

ACKNOLEDGEMENT

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ACT is very grateful to all team members of Ambuja Cement Foundation (ACF) Kodinar, Agakhan Rural Support Programme India (AKRSP-I) and Shri Vivekanand Research and Training Institute, (VRTI) Bhavnagar for their support during field visits.

ACT also gratefully acknowledges its board members and all the team members who have regularly help and supported this study whenever the need arise.

At last but not least ACT highly appreciates all villagers of study villages who have provided support by facilitating in data collection and sharing of information those have increased a confidence in team and make this study possible. At last ACT would like to say thanks to all who have provided any kind of support during this study.

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ARID COMMUNITIES AND TECHNOLOGIES

Bhuj

CONTENT

L I S T OF T A B L E S

(Continue on Next Page)

(Continue on Next Page)

LIST OF FIGURES

(Continue on Next Page)

(Continue on Next Page)

L I S T OF P L A T E S

1. INTRODUCTION

1.1 BACKGROUND

Coastal Salinity Prevention Cell, (CSPC) – An Ahmadabad based organization working on mitigating salinity issues in coastal areas of Gujarat State in collaboration with her partner/member organizations located in various part of the coastal region. With the partnership with Water and Sanitation Management Organization (WASMO), CSPC is coordinating Coastal Area Development Program (CADP) especially to increase drinking water securities in coastal areas. The main aim of this program is to cover about 1,00,000 households with drinking water facilities and 15,000 households with sanitation facilities in about 300 villages of nine coastal districts of Gujarat.

Arid Communities and Technologies (ACT) a Bhuj Based organization and technical resource partner of CSPC, has given the task to assess the impact of water management activities on strengthening local water resources under the CADP.

1.2 AIM AND OBJECTIVES

The main aim of the study is to assess impact of WRM activities carried out under Coastal Area Development Program. Therefore the main aim of the study is main objective of CADP to establish community manages system to secure access to safe drinking water and sanitation facilities in salinity affected coastal villages of Gujarat. However the task for this study is restricted up to technical impact assessment around WRM structures in identified villages located in various zone of coastal areas. The specific objectives for impact assessment have set as below.

- Technical assessment of WRM activities to understand the impact of the intervention
- To assess changes in the groundwater scenario, aquifer systems due to WRM interventions
- To establish monitoring system to technical Analysis of all the WRM interventions
- To build capacity of partner organizations on undertaking impact assessment exercise.

1.3 APPROACH AND METHODOLOGY

The whole assessment has carried out in about 10 villages located in different coastal parts. The villages have selected based on project areas of implementing partners of CSPC such as (01) Ambuja Cement Foundation, Kodinar (ACF); (02) Agakhan Rural Support Programme India (AKRSP-I) and (03) Shri Vivekanand Research and Training Institute, (VRTI) Bhavnagar. As far as data collection and monitoring is concerned, partners have involved in five villages whereas in remaining five villages ACT has directly carried out monitoring. All data analysis has been held by ACT team members. One of the important aspects of this assessment is to build capacity of partner organizations how to collect data and monitor for such project and therefore, training on various aspects of data collection and various tools like well inventory, monitoring methods etc. have given to technical person and village volunteer of each organizations by ACT.

The data base were analyzed and monitoring network in one km radius around WRM structure has established, that monitored for three seasons viz., pre and post monsoon seasons of year 2012 and pre monsoon season of year 2013. About 192 wells were monitored for three seasons

Water levels and concentrations of total dissolved solid in groundwater were observed during monitoring and for all seasons Iso - RWL (Reduced Water levels) and Iso - TDS maps were prepared to understand seasonal changes after implementation.

In addition to hydro-geological surveys consultations with stakeholders and village wise sample surveys were held to understand previous scenario of landuse and changes in cropping pattern in villages. About 30 households were surveyed to understand impact of WRM structure at micro level. Table 1.1 quantifies village wise primary surveys held during study.

Table 1.1 Village Wise Survey Detaials

District	Block	Village	Well Inventory No	HH surveys No
Junagadh	Una	Khajudra	35	4
		Khatrivada	28	4
		Dandi	06	3
		Bhebha	10	2
	Maliya	Khera	25	4
	Mangrol	Kalej	27	3
Amreli	Jafrabad	Pinchadi	11	3
		Fachariya	08	2
	Rajula	Ganjavadar	21	----
		Untiya	21	3
Total			**192**	**29**

1.4 THE STUDY AREA

Total ten villages were selected for impact assessment studies distributed among three implementing partner's project area i.e. Aga Khan Rural Support Program (AKRSP-I); Abuja Cement Foundation (ACF) and Shri Vivekanand Research and Training Institute (VRTI). Table 1.1 shows district and block wise distribution of study villages.

Table 1.2 Selected Villages and Organizations for CADP Impact Assessment

District	Block	Village	Organization
Junagadh	Una	Dandi	ACF, Kodinar
		Bhebha	
Amreli	Jafrabad	Pinchadi	VRTI, Bhavnagar
		Fachariya	
Junagadh	Maliya	Khera	AKRSP(I),
	Mangrol	Kalej	ACT, Bhuj
	Una	Khajudra	
		Khatrivada	
Amreli	Rajula	Ganjavadar	
		Untiya	

2. VILLAGE WISE IMPACT ASSESSMENTS

2.1 AMBUJA CEMENT FOUNDATION PROJECT VILLAGES

Four villages viz., (01) Kajudra; (02) Khatrivada; (03) Bhebha and (04) Dandi were identified for impact assessment where Ambuja Cement Foundation has implemented various activities of CADP. Table 2.1 shows village wise salient features of different structure constructed by ACF. Constructors of all structures has completed in the year 2011. ACF has constructed two waste weirs in existing water body in village Kajudra and Dandi, one C Wall in village Bhebha in the road Nalla Bridge (to harvest out flowing water through it) and a check dam in village Khatrivada.

Table 2.1 Village Wise Structure Wise Salient Features

Village	Khajudra	Khatrivada	Bhebha	Dandi
Type Of Structure	West weir	Check dam	C Wall	West weir
Height Of Structure (M)	0.87	0.8	1.4	0.84
Length of Structure (M)	32	32	29.2	32
Storage Capacity (MCM)	0.8	0.19	0.28	1.26
HFL (M)	100.5	99.85	99.5	100
Catchment area (Ha)	600	400	500	1000
Design Discharge (cusec)	3214	2211	2612	5151
Objective	GW Recharge	GW Recharge	GW Recharge	GW Recharge
Starting year	2011	2011	2011	2011
Completion year	2011	2011	2011	2011
Cost (Rs.)	542242	741600	243270	514750

Following are description of village wise impact assessment carried out under present study.

2.1.1 KAJUDRA WASTE WEIR

General Information: Village Kajudra (Fig 2.1) of Una Taluka spreaded over about 668.9 Ha areas and has total population of about 2329 persons. Agriculture is dominant land use of the village and covers about 52 % of the total land of the area followed by non cultivated areas. Table 2.2 shows general demographic and land use pattern of village Khajudra.

A waste weir has been constructed in this village to existing pond located in nearly

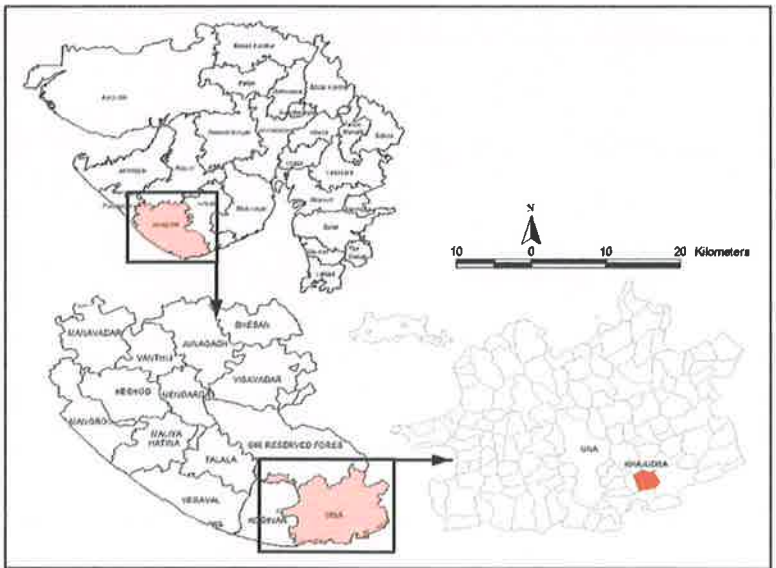
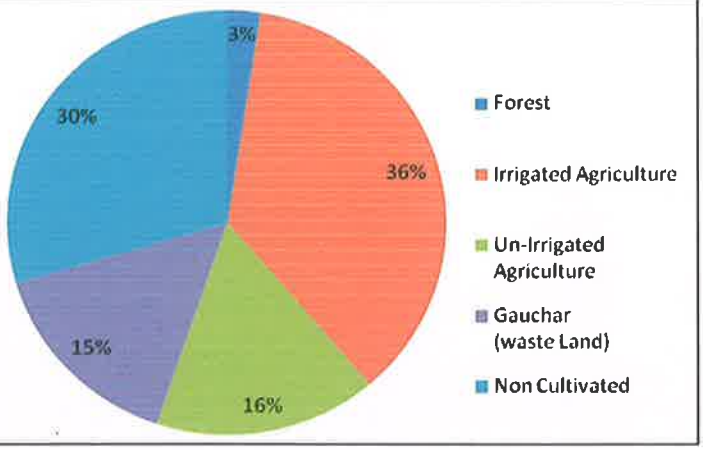


Fig. 2.1 Location Map of Khajudra Village

undulating alluvium plains, surrounded by agriculture land of the village. (Fig. 2.2 and Plate 2.1)

Table 2.2 Demographic and Land use Pattern of Kajudra, Tal. Una, Dist. Junagarh

Population	Male	1198
	Female	1131
	Total	**2329**
Land Use (Ha)	Forest	16.8
	Irrigated Agriculture	249
	Un-Irrigated	112.6
	Waste Lands	104.6
	Non Cultivation	202.7
	Total	**668.9**



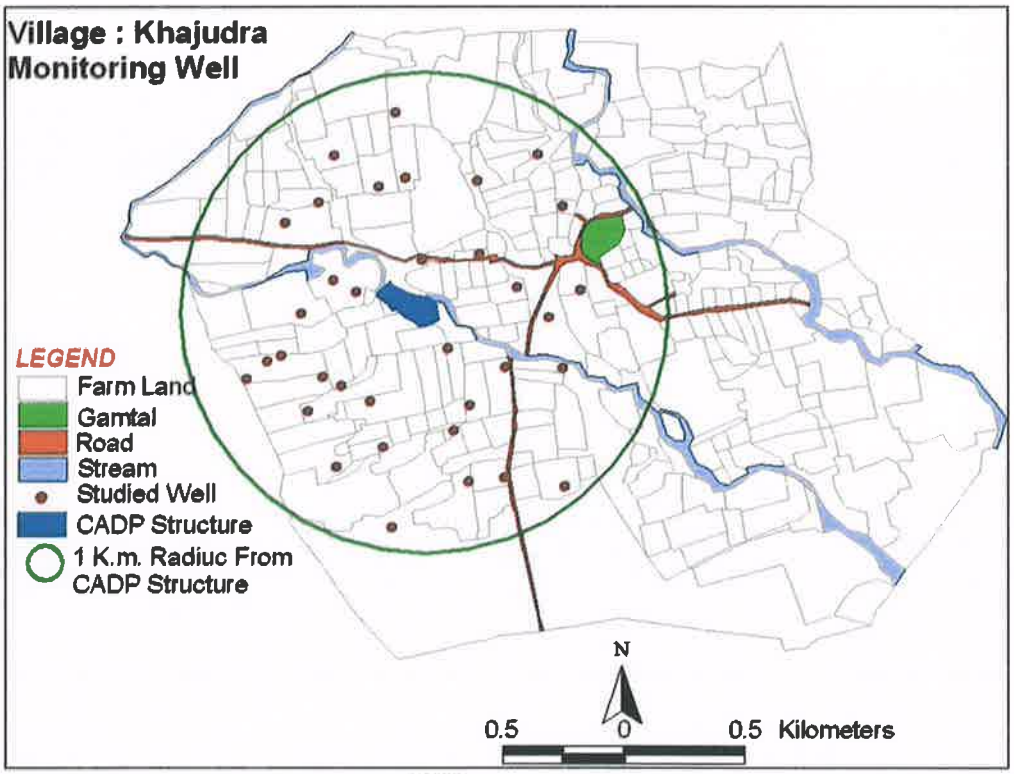


Fig. 2.2 Map Showing Location of WRM structure, Land Use and Monitoring Wells Vill. Khajudra

Pre Monsoon

Post Monsoon

Plate 2.1 Waste Weir Construction in Existing Pond, Village Khajundra

Geology and Hydro-Geology: Geologically the area shows intercalated strata of lime stone and clay of Gaj formation of Tertiary age. Well inventory data of the area shows thickness of about 3 to 5 of loose alluvium overlies 5 to 6 m thick layers of clay that rests over 6 to 18 m thick limestone layers. Again yellow clay of Gaj formation occurs in area at the depth below 30 m. To characterize the area hydro-geologically, total 35 wells were studied in detail with respect to its physical parameters, use, geology, water levels, aquifer etc. Table 2.3 shows summarized account of wells whereas Table 2.4 shows the well wise details of use, lifting device type and capacity. The maximum depth of the well is about 24 m whereas minimum depth is about 5.2 m. water levels in all well ranges from 3.1 m to 8.1 m.

Table 2.3: Summary of Well Data, Village Khajudra

Total Nos of Well		**35**
Use	Only Irrigation	28
	Only Drinking	00
	Drinking& Irrigation	01
	Non Use	06
Pumping Device	Diesel Engine (No)	10
	Electric Motor	19
Total depth of well (m)	Max	24
	Min	5.2
Water Level (m)	Max	8.1
	Min	3.1
Monitoring Well		**35**

Table 2.4 Use Wise Details of Studied Wells in Village Khajudra

Well Code	Owner name	Use	Irri (Ha)	Total depth (m)	WL (M)	Dia (M)	Lifting Device	
							Type	hp
UKJ1	Naran Abha Rathod	Irrigation	0.8	16	5.5	4.9	Diesel	5
UKJ2	Udar Bholabhai	Unused		11.3	5.2	3.5		
UKJ3	Rambhai Khimabhai	Irrigation		9.20	5.50	2.5	Diesel	5
UKJ4	Rambhai Ala	rrgation	1.2	9.2	5.6	3	Diesel	5
UKJ5	Bijal Varjang	Irrigation	1.2	7.2	5	3	Diesel	5
UKJ6	Hamirbhai Laxmanbhai Rathod	Irrigation	1.0	9.7	5	3	El.mot.	5
UKJ7	Uka Vira	Irrigation	1.2	5.2	3.1	2.5	Diesel	5
UKJ8	Meghbhai Deshbhai	Irrigation	2.0	9	5	3	Diesel	5
UKJ9		Irrigation		13.1	7.3	3.5	El.mot.	5
UKJ10	Jodha Masari	Irrigation		12.8	8.1	4	El.mot.	5
UKJ11	Laxaman Vishram	Irrigation		11.5	7.4	3.5	El.mot.	5
UKJ12		Irrigation		14.3	6.5	2		

Table 2.4 Use Wise Details of Studied Wells in Village Khajudra (Contd...)

Well Code	Owner name	Use	Irri (Ha)	Total depth (m)	WL (M)	Dia (M)	Lifting Device	
							Type	hp
UKJ13	Govindbhai Pithabhai	Irrigation	1.8	15.2	6.6	3.5	El.mot.	5
UKJ14		Irri & Dr.w		13.1	7.3	3	Diesel	8
UKJ15		Irrigation	2	15.8	7.7	4	El.mot.	5
UKJ16		Irrigation		13	7.7	6	El.mot.	5
UKJ17	Babu Pithabhai	Unused		24	6.3	5		
UKJ18	Ranabhai Devanandbhai	Irrigation	0.5	15.4	4.3	3	El.mot.	5
UKJ19	Shambhugar Shivar	Irrigation	2.1	18.6	6.2	2.5	El.mot.	5
UKJ20	Nanaji Manga	Irrigation	2	12.4	7.8	5	Diesel	8
UKJ21	Kanabhai M. Makvana	Unused		12.5	5.6	3.5		
UKJ22	Kanabhai M. Makvana	Irrigation	0.5	14.1	5.5	3	Disel	8
UKJ23		Irrigation		13.9	5.2	3	El.mot.	5
UKJ24		Irrigation		18.3	6.5	3.5	El.mot.	5
UKJ25	Ranbhai Rathod	Unused		7	5.8	6		
UKJ26		Irrigation		14.5	5.8	3	El.mot.	5
UKJ27		Irrigation		14.2	6.2	4.5	El.mot.	5
UKJ28	Laxmanbhai Rambhai	Irrigation	3.0	14	5.9	2	El.mot.	5
UKJ29	Samatbhai Kababhhai	Irrigation	0.8	17.8	4.7	4	El.mot.	3
UKJ30	Lakha Bhikha	Irrigation	2.0	14.9	4.5	2.5	Sub.M.	5
UKJ31	Gram Panchayat	Unused		11	4	6		
UKJ32	Karshan Ranshi	Irrigation	2.0	16.3	4.8	2.5	El.mot.	5
UKJ33	Bachubhai Rambhai	Irrigation	1.1	11.7	4.1	3	Diesel	5
UKJ34	Uka Raja	Unused		10	5.5	4		
UKJ35	Lakhaman visharam	Irrigation		17	6.8	4.4	El.mot.	5

Well litholog observations clearly show presence of two aquifers in the area around structure upper aquifer is alluvium has thickness about 3-7 m whereas limestone occurs at lower position at various depth and thickness as shown in Table 2.5 i.e. first layer 7 to 17 m, second layer 1 to 16 m, third layer average thickness 12.8 m and lower and fourth has 5.6 to 8 m. Table 2.6 shows well wise aquifer type, occurrence at depth and respective thickness.

Table 2.5: Details of Aquifers, Village Khajudra

Aquifer	Position Wise Thickness (M)				Discharge LPM
	1st	2nd	3rd	4th	
Alluvium (Sandy Clay)	3.00 - 7.00	--	--	--	--
Limestone	7.20 - 17.0	1.00 - 16.0	12.8	5.60- 8.00	103-510

Impact on Groundwater: To understand groundwater status of the area and probable changes due to WRM structure all well were monitored for three season I.e. pre and post monsoon season of year 2012 and pre monsoon season of year 2013. It is important to clarify that the structure has constructed during pre monsoon season of year 2011 but due to heavy siltation the pond has not received any significant water during monsoon season of the year 2011. Successively during year 2012 de-silting activities were carried out in pond under MNREGS that helped lot to increase storage capacity of the pond. Therefore pre monsoon season of year 2012 can considered as pre structure season. During monitoring water levels and TDS concentrations (Table 2.7) were measured than

hydrograph as well as various thematic maps were prepared such as Iso-RWL (Fig. 2.5) and Iso-TDS (Fig. 2.7). In addition, groundwater flow directions (Fig. 2.6) were also studied seasonally with the help of reduced water level maps to understand change due to structure.

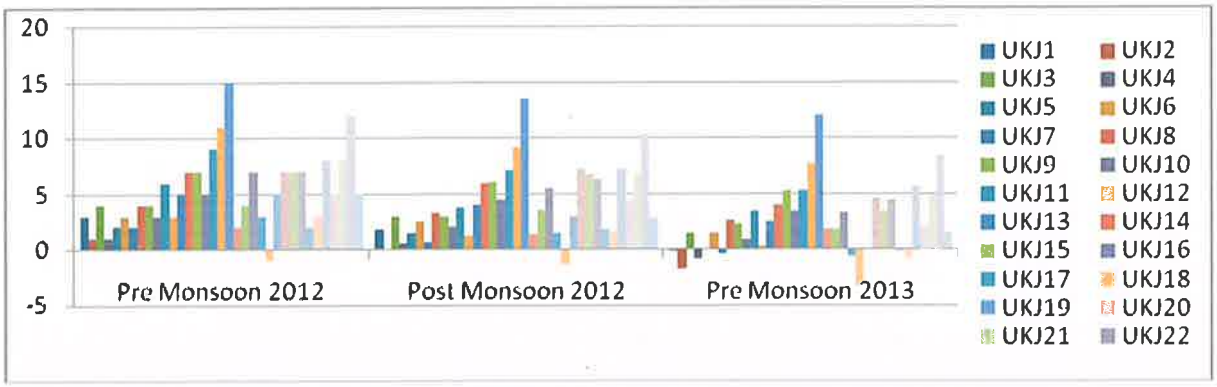


Fig. 2.3 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Khajudra Year 2012, 2013

Analysis of hydrograph and iso-RWL map shows following changes in village Khajudra around the structure

- Water levels in observation wells have gradually depleted from pre monsoon season of year 2012 to pre monsoon season of year 2013. The same observation can be judged through decreasing area of 10-15 WL zone in Iso- RWL map (Fig. 2.4) and in hydro graph where reduced water levels in some of the observation wells have lowered down below AMSL. (Fig. 2.3)
- As far as water quality is concern there is no any significant changes in TDS concentrations have observed during these three seasons. (Fig. 2.6)
- It is important to mentioned, that the structure has not filled with its full capacity due to low rainfall during year 2012.
- Another important justification is the two years monitoring for impact assessment is too early to draw robust conclusions about impact.

Table 2.6 Well Litholog of Khajudra Village

Well Code	Aquifer		Aquifer Position	Thickness of Different Aquifers at Various Position (M)									Discharge		Recharge	
	Type	Th.		Total	1st	Th	2nd	Th.	3rd	Th	4th	Th	Hr.	LPM	Hr.	LPM
UKJ1	L. St.	10	Lower	2	Soil	4.9	L. St.	9.9								
UKJ2	L. St.	9	Lower	2	Soil	2.2	L. St.	9.3								
UKJ3	L. St.	9	Upper	1	L. St.	9.2										
UKJ4	L. St.	9.2	Upper	1	L. St.	9.2										
UKJ5	L. St.	7	Upper	1	L. St.	7.2							8	103	1	824
UKJ6	L. St.	9.7	Upper	1	L. St.	9.7							5	228	2	571
UKJ7	L. St.	4	Lower	2	Soil	1	L. St.	4.2								
UKJ8	L. St.	9	Upper	1	L. St.	9										
UKJ9	L. St.	13.1	Upper	1	L. St.	13.1										
UKJ10	L. St.	13	Upper	1	L. St.	12.9										
UKJ11	L. St.	11.5	Upper	1	L. St.	11.5										
UKJ12	L. St.	12.8	Lower	2	Soil	1.7	L. St.	1.7	L. St.	12.8						
UKJ13	L. St.	13.5	Lower	2	Soil	1.7	L. St.	13.5					5	433	2	1082
UKJ14	L. St.	12	Lower	2	Soil	1	L. St.	12.3								
UKJ15	L. St.	14	Lower	2	Soil	1.6	L. St.	14.2								
UKJ16	L. St.	10.3	Lower	2	Soil	2.7	L. St.	10.3								
UKJ17	L. St.	10	Middle	3	Soil	2	L. St.	10	Clay	12						
UKJ18	L. St.	8	Second & Lower	4	Soil	2	L. St.	1	Clay	2	L. St.	8	5	188	3	314
UKJ19	L. St.	15	Second & Lower	4	Soil	1	L. St.	9	Cay	3	L. St.	5.6	6	204	2	613
UKJ20	L. St.	9	Lower	2	Soil	3.4	L. St.	9.1					2	1472	8	368
UKJ21	L. St.	9	Lower	2	Soil	3.8	L. St.	8.7								
UKJ22	L. St.	13	Lower	2	Soil	1	L. St.	13.4					3	510	0.5	3062
UKJ23	L. St.	11	Lower	2	Soil	2	L. St.	11.9								
UKJ24	L. St.	16	Lower	2	Soil	2	L. St.	16								
UKJ25	Sandy Clay	7	Upper	1	All	7										
UKJ26	Sandy Clay	11	Lower	2	Soil	3	All	11.5								
UKJ27	L. St.	8	Second & Lower	4	Soil	1	L. St.	1.5	All.	4.5	L. St.	7.2				
UKJ28	L. St.	11	Lower	2	Soil	3	L. St.	11					5	115	1	576
UKJ29	L. St.	13	Lower	2	Soil	4.7	L. St.	13.1								
UKJ30	L. St.	10	Lower	2	Soil	5	L. St.	9.9								
UKJ31	Cavern L. St.	11	Upper	1	L. St.	11										
UKJ32	L. St.	12	Upper	2	Soil	4	L. St.	12.3					5	196	2	491
UKJ33	L. St.	10	Upper	2	Soil	2.3	L. St.	9.4								
UKJ34	L. St.	4.5	Lower	2	Soil	5.5	L. St.	4.5								
UKJ35	L. St.	17	Lower	1	L. St.	17										

Table 2.7 Changes in Reduced Water Levels and TDS in Observation Wells, Khajudra

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Year 2012		2013	Year 2012		2013
	Pre Monsoon	Post Monsoon	Pre Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon
UKJ1	3	1.8	-0.1	3900	6800	5000
UKJ2	1	0.0	-1.8	>2000	6200	5000
UKJ3	4	2.9	1.4	>2000	9000	6500
UKJ4	1	0.5	-0.9	>2000	2300	5200
UKJ5	2	1.4	0.0	>2000	6000	4300
UKJ6	3	2.5	1.4	>2000	5200	4600
UKJ7	2	0.6	-0.4	>2000	4700	3900
UKJ8	4	3.3	2.6	>2000	6800	6000
UKJ9	4	3.0	2.3	>2000	7800	6000
UKJ10	3	2.0	0.9	>2000	4700	4400
UKJ11	6	3.8	3.4	>2000	5700	5000
UKJ12	3	1.2	0.3	>2000	6600	5600
UKJ13	5	4.0	2.5	>2000	5700	5200
UKJ14	7	6.0	4.0	960	1800	1900
UKJ15	7	6.1	5.3	>2000	3700	3300
UKJ16	5	4.5	3.4	>2000	6000	4700
UKJ17	9	7.1	5.3	>2000	9000	6800
UKJ18	11	9.2	7.7	>2000	6500	5700
UKJ19	15	13.6	12.1	>2000	6600	5800
UKJ20	2	1.3	1.8	>2000	5500	5300
UKJ21	4	3.5	1.8	>2000	1030	2700
UKJ22	7	5.5	3.3	>2000	7400	5700
UKJ23	3	1.4	-0.6	>2000	6800	5500
UKJ24	-1	-1.3	-3.3	>2000	5500	4500
UKJ25	5	3.0	Nill	>2000	4200	Nill
UKJ26	7	7.2	4.6	>2000	3900	2900
UKJ27	7	6.8	3.4	>2000	5700	3700
UKJ28	7	6.3	4.5	>2000	5700	4400
UKJ29	2	1.8	-0.1	>2000	8000	6100
UKJ30	3	1.6	-0.9	>2000	6700	5100
UKJ31	8	7.2	5.6	>2000	6600	5500
UKJ32	5	4.3	2.2	>2000	6700	5600
UKJ33	8	6.9	4.9	>2000	7400	5800
UKJ34	12	10.3	8.4	>2000	6400	5100
UKJ35	5	2.8	1.4	>2000	5800	5600

to add the data

* possibilities of 2010 & 2011 for comparision & change pattern
* can be add Rainfall data on that above table
* other WQ measure like PH, Chloride, Fluoride ?
* WRM Location of different water source near structure on GIS platform Longitude Latitude ?

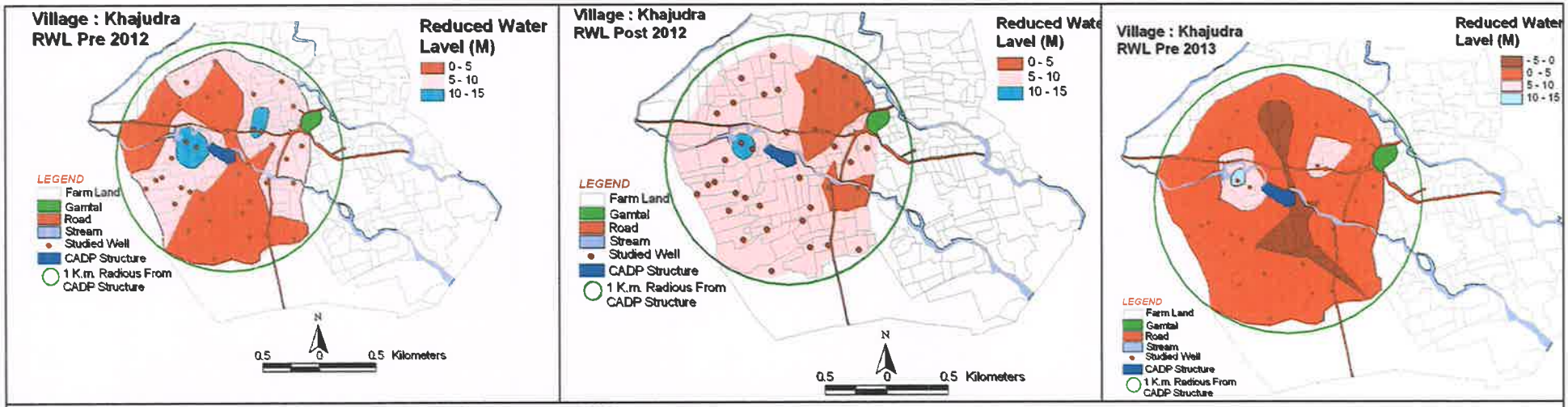


Fig. 2.4 Pre and Post Monsoon Iso RWL Maps of Village Khajudra, Year 2012, 2013

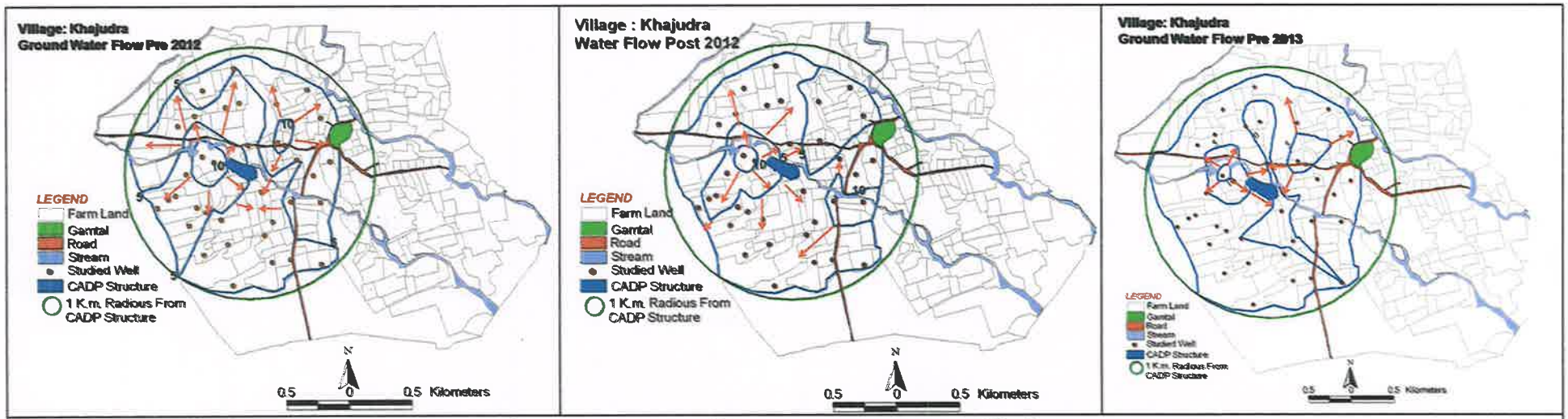


Fig. 2.5 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Khajudra, (Year 2012, 2013)

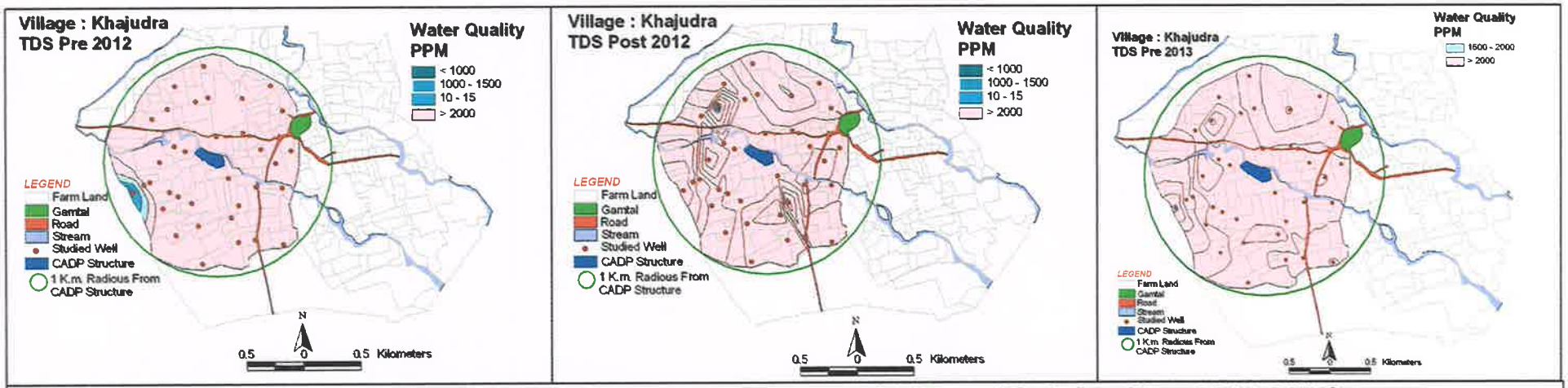


Fig. 2.6 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Khajudra, (Year 2012, 2013)

Socio Economic Impact: As discussed in previous section there is no significant impact on water levels and water quality even after renovation of village pond the attempt have made to understand weather any changes took place from socio-economic point of view especially changes in crop pattern, changes in assets, increased availability of drinking and irrigation water or any changes in lifting devices, improvement in health quality etc. Group discussions and case studies of farmers located in study area were held. Table 2.8 shows changes in amenities and assets during before and after construction of structure.

Table 2.8 Before and and After Status of Drinking Water and Asset in Khajudra

Drinking Water Availability	Details	Before Structure	After Structure
	Problem of Drinking Water	Shortage in summer	Shortage in summer
	Source of Drinking Water	Open well and Tube well	Open well and Tube well
	Quantity of Drinking Water	Sufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Fluoride problem, brackish in summer	Fluoride problem
	Availability for Livestock	yes	yes
Assets (No.)	Type	Before Structure	After Structure
	Four Wheeler	4	4
	Cattle Shed	350	350
	Tractor	30	30
	Two Wheeler	125	125
	Diesel Engine	15	15
	Electric Pump	15	15
	Other	30	30

To understand changes in cropping pattern two methods were adopted i.e. group discussions with the farmers of surrounding area as well as case studies of four farmers of the village. Group discussion reveals that there is only change observed in cotton i.e. increase in production from 800 Kg/ha (before) to 1200 Kg/ha (after). Table 2.9 shows the details of before and after agriculture status in surrounding areas of structure. There were four farmers were consulted to understand any changes taken place in their lifestyle as well as in their agriculture practices. (Table 2.10)

Table 2.9 Before and After Changes in Cropping Area and Production in Khajudra

Season	Before Structure			After Structure			Change	
	Crop	Area Ha	Prod. kg/Ha	Crop	Area Ha	Prod. kg/Ha	Area Ha	Prod. kg/Ha
Kharif	Cotton	100	800	Cotton	100	1200	0	400
	Pearl Millet	10	2500	Pearl Millet	10	2500	0	0
Rabi	Wheat	140	3000	Wheat	140	3000	0	0

The cumulative impact of WRM structure has also been supported with the help of four case studies of farmers located in study area. All four case studies very reflects no significant impact on agriculture has observed except following changes such as (01) increase in cotton cotton production about 300 kg/ha in case of Jivabhai Vabhai Baraiya's farm and (02) Jodhabhai Mashribhai Koli has started wheat sawing in winter due to availability of electric connection and motor facility.

Table 2.10 Case Studies on Before and After Changes at House Hold Level Khajudra

Name of the Farmer				Jivabhai Vabhai Baraiya		Jodhabhai Mashri Bhai Koli	
Caste				Koli		Koli	
Total Family Members (No)				7		6	
Land holding	Type			Area Ha			
	Irrigated			0.6		2	
	Non Irrigated			3.6		0	
	Waste land			0.4		0	
	Total			4.6		2	
Change in Crop	Season	Crop	Period	Area Ha	production KG/ha	Area Ha	production KG/ha
	Kharif	Bajra	Before	1.4	1200	0.6	2000
			After	1.4	1200	0.6	2000
			Change	0	0	0	0
		Cotton	Before	1.2	1200	1.4	1000
			After	1.2	1500	1.4	1000
			Change	0	300	0	0
	Rabi	Wheat	Before	0	0	0.6	3000
			After	0	0	0.6	3000
			Change	0	0	0	0
Livestock		Type		No.		No.	
		Cow		2		1	
		Buffalo		7		1	
		Bullock		2		2	
Change in Source of Irrigation		Type	Before	Open Well		Open Well	
			After	Open Well		Open Well	
		Change in supply	Before	Available for Kharif only		Available for Kharif and Rabi	
			After	---		Available for Kharif and Rabi	
		Irrigation Techniques	Before	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			Before	60000		50000	
			After	70000		50000	
Changes in Asset	House		Before	Pakka House 2 No.		Pakka House 2 No.	
			After	Pakka House 2 No.		Pakka House 2 No.	
	Vehicle		Before	Two wheeler 1 No		Two wheeler 1 No	
			After	Two wheeler 1 No		Two wheeler 1 No	
	Plaughing equipment		Before	Bullock Plough		Bullock	
			After	Bullock Plough		Bullock	
	Lifting Device		Before	Diesle Engin 5 H P		Diesel Engine 5 HP	
			After	---		Ele. Motor 5 HP	

Table 2.10 Case Studies on Before and After Changes at House Hold Level Khajudra (Contd...)

Name of the Farmer				**Samatbhai Ramshibhai Koli**		**Bamniya Kalubhai Ranabhai**	
Caste				Koli		Koli	
Total Family Members (No)				5		6	
Land holding	**Type**			**Area Ha**			
	Irrigated			0		0.5	
	Non Irrigated			0.8		1.9	
	Waste land			0		0	
	Total			0.8		2.4	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**			1.9	2000
			After			1.9	2000
			Change	0	0	0	0
		Cotton	**Before**	0.8	1000	0.5	2000
			After	0.8	1000	0.5	2000
			Change	0	0	0	0
	Rabi	Wheat	**Before**	0	0	0	0
			After	0	0	0	0
			Change	0	0	0	0
Livestock		**Type**		**No.**		**No.**	
		Cow		1		1	
		Buffalo		0		0	
		Bullock		2		2	
Change in Source of Irrigation		**Type**	**Before**	---			
			After	---		Open Well	
		Change in supply	**Before**	Available for Kharif only		Available for Kharif	
			After	Available for Kharif only		Available for Kharif	
		Irrigation Techniques	**Before**	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			**Before**	30000		15000	
			After	30000		30000	
Changes in Asset	**House**		**Before**	Pakka House 2 No.		Pakka House 2 No.	
			After	Pakka House 2 No.		Pakka House 2 No.	
	Vehicle		**Before**	----		Two wheeler 1 No	
			After	----		Two wheeler 1 No	
	Plaughing equipment		**Before**	----		---	
			After	----		---	
	Lifting Device		**Before**	----		---	
			After	----		Ele. Motor 3 HP	

2.1.2 KHATRIVADA CHECKDAM

General Information: Village Khatrivada of Una taluka (Fig. 2.7) covers an area of about 767.5 Ha and having total population of 2,421 persons. Out of total land, 68 % land is in use for agriculture where irrigated agriculture is about 25 % and un-irrigated agriculture is 43 % of total land. (Table 2.11) The village has no forest land. About 18 percentages of waste land is used as grazing land.

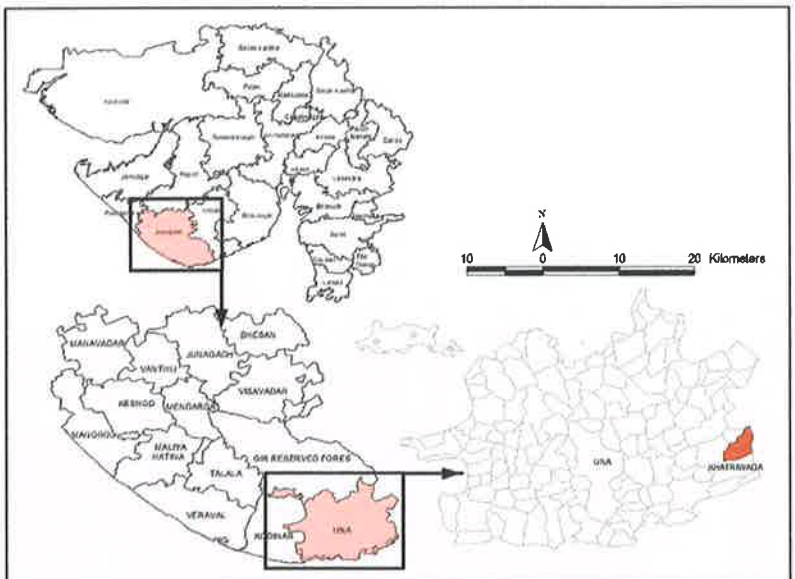
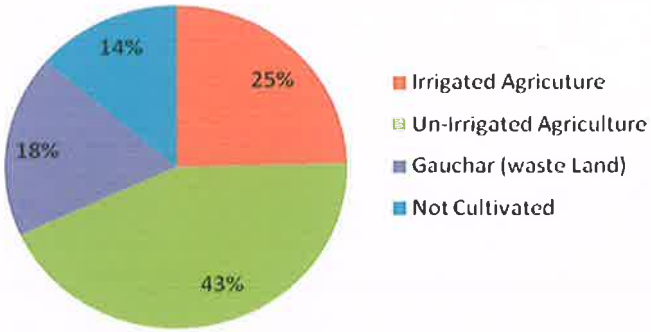


Fig. 2.7 Location Map of Khatrivada Village

Under the CADP program, a check dam has been constructed located in north of settlement. The surrounding land is in use for agriculture. (Fig. 2.8 & Plate 2.2)

Table 2.11 Demographic and Land use Pattern of Khatrivada, Tal. Una, Dist. Junagarh

Population	Male	1236
	Female	1185
	Total	**2421**
Land Use (Ha)	Forest	0.0
	Irrigated Agriculture	188.8
	Un Irrigated	334.1
	Waste Lands	140.0
	Non Cultivated	104.6
	Total	**767.5**



Check dam

Discussion with Villagers

Plate 2.2 Check Dam Construction in Khatrivada village

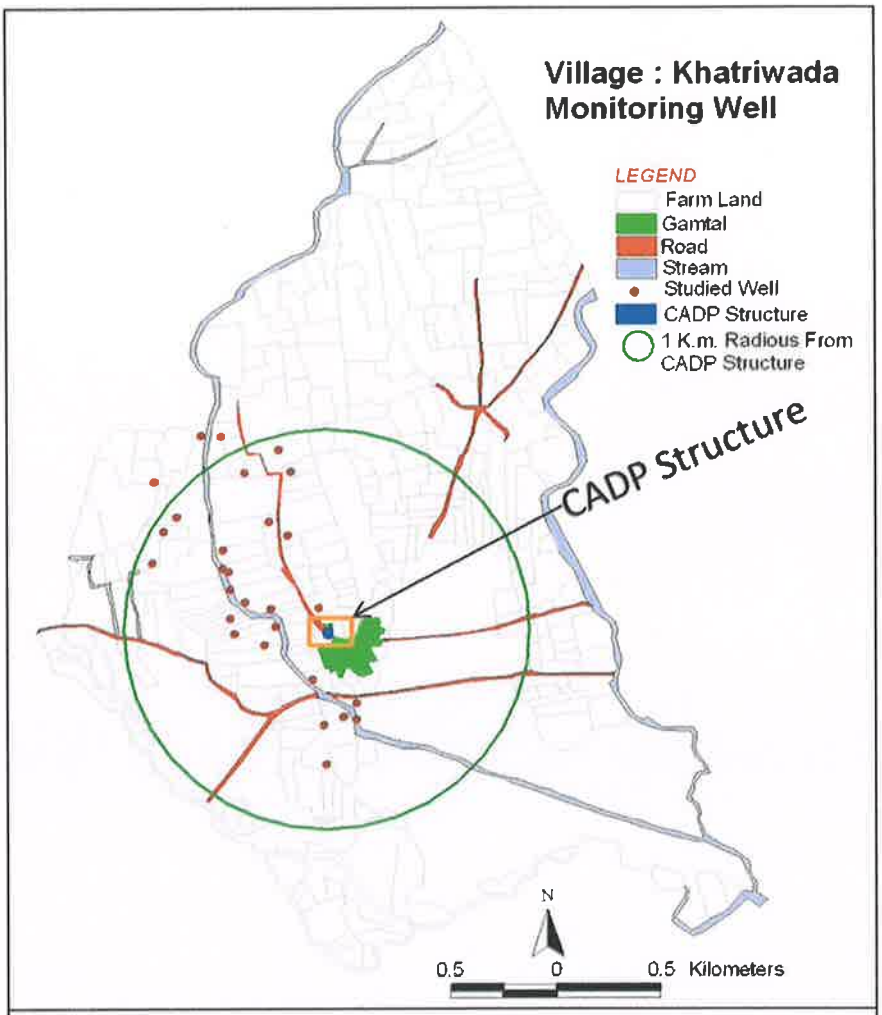


Fig. 2.8 Map Showing Location of WRM Srtucture, Land Use and Monitoring wells, Khatrivada Village

Geology and Hydro-Geology: Geologically the area shows sediments of quarternary and Tertiary age. Based on well inventory data, upper layer is of alluvium having thickness of about 2 to 5 m and it comprises of loose sand, pebbles and coarse grain sand. Below this layer, limestone occurs of about 6 to 7 m thickness which overlies yellow clay of Gaj formation of Tertiary age.

Table 2.12 Summary of Well Data, Village Khatrivada

Total No of Well		**28**
Use	Only Irrigation	23
	Only Drinking	00
	Drinking& Irrigation	03
	Non Use	02
Pumping Device	Diesel Engine (No)	25
	Electric Motor	01
Total Depth of Well (m)	Max	11.1
	Min	4.0
Water Level (m)	Max	6.6
	Min	1.0
Monitoring		**28**

To characterize the area hydro-geologically, total 28 wells were studied in detail with respect to its physical parameters, use, geology, water levels, aquifer etc. Table 2.12 shows summarized account of wells whereas Table 2.13 shows the well wise details of use, lifting device type and capacity.

The maximum depth of the well is about 11.1 m whereas minimum depth is about 5.2 m. water levels in all well ranges from 3 m to 6.6 m.

Table 2.13 Details of Studied Wells in Village Khatrivada

Well Code	Owner name	Use	Irr.igation (Bigha)	Total Depth of Well (m)	Water Level (M)	Dia-meter M	Lifting Device	
							Type	HP
UKT1	Babu Arjan Rathod	Irrigation	10	8.5	5.5	2.7	Diesel	5
UKT2	Bhagvan Pancha Chad	Irrigation	10	10.6	5.6	4	Diesel	5
UKT3	Bhikha Nan	Irrigation		9.2	6	4.5	Diesel	5
UKT4	Ruda Kala	Irrigation		10.8	3.8	3.2	Diesel	5
UKT5	Bachubhai Bhagvanbhai	Irrigation		8.6	5.5	3	Diesel	5
UKT6	Bhaga Ranshi	Not Ues		10.6	5.2	3	Diesel	
UKT7	Bhanabhai Bijalbhai	Irrigation	12	10.9	5.7	3.5	Diesel	5
UKT8	Bhikha Kandha Shiyal	Irrigation	6	10.7	5.7	3.5	Diesel	6
UKT9	Bhima Varjang Shiyal	Irrigation	10	9	6.4	3.5	Diesel	5
UKT10	Bhagavan Bhura Rathod	Irrigation & Drinking	4	10.9	6.3	3.5	Diesel	6
UKT11	Jetha varjang	Irrigation	8	9.5	6.6	3.5	Diesel	5
UKT12	Kan Bhikha Pamak	Irrigation & Drinking	14	9.10	5.80	5.5	Diesel	5
UKT13	Rambhai Hajabhai	Irrigation & Drinking	7	11.1	5.4	4	Diesel	8
UKT14	Ram Bhana	Irrigation	8	10	5.3	4.4	Diesel	8
UKT15	Bijal Giga	Irrigation	4	9.9	4.3	4	Diesel	5
UKT16		Irrigation		9.9	5.7	4	Diesel	8
UKT17		Irrigation		9.6	5.5	3	Diesel	5
UKT18		Irrigation		9	4.7	2.5	Diesel	10
UKT19		Irrigation		6.5	4.6	3.5	Diesel	8
UKT20		Irrigation		5.5	4.5	3	Diesel	5
UKT21	LaxmanBhai	Irrigation		7.3	4.3	3.5	Diesel	8
UKT22		Irrigation		7	3	5.5	Diesel	10
UKT23	LonganBhai Ranabhai	Irrigation	8	4	3.6	2.5	Diesel	8
UKT24	Ram Dana	Not Ues		5.2	3.7		Diesel	5
UKT25	Noganbhai Rana	Irrigation	12	6.2	3.9	5	Diesel	8
UKT26		Irrigation		5.2	1	5.5	Diesel	8
UKT27	Punjsbhai	Irrigation		6.2	3.7	4	Diesel	8
UKT28	Bhagvan Pala Rathod	Irrigation	5	8.3	4.1	3.2	Diesel	5

Well litholog study discloses two types of aquifers in the study area. Uppermost aquifer is alluvium of 1 to 7 m thickness whereas limestone occurs at lower position at various depth and thickness as shown in Table 2.14 i.e. first layer of 0.9 to 10.2 m, second layer 2.1 to 7.9 m and third layer of average 4 m thickness. Table 2.15 shows well wise aquifer type, occurrence at depth and respective thickness.

Table 2.14 Details of Aquifers of Village Khatriwada

Aquifer	Position Wise Thickness (M)				Discharge
	1st	2nd	3rd	4th	
Alluvium (including sandy clay)	1.00 – 7.00				--
Limestone	--	0.9 - 10.2	2.1 – 7.9	4.00	99-327

Table 2.15 Well Litholog of Khatrivada Village

Well Code	Aquifer		Aquifer Position	Thickness of Different Aquifers at Various Position (M)									Discharge Time (Hr)		Recharge Time (Hr)	
	Type	Th.		Total	1st	Th.	2nd	Th.	3rd	Th.	4th	Th.	Hr.	LPM	Hr.	LPM
UKT1	Limestone	3	Middle	2	Soil	4.5	L. St.	3	Clay	1			1	286	5	57
UKT2	Limestone	4.6	Lower	2	Soil	6	L. St.	4.6								
UKT3	Limestone	2	Lower	2	Soil	7	Line Stone	2								
UKT4	Sandy Clay	8	Lower	2	Soil	2	Sandy Clay	8								
UKT5	Limestone	2	Middle & Lower	3	Soil	3.8	L. St.	2	Sandy Clay	2.8						
UKT6	Limestone	6.6	Lower	2	Soil	3	L. St.	6.6								
UKT7	Limestone	6.7	Lower	2	Soil	3.2	L. St.	6.7								
UKT8	Limestone	10.2	Lower	2	Soil	2.5	L. St.	10.2								
UKT9	Limestone	2.6	Middle &Lower	3	Soil	2.5	L. St.	2.6	Sandy Clay	4.4			1.5	278		
UKT10	Sandy Clay	7.9	Lower	3	Soil	2	Clay	1	Sandy Clay	7.9			4	317	2	633
UKT11	Limestone	3	Lower	3	Soil	2	Sandy Clay	4.6	L. St.	2.9						
UKT12	Limestone	2	Middle & Lower	3	Soil	2	L. St.	2	Sandy Clay	2.1			8	99	2	396
UKT13	Limestone	6.1	Middle & Lower	3	Soil	1	Sandy Clay	4.3	L. St.	6.1			8	160	1	1277
UKT14	Sandy Clay	4.5	Middle & Lower	3	Soil	1.2	L. St.	4.3	Sandy Clay	4.5			8	142	1	1140
UKT15	Limestone	3	Middle & Lower	3	Soil	1	L. St.	3	Sandy Clay	5.9						
UKT16	Sandy Clay	8	Lower	2	Soil	2	Sandy Clay	7.9								
UKT17	Sandy Clay	8.6	Lower	2	Soil	1	Sandy Clay	8.6								
UKT18	Limestone	4.3	Lower	2	Soil	4.7	L. St.	4.3								
UKT19	Limestone	2.6	Lower	2	Soil	3.9	L. St.	2.6								
UKT20	Limestone	1	Lower	2	Soil	4.4	L. St.	0.9								
UKT21	Limestone	3	Lower	2	Soil	4.3	L. St.	3								

Table 2.15 Well Litholog of Khatrivada Village (Contd..)

Well Code	Aquifer		Aquifer Position	Thickness of Different Aquifers at Various Position (M)								Discharge Time (Hr)		Recharge Time (Hr)	
	Type	Th.		Total	1st	Th.	2nd	Th.	3rd	Th.	4th	Th.	Hr.	LPM	Hr.	LPM
UKT22	Limestone	3	Lower	2	Soil	3	L. St.	3								
UKT23	Sandy Clay	4	Upper	1	Sandy Clay	4							1	327	12	27
UKT24	Sandy Clay	5.2	Upper	1	Sandy Clay	5.2										
UKT25	Sandy Clay	6	Upper	1	Sandy Clay	6										
UKT26	Sandy Clay	5	Upper	6	Sandy Clay	6										
UKT27	Sandy Clay	6.2	Upper	1	Sandy Clay	6.2										
UKT28	Limestone	6	Second & Lower	4	Soil	2.5	L. St.	3	Clay	1.2	L. St.	4	5	161	5	161

Impact on Groundwater: To understand groundwater scenario of the area and possible impact of WRM structure, all well were monitored in term of water table and TDS concentration. Monitoring has been done for three season I.e. pre and post monsoon season of year 2012 and pre monsoon season of year 2013. Based on the monitoring data (Table 2.16), hydrograph as well as various thematic maps were prepared such as well hydrograph (Fig 2.9), Iso-RWL (Fig. 2.10) and Iso-TDS (Fig. 2.12). In addition, groundwater flow directions (Fig. 2.11) were also studied seasonally with the help of reduced water level maps to understand change due to structure.

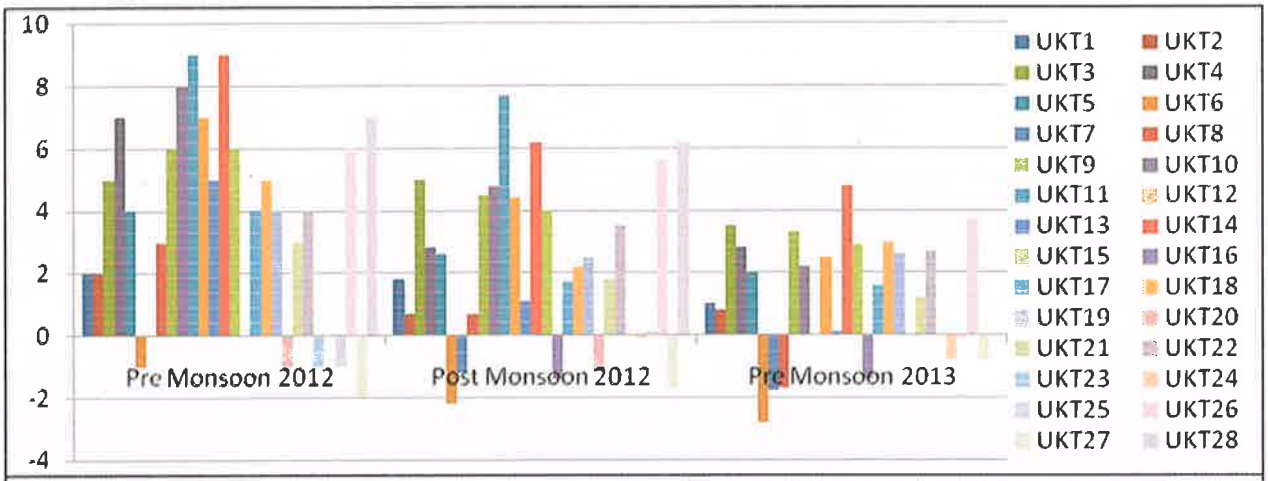


Fig. 2.9 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Khatrivada Year 2012, 2013

Analysis of hydrograph and iso-RWL map show following changes in area around the structure of Khatrivada village.

- Water levels in observation wells have gradually depleted from pre monsoon season of year 2012 to pre monsoon season of year 2013. This can observe by comparing RWL in table 2.16, well hydrograph (Fig. 2.9) and iso RWL maps (Fig. 2.10). It can say that groundwater level having 5 to 10 m height above MSL has been disappeared in year 2013.
- As far as water quality is concern there is degradation in water quality in term of TDS. Based on ISO TDS map (Fig. 2.12), it can clearly say that water quality zone (<2000 mg/l TDS) has disappear from pre monsoon 2012 to 2013.
- Therefore, water table and TDS based data analysis did not show any positive impact of the structure on groundwater regime of the study area.
- Another important justification is that, two years monitoring for impact assessment is too early to draw robust conclusions about impact.

Table 2.16 Changes in Reduced Water Levels and TDS in Observation Wells, Khatrivada, year 2012

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
UKT1	2	1.8	1.0	>2000	7100	7100
UKT2	2	0.7	0.8	1060	2800	4100
UKT3	5	5.0	3.5	1720	5300	5800
UKT4	7	2.8	2.8	1880	2900	2800
UKT5	4	2.6	2.0	>2000	7900	6500
UKT6	-1	-2.2	-2.8	>2000	8300	6700
UKT7	0	-1.2	-1.8	>2000	5400	5400
UKT8	3	0.7	-1.7	>2000	4600	3300
UKT9	6	4.5	3.3	1720	3500	3400
UKT10	8	4.8	2.2	1370	1800	2200
UKT11	9	7.7	Nill	1850	750	Nill
UKT12	7	4.4	2.5	1380	2000	2200
UKT13	5	1.1	0.1	1460	2400	3100
UKT14	9	6.2	4.8	>2000	5900	5200
UKT15	6	4.0	2.9	>2000	3300	2700
UKT16	0	-1.4	-1.4	>2000	4600	4800
UKT17	4	1.7	1.6	1800	4700	4500
UKT18	5	2.2	3.0	>2000	3500	4200
UKT19	4	2.5	2.6	>2000	6100	5400
UKT20	-1	-1.2	Nill	>2000	6500	Nill
UKT21	3	1.8	1.2	>2000	5100	5500
UKT22	4	3.5	2.7	>2000	5100	4800
UKT23	-1	Nill	Nill	>2000	Nill	Nill
UKT24	0	-0.1	-0.8	>2000	5000	5700
UKT25	-1	0.1	-0.1	>2000	4000	4400
UKT26	6	5.6	3.7	>2000	1500	2300
UKT27	-2	-1.7	-0.8	>2000	6000	5700
UKT28	7	6.2	Nill	5100	8400	6600

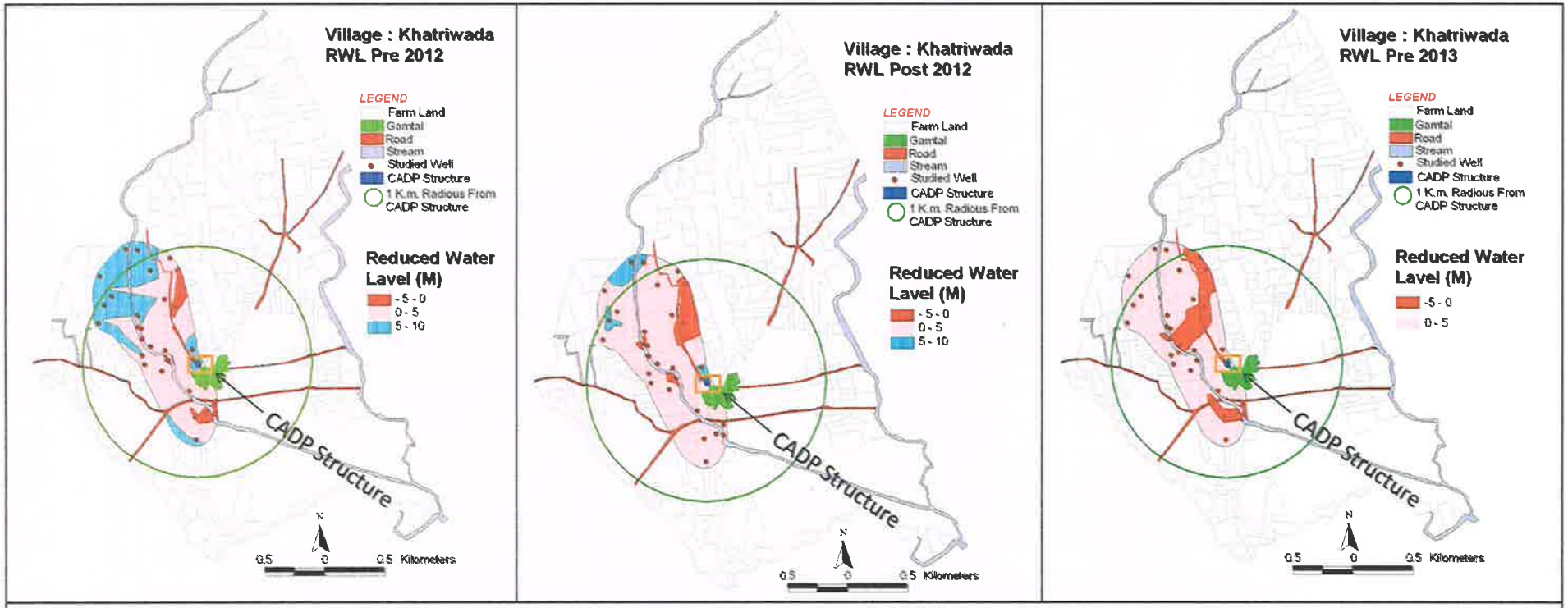


Fig. 2.10 Pre and Post Monsoon Iso RWL Maps of Village Khatrivada, Year 2012, 2013

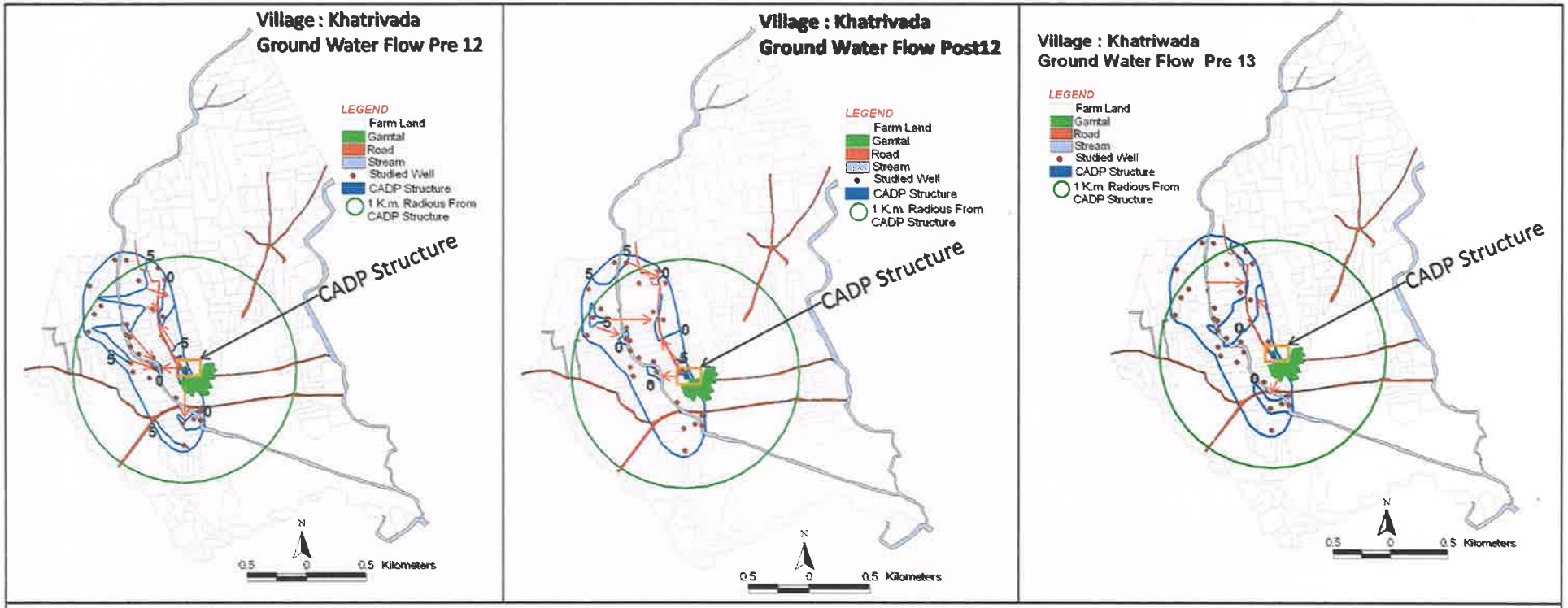


Fig. 2.11 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Khatrivada, (Year 2012, 2013)

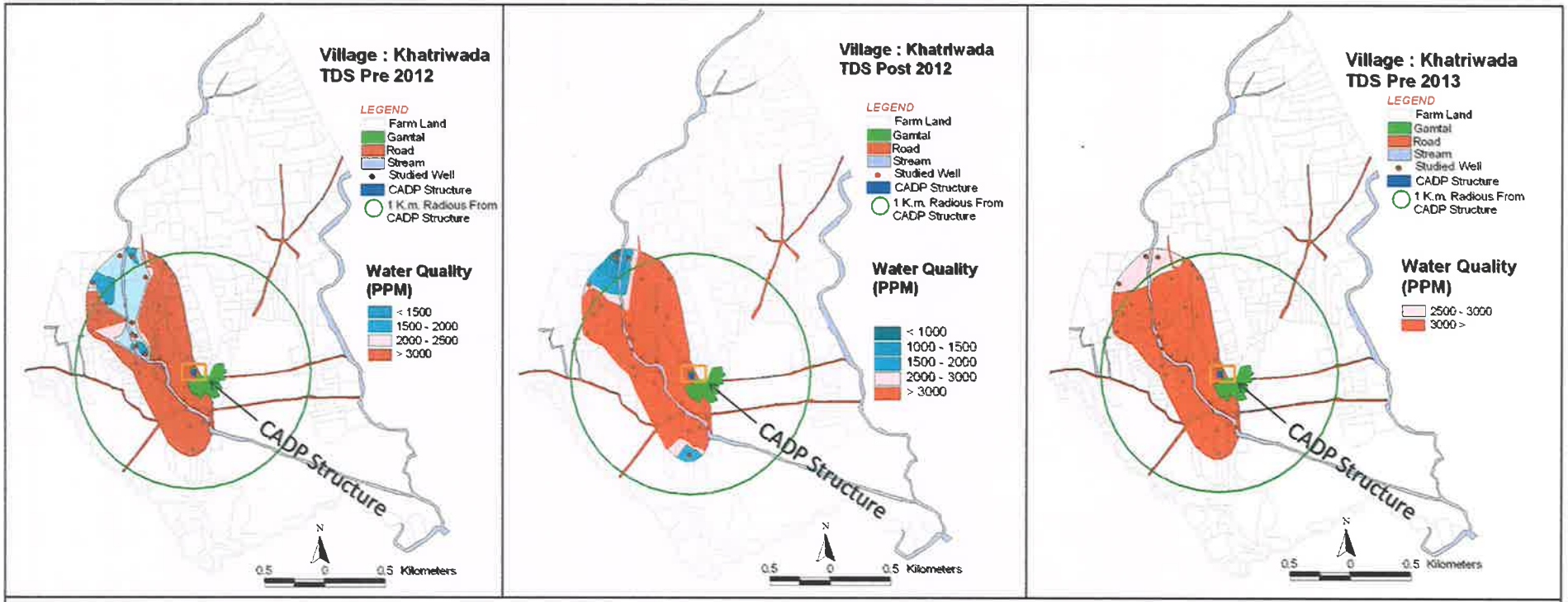


Fig. 2.12 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Khatrivada, (Year 2012, 2013)

Socio Economic Impact: As per discussions with village groups the groundwater in village has turned saline since last twenty years and hence people have adopted only rainfed farming in village. They do not prefers to use saline water for irrigation since it degrads soil quality. Another observation specific to structure, that no any storage took place in structure due to very low rainfall after its construction in last year (i.e.year 2012). Eventhough the attempt have made to understand weather any changes took place from socio-economic point of view especially changes in crop pattern, changes in assets, increased availability of drinking and irrigation water or any changes in lifting devices, improvement in health quality etc. Group discussions and case studies of farmers located in study area were held. Table 2.17 shows changes in amenities and assets during before and after construction of structure.

Table 2.17 Before and and After Status of Drinking Water and Asset in Khatrivada

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Problem of Drinking Water	Shortage in summer	Shortage in summer
	Source of Drinking Water	Open well and Tube well	Open well and Tubewell
	Quantity of Drinking Water	Sufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Flouride problem, brackish in summer	Flouride problem
	Availability for Livestock	yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	1	2
	Cattle Shed	390	390
	Tractor	10	15
	Two Wheeler	100	100
	Diesel Engine	100	100
	Electric Pump	15	15
	Other		

To understand changes in cropping pattern two methods were adopted i.e. group discussions with the farmers of surrounding area as well as case studies of four farmers of the village. Group discussion reflected that there is only change observed in slight increase in cotton production from 2500 Kg/ha (before) to 3000 Kg/ha (after). Table 2.18 shows whereas in case of wheat it is about 200 kg increase. It is important to mentioned that this increase is not due to changes in groundwater but due to practices of the farmers and availability of rainwater in river bed. (Table 2.18)

Table 2.18 Before and After Changes in Cropping Area and Production in Khtrivada

Season	**Before Structure**			**After Structure**			**Change**	
	Crop	**Area Ha**	**Prod. kg/Ha**	**Crop**	**Area Ha**	**Prod. kg/Ha**	**Area Ha**	**Prod. kg/Ha**
Kharif	Cotton	60	2500	Cotton	60	3000	0	500
	Sourghum	60	15000	Sourghum	60	15000	0	0
	Pearl Millet	10	2500	Pearl Millet	10	2500	0	0
Rabi	Wheat	37.6	3000	Wheat	37.6	3200	0	200

Table 2.19 Case Studies on Before and After Changes at House Hold Level Khatrivada

Name of the Farmer				Bachubhai Kesubhai Chohan		Mohanbhai Sajan Shiyani	
Caste				Koli		Koli	
Total Family Members (No)				4		5	
Land holding	**Type**			**Area Ha**		**Area Ha**	
	Irrigated			0		3.1	
	Non Irrigated			0.7		0	
	Waste land			0		0	
	Total			0.7		3.1	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0.7	3000	0	0
			After	0.7	3000	0	0
			Change	0	0	0	0
		Cotton	**Before**	0	0	3.1	1200
			After	0.7	600	3.1	2000
			Change	0.7	600	0	800
Livestock		**Type**		**No.**		**No.**	
		Cow		4		1	
		Buffalo		0		6	
		Bullock		0		2	
Change in Source of Irrigation		**Type**	**Before**	No		Open Well	
			After	Chek Dam		Open Well	
		Change in supply	**Before**	Available for Kharif		Available for Kharif	
			After	Available for Kharif and rabi		Available for Kharif and rabi	
		Irrigation Techniques	**Before**	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			**Before**	10000		30000	
			After	20000		50000	
Changes in Asset	**House**		**Before**	Pakka House 1 No.		Pakka House 5 No.	
			After	Pakka House 1 No.		Pakka House 5 No.	
	Vehicle		**Before**	------		Two Wheeler 2, Tractor 1	
			After	------		Two Wheeler 2, Tractor 1	
	Plaughing equipment		**Before**	Bullock(Hired)		Bullock	
			After	Bullock(Hired)		Bullock	
	Lifting Device		**Before**	Diesel Engine 5HP		Ele. Motor 3 HP, Disale Eng.5 HP	
			After	Diesel Engine 5HP		Ele. Motor 3 HP, Disale Eng.5 HP	

Table 2.19 Case Studies on Before and After Changes at House Hold Level Khatrivada (Contd...)

Name of the Farmer				Babubhai Mishribhai Koli		Kalu Lakha Koli	
Caste				Koli		Koli	
Total Family Members (No)				7		6	
Land holding	**Type**			**Area Ha**			
	Irrigated			3		1	
	Non Irrigated			0		0.8	
	Waste land			0		0	
	Total			3		1.8	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Cotton	**Before**	3	2000	1.7	3000
			After	3	2500	1.7	3000
			Change	0	500	0	0
	Rabi	Wheat	**Before**	0	0	0.1	2000
			After	0	0	0.1	2000
			Change	0	0	0	0
Livestock		**Type**		**No.**		**No.**	
		Cow		2		2	
		Buffalo		1		6	
		Bullock		0		2	
Change in Source of Irrigation		**Type**	**Before**	Open Well		Open Well	
			After	Open Well		Open Well	
		Change in supply	**Before**	Available for Kharif only		Available for Kharif only	
			After	Available for Kharif & Rabi		Available for Kharif & Rabi	
		Irrigation Techniques	**Before**	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			**Before**	60000		70000	
			After	70000		80000	
Changes in Asset	**House**		**Before**	Pakka House 3 No.		Pakka House 2 No.	
			After	Pakka House 3 No.		Pakka House 2 No.	
	Vehicle		**Before**	Two Wheeler 1		Two Wheeler 1	
			After	Two Wheeler 1		Two Wheeler 1	
	Plaughing equipment		**Before**	Bullock		Bullock	
			After	Bullock		Bullock	
	Lifting Device		**Before**	Diesel Engine 5HP		Diesel Engine 5HP	
			After	Diesel Engine 5HP		Diesel Engine 5HP	

The cumulative impact of WRM structure has also been supported with the help of four case studies of farmers located in study area. All four case studies very reflects no significant impact on agriculture has observed except following changes such as (01) Increase in cotton cotton production about 500 kg/ha in case of Babubhai Mishribhai Koli's farm and (02) Bachubhai Keshubhai Chauhan has started cotton during Kharif due to little water availability in river for protective irrigation in Rabi season.

2.1.3 DANDI WASTE WEIR

General Information : Dandi village of Una taluka has total 1057 population. The village covers an area of about 457 Ha land. Out of the total area, 62 % (285.4 ha) area is agriculture land where dominant agriculture is rainfed agriculture (266.4 ha). The village has forest land of about 7 % of total area. Table 2.20 shows general demographic and land use pattern of Dandi village.

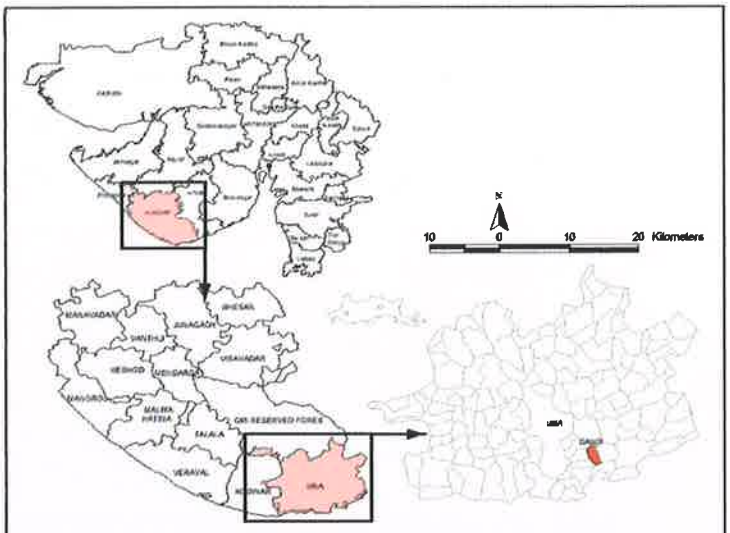


Fig. 2.13 Location Map of Dandi Village

Under CADP program, a waste weir has been constructed in this village in year 2011. The objective of the structure is for groundwater recharge. Surrounding land of the structure is agricutlreu land and open waster land. (Fig. 2.14 and Plate 2.3)

Table 2.20 Demographic and Land use Pattern of Dandi village, Tal. Una, Dist. Junagarh

Population	**Male**	**556**
	Female	**501**
	Total	**1057**
Land Use (Ha)	**Forest**	**30.5**
	Irrigated Agriculture	**19**
	Un-Irrigated	**266.4**
	Waste Lands	**84.8**
	Non Cultivation	**56.3**
	Total	**456.9**

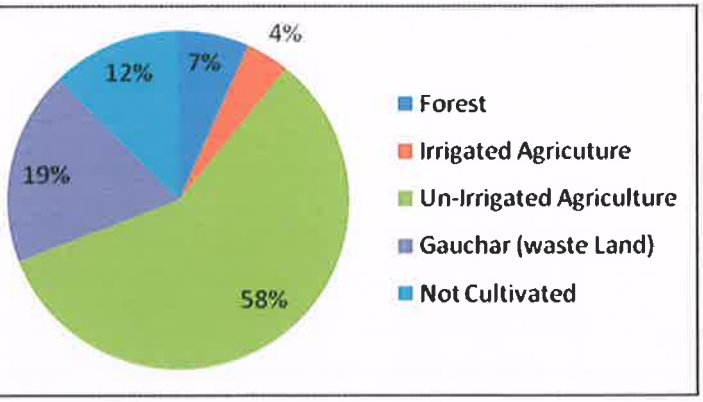


Plate 2.3 Photographs showing WRM Structure and Nearby Open Well

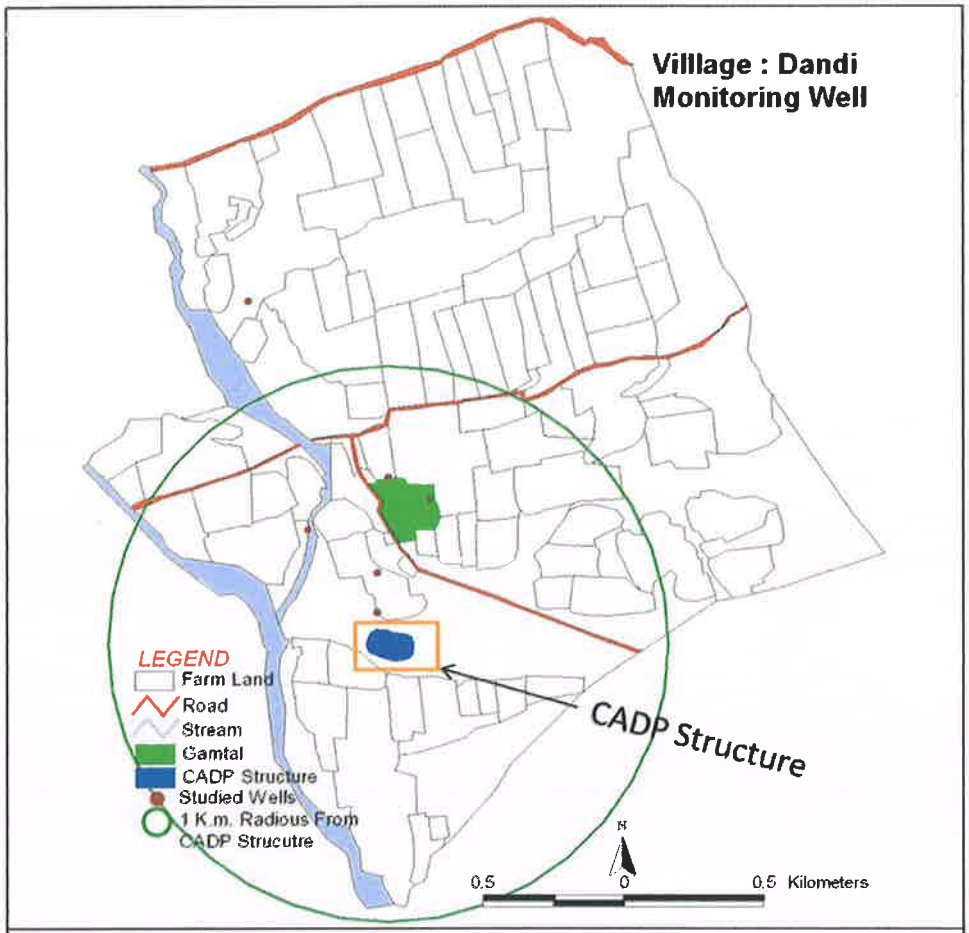


Fig. 2.14 Map Showing Location of WRM structure, Land Use and Monitoring Wells, Vill. Dandi

Geology and Hyro-geology: Geologically the area shows intercalated strata of lime stone and clay of Gaj formation of Tertiary age. In the village, limestone is a main aquifer. According to profile of the aquifer, top layer of alluvium is about a m which overlies abput 9 m thick limestone.

Table 2.21 Summary of Well Data, Village Dandi

Total No of Well		06
Use	Only Irrigation	03
	Only Drinking	03
	Drinking& Irrigation	00
	Non Use	00
Pumping Device	Diesel Engine (No)	03
	Electric Motor	00
Total depth of well (m)	Max	9.15
	Min	2.74
Water Level (m)	Max	6.5
	Min	0.15
Monitoring		06

Well inverntory known as a tool to study hydro-geology, existing wells have been studied in the Dandi village. Total 06 wells were studied in detail with respect to its physical parameters, use, geology, water levels, aquifer etc. Table 2.21 shows summarized account of wells whereas Table 2.22 shows the well wise details of use, lifting device type and capacity. The maximum depth of the well is about 9.15 m whereas minimum depth is about 2.74 m while, water levels l well ranges from 0.2 m to 6.5 m.

Table 2.22 Details of Studied Wells in Village Dandi

Well Code	Owner name	Use	Irrigation (Bigha)	Total depth of well (m)	Water Level (m)	Dia. (m)	Lifting Device	
							Type	HP
DW-11	Dayabhai Punabhai Majethiya	Irrigation	5	4.57	0.3	L=20 W=5	Diesel Engine	5.5
DW-12	Manubhai Rambhai Majethiya	Irrigation	4.8	4.87	1.37	4.5	Diesel Engine	5.5
DW-13	Manubhai Rambhai Majethiya	Irrigation	4.8	2.74	0.15	4	Diesel Engine	5.5
DW-14	Ukabhai Menshibhai Rathod	Drinking water	0	9.15		1.5	Manual	---
DW-15	Kumbhabhai Kanabhai Majethiya.	Drinking water	0	7.62	6.5	L=3, W=3	Manual	---
DW-16	Gram Panchayat-Dandi	Drinking water	0	8.23	3.65	8	Manual	---

Impact on Groundwater : To assess impat of WRM structure on groundwater of the study area, all wells have been monitored seasonally i.e. pre and post monsoon season of year 2012 and pre monsoon season of year 2013. The groundwater has been monitored in term of TDS as a parameter of water quality and static water level to assess recharge (Table 2.23). Based on the data hydrograph asn thematic iso maps have been prepared. Thematic maps includes iso-RWL maps (Fig. 2.16), groundwater flow map (Fig. 2.17) and iso TDS maps (Fig. 2.18).

Table 2.23 Changes in Reduced Water Levels and TDS in Observation Wells, Dandi village

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
DW-1	11	11	1.1	10000	2100	1910
DW-2	7	Nill	Nill	10000	Nill	Nill
DW-3	7	7	1.1	10000	7850	2900
DW-4	Nil	9	4.3	2000	1650	3000
DW-5	3	5	5.2	2000	1620	1180
DW-6	10	13	Nill	1900	2380	2800

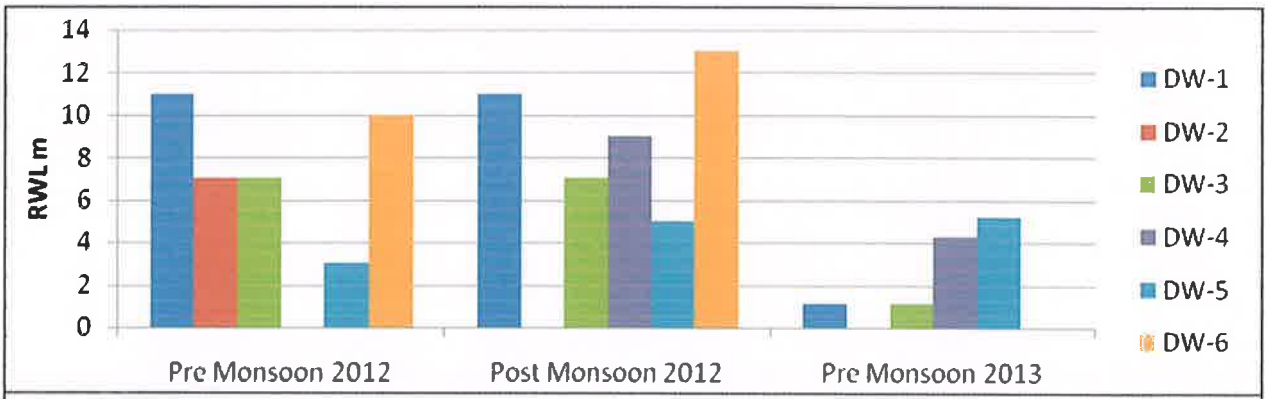


Fig. 2.15 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Dandi, Year 2012, 2013

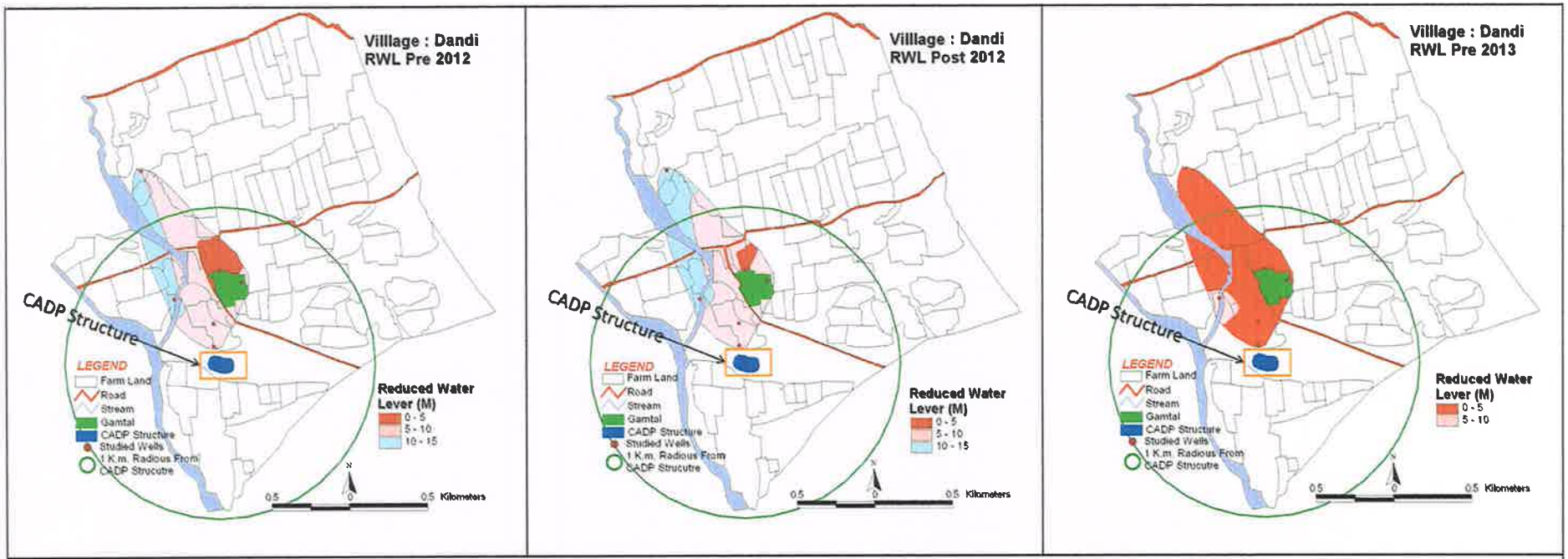


Fig. 2.16 Pre and Post Monsoon Iso RWL Maps of Village Dandi, Year 2012, 2013

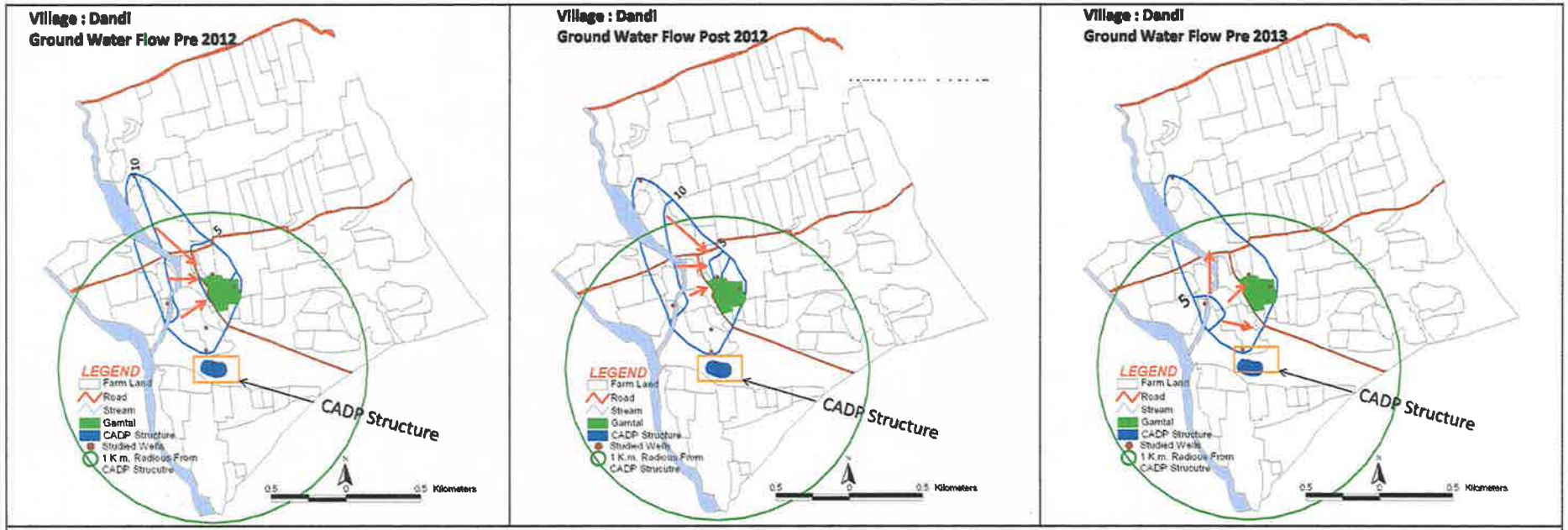


Fig. 2.17 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Dandi, (Year 2012, 2013)

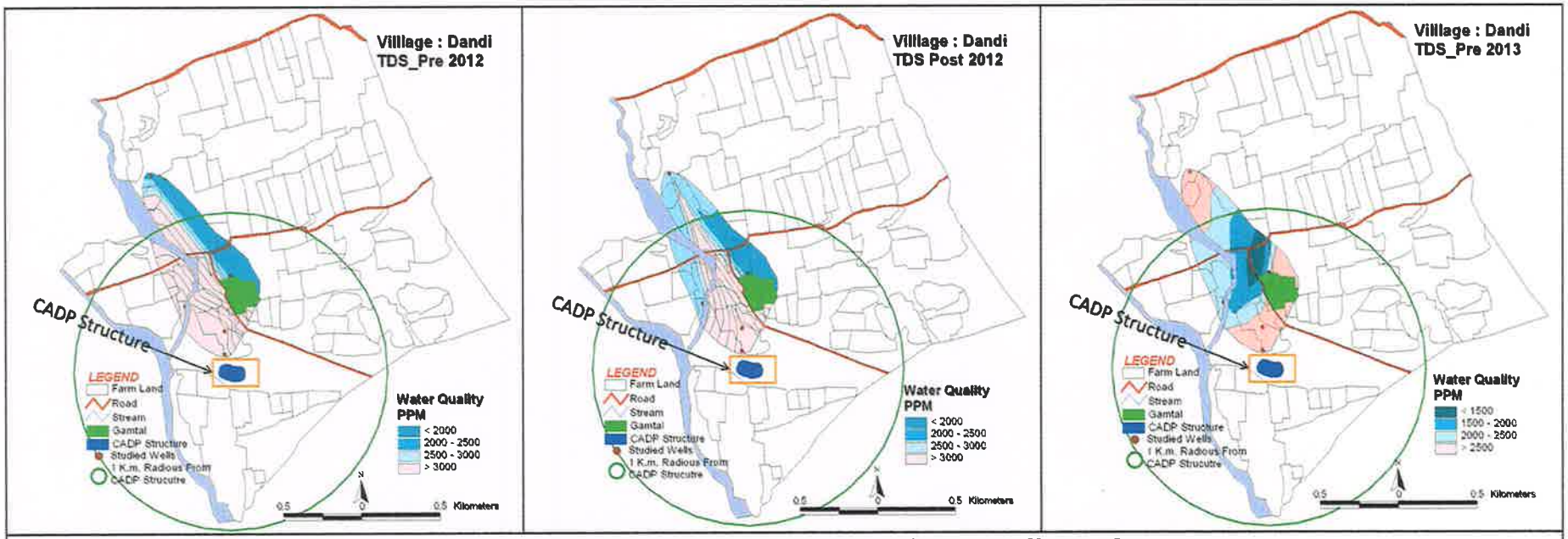


Fig. 2.18 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Dandi

Analysis of hydrograph and iso-RWL maps show following changes in groundwater.

- Water levels in observation wells have gradually depleted from pre monsoon season of year 2012 to pre monsoon season of year 2013. This analysis can also reflects in Iso RWL map (Fig. 2.16) and hydro graph (Fig. 2.15).
- Iso TDS (Fig. 2.18) shows considerable improvement in groundwater quality after construction of structure. However, it is also important to mentioned observations by people that earlier sea water was inundating up to present tank (CADP WRM) that has stopped due to Tidal Reglator constructed in the river by ACF.
- Overall it can be said that the structure has made considerable impact on groundwater quality however, it is not reflected more in case of water levels this may be dur to high extraction rate also.
- Another important justification is the two years monitoring for impact assessment is too early to draw robust conclusions about impact.

Socio Economic Impact: As per discussions with village groups the groundwater in village has turned saline earlier due to sea water ingression through river up to exisitn tank but after construction of Tidal Regulator at coast the ingression stopped has made significant impact on salinity. As far as impact on drinking water due to particular structure is concern till shortage of drinking water takes place in summer season. As far as water quality is concern, there were salinity and fluoride problems in drinking water but now ***only fluoride problem is in groundwater***. No any change has observed in case of assets in village. Table 2.24 shows changes in amenities and assets during before and after construction of structure. To understand changes in cropping pattern two methods were adopted i.e. group discussions with the farmers of surrounding area as well as case studies of four farmers of the village. Group discussion reflected that there is only change observed in slight increase in cotton production from 2000 Kg/ha (before) to 2500 Kg/ha (after). Table 2.25 shows whereas in case of wheat it is about 300 kg increase. According to farmers there were only 40 % of the area sown during Rabi season but now total sowing takes place during Rabi season.

Table 2.24 Before and and After Status of Drinking Water and Asset in Dandi

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Problem of Drinking Water	Shortage in summer	Shortage in summer
	Source of Drinking Water	Open well	Open well and Tubewell
	Quantity of Drinking Water	Sufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Fluoride problem, brackish in summer	Only Fluoride problem
	Availability for Livestock	Yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	1	1
	Cattle Shed	150	150
	Tractor	3	3
	Two Wheeler	15	15
	Diesel Engine	2	2
	Electric Pump	20	20
	Other	8	8

Table 2.25 Before and After Changes in Cropping Area and Production in Dandi

Season	Before Structure			After Structure			Change	
	Crop	Area Ha	Prod. kg/Ha	Crop	Area Ha	Prod. kg/Ha	Area Ha	Prod. kg/Ha
Kharif	Cotton	60	2000	Cotton	200	2500	0	500
	Sourghum	50	20000	Sourghum	50	20000	0	0
	Pearl Millet	70	2500	Pearl Millet	70	2500	0	0
Rabi	Wheat	30	2500	Wheat	30	2800	0	300

Table 2.26 Case Studies on Before and After Changes at House Hold Level Dandi

Name of the Farmer				Kalubhai Majethiya		Hamirbhai Majethiya	
Caste				Koli		Koli	
Total Family Members (No)				5		7	
Land holding	**Type**			**Area Ha**		**Area Ha**	
	Irrigated			0.7		0	
	Non Irrigated			0		2.5	
	Waste land			0		0	
	Total			0.7		2.5	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0.3	1800	1	1200
			After	0.3	1900	1	1200
			Change	0	100	0	0
		Cotton	**Before**	0.3	1800	1.4	1500
			After	0.6	1900	1.4	1600
			Change	0.3	100	0	100
	Rabi	Fodder	**Before**	0	0	0.1	2000
			After	0	0	0.1	2000
			Change	0	0	0	0
Livestock	**Type**			**No.**		**No.**	
	Cow			0		1	
	Buffalo			0		2	
	Bullock			1		2	
Change in Source of Irrigation	**Type**		**Before**	Open Well		Near Other Farmer	
			After	Open Well		Near Other Farmer	
	Change in supply		**Before**	Available for Kharif only		Available for Kharif	
			After	---		Available for Kharif	
	Irrigation Techniques		**Before**	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			**Before**	30000		50000	
			After	30000		50000	
Changes in Asset	**House**		**Before**	Pakka House 1 No.		Pakka House 3 No.	
			After	Pakka House 1 No.		Pakka House 3 No.	
	Vehicle		**Before**	Two wheeler 1 No		Two wheeler 1 No	
			After	Two wheeler 1 No		Two wheeler 1 No	
	Plaughing equipment		**Before**	Bullock Plough		Bullock	
			After	Bullock Plough		Bullock	
	Lifting Device		**Before**	Ele. Motor 5 HP		----	
			After	Ele. Motor 5 HP		----	

Table 2.26 Case Studies on Before and After Changes at House Hold Level Dandi (Contd...)

Name of the Farmer				Naranbhai Jivabhai Koli	
Caste				Koli	
Total Family Members (No)				6	
Land holding	**Type**			**Area Ha**	
	Irrigated			0.5	
	Non Irrigated			0.3	
	Waste land			0	
	Total			0.8	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0.3	1000
			After	0.3	1000
			Change	0	0
		Cotton	**Before**	0.5	1000
			After	0.5	1000
			Change	0	0
	Rabi	Fodder	**Before**	0	0
			After	0	0
			Change		
Livestock		**Type**		**No.**	
		Cow		----	
		Buffalo		2	
		Bullock		2	
Change in Source of Irrigation		**Type**	**Before**	Open Well	
			After	Open Well	
		Change in supply	**Before**	Available for Kharif only	
			After	Available for Kharif only	
		Irrigation Techniques	**Before**	Flood	
			After	Flood	
Income (Profit Rs.)			**Before**	30000	
			After	30000	
Changes in Asset	**House**		**Before**	Pakka House 1 No.	
			After	Pakka House 1 No.	
	Vehicle		**Before**	----	
			After	----	
	Plaughing equipment		**Before**	Bullock	
			After	Bullock	
	Lifting Device		**Before**	Ele. Motor 5 HP	
			After	Ele. Motor 5 HP	

The cumulative impact assessment of WRM structure has also been checked with the help of three case studies of farmers located in study area. Out of three farmers one farmer has started agriculture during Rabi season. However there is no any change has seen in cropping pattern and /or production.

2.1.4 BHEBHA CHECK WALL

General Information : Bhebha village is situated in Una Taluka of Junagrah district (Fig. 2.19). The village spreaded over 670.7 ha of area. The village has population of about 1753 persons. Agriculture is a dominant type of land use (Table 2.27). Irrigated and un-irrigated agriculture covers a land of about 85 % of total land. Remaining land is in use for open grazing land. Table 2.27 gives demographic and land use details of Bhebha village. Under CADP program, check wall has been constructed in the village in year 2011 (Fig 2.20). Plate 2.4 shows photographs of pre and post monsoon status of the structure.

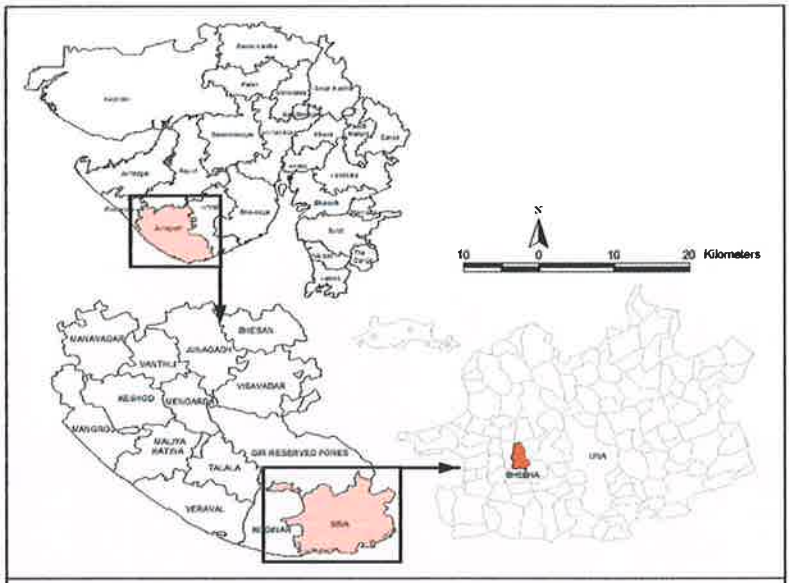


Fig. 2.19 Location Map of Bhebha Village

Table 2.27 Demographic and Land use Pattern of Bhebha, Tal. Una, Dist. Junagarh

Population	Male	904
	Female	849
	Total	**1753**
Land Use (Ha)	Forest	0.0
	Irrigated Agriculture	278.8
	Un-Irrigated	285.7
	Waste Lands	9.9
	Non Cultivation	96.3
	Total	**670.7**

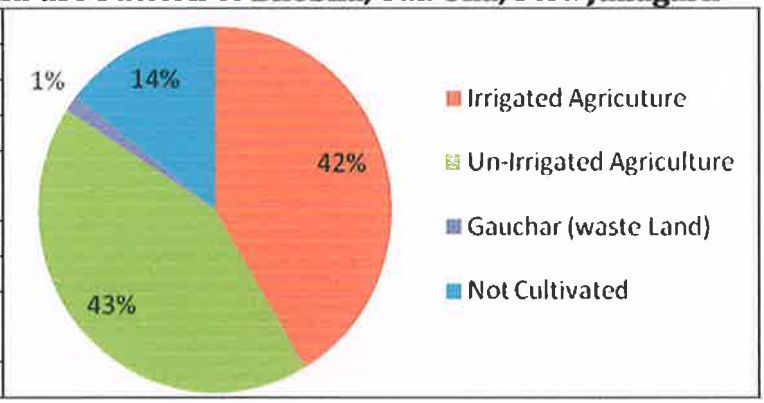


Plate 2.4 Photographs showing WRM structure before and after Monsoon

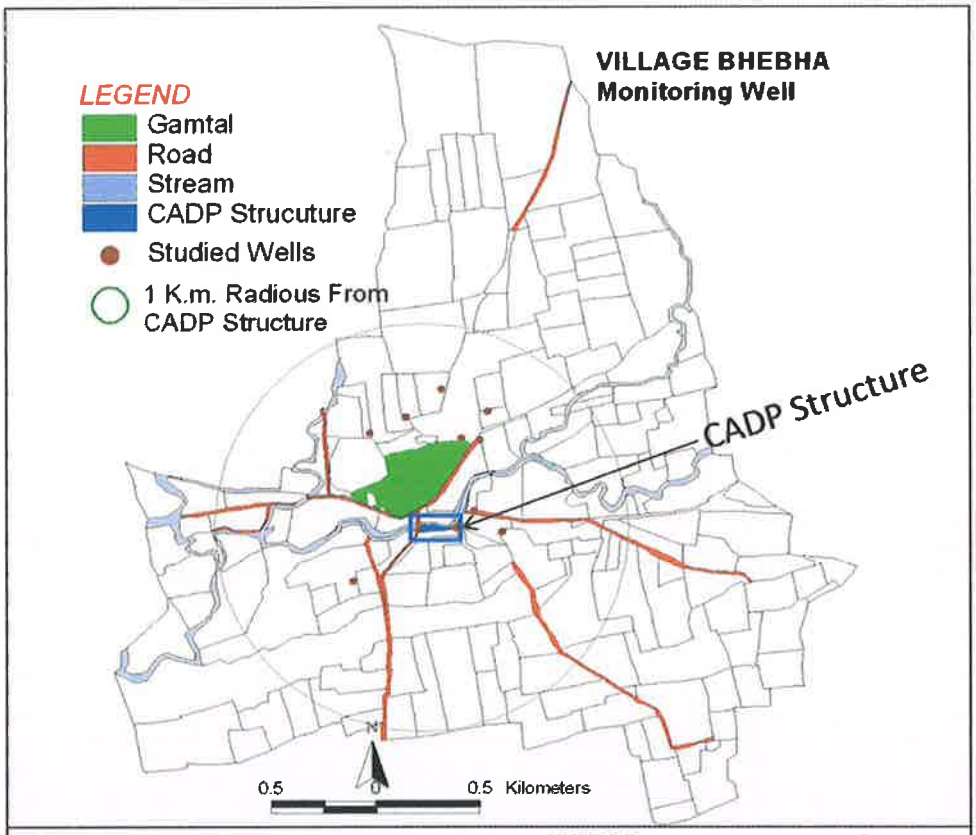


Fig. 2.20 Map Showing Location of WRM structure, Land Use and Monitoring Wells, Vill. Bhebha

Geology and Hydro-geology: Geology of the village is dominated by limestone and clay formation of Tertiary age. Limestone is function as an aquifer for the area. To understand hydro-geological character of the area, existing wells have been studied in detail i.e. total depth, water level, water quality, use, pumping machine etc. Total 10 wells have studied and its summary has been given in table 2.28. Details of all wells have presented in table 2.29. Maximum depth of well is 13.5 m while minimum depth is 6.7. Similarly water level ranges from 1.2 m to 9.8 m. Dominant use of groundwater is for irrigation in agriculture.

Table 2.28 Summary of Well Data, Village Bhebha

Total No of Well		**10**
Use	Only Irrigation	09
	Only Drinking	01
	Drinking& Irrigation	00
	Non Use	00
Pumping Device	Diesel Engine (No)	03
	Electric Motor	06
Total depth of well (m)	Max	13.5
	Min	6.7
Water Level (m)	Max	9.8
	Min	1.2
Monitoring		10

Table 2.29 Details of Studied Wells in Village Bhebha

Well Code	Owner name	Use	Irri. (Bigha)	Total depth of well (m)	Water Level (M)	Diam eter (m)	Lifting Device	
							Type	HP
BW-1	Balubhai Thumar	Irrigation	7.2	13.5	6.5	3.8	E. M.	5.5
BW-2	Mohanbhai Vaja.	Irrigation	7.2	9.5	2.2	3.8	E. M.	5.5
BW-3	Naranbhai Vaja.	Irrigation	2.2			3.8	E. M.	5.5
BW-4	Nathubhai Shingad	Irrigation	3.6	7	1.21	3.8	D.E.	5.5
BW-5	Gram Panchayat	Dri. water	0	13.1	9.8	3.6	Manual	
BW-6	Manubhai Gohil	Irrigation	3	7	0.76	3.8	E. M.	5.5
BW-7	Bhikhabhai Shingad	Irrigation	16	6.7	2.43	3.6	D.E.	5.5
BW-8	Meghajibhai Vaja.	Irrigation	6.42	7.62	3	3.8	D.E.	5.5
BW-9	Mulubhai Makawana	Irrigation	2	7.62	1.52	3.8	D.E.	5.5
BW-10	Vasarambhai Mevad	Irrigation	4	7.5	3	3.8	E. M.	5.5

Impact on Groundwater: To assess impact of the WRM structure on groundwater, existing wells have been monitored seasonally in term of change in water level and water quality especially TDS. About 10 well have been monitored from pre monsoon 2012 to pre monsoon 2013 (Table 2.30). Based on the monitoring data, analysis has been derived through hydrograph (Fig. 2.21) and thematic maps i.e. iso RWL map (Fig. 2.22), iso TDS map (Fig. 2.24) and groundwater flow map (Fig. 2.23).

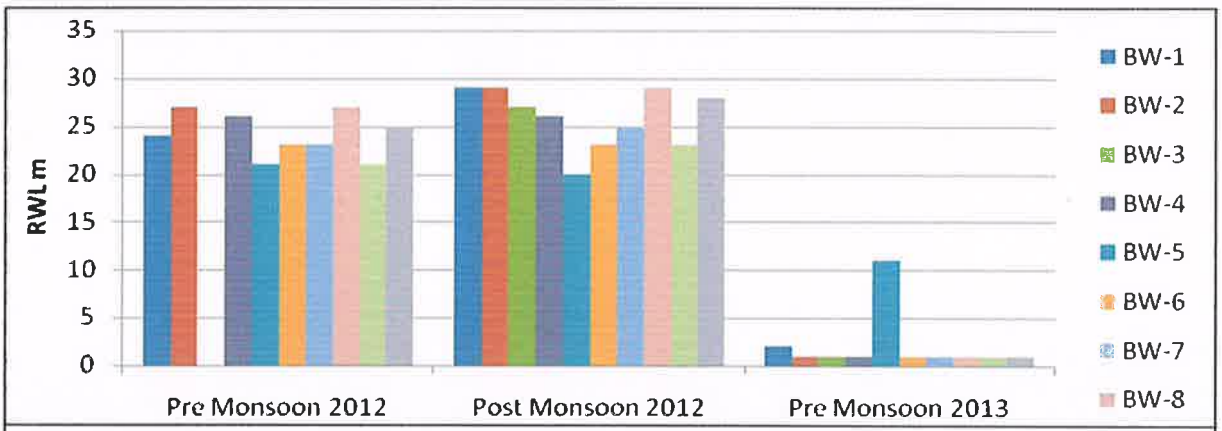


Fig. 2.21 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Bhebha, Year 2012, 2013

Table 2.30 Details of Changes in Water Level and Water Quality, Village Bhebha

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
BW-1	24	29	2	10000	2520	2700
BW-2	27	29	1	10000	1880	2900
BW-3	Nill	27	1	10000	2000	2800
BW-4	26	26	1	10000	2100	2800
BW-5	21	20	11	1800	925	960
BW-6	23	23	1	10000	1875	2700
BW-7	23	25	1	10000	1880	2900
BW-8	27	29	1	10000	2040	2750
BW-9	21	23	1	10000	2100	2650
BW-10	25	28	1	10000	1880	2900

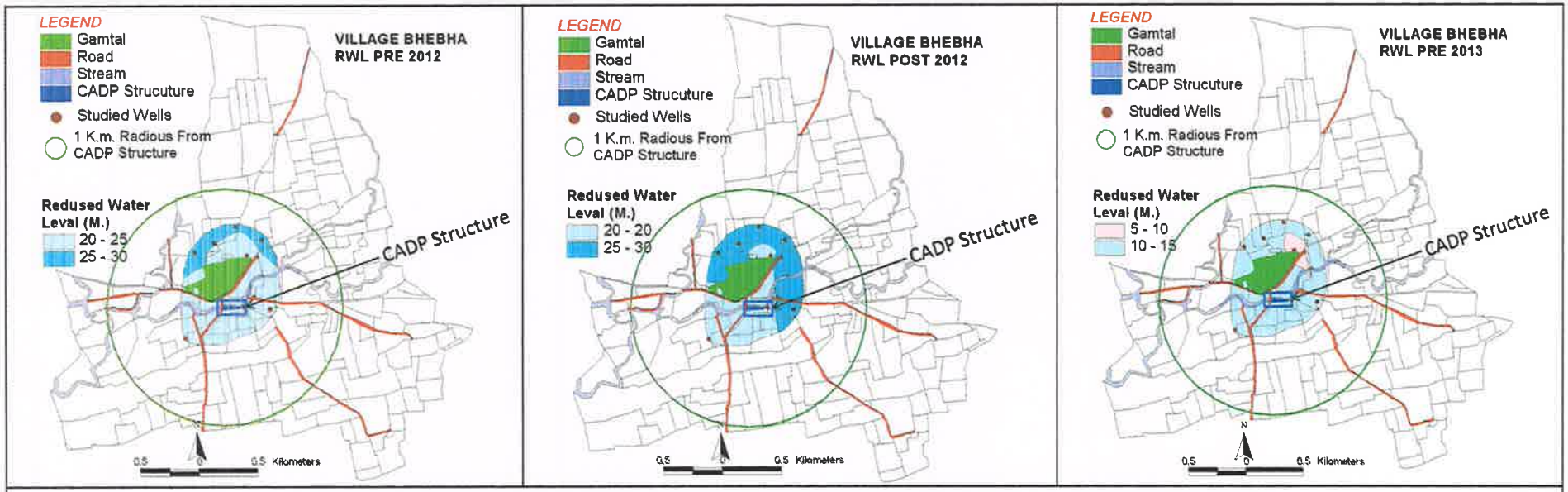


Fig. 2.22 Pre and Post Monsoon Iso RWL Maps of Village Bhebha, Year 2012, 2013

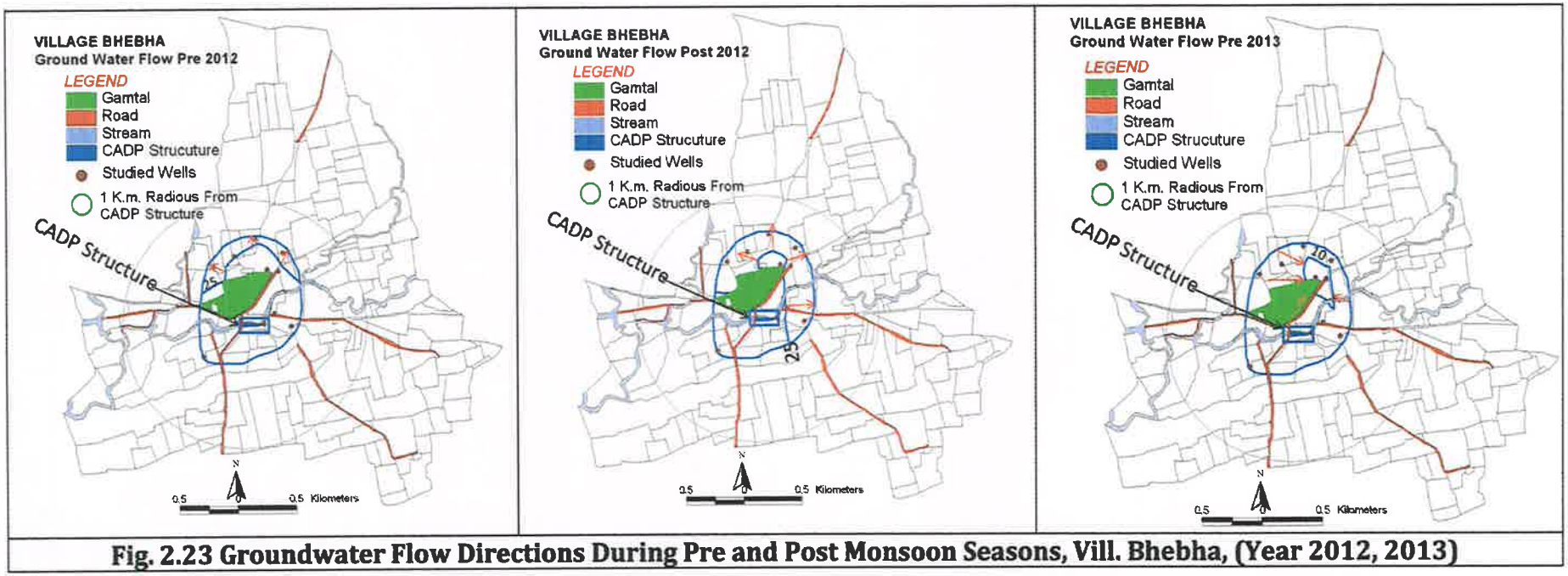


Fig. 2.23 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Bhebha, (Year 2012, 2013)

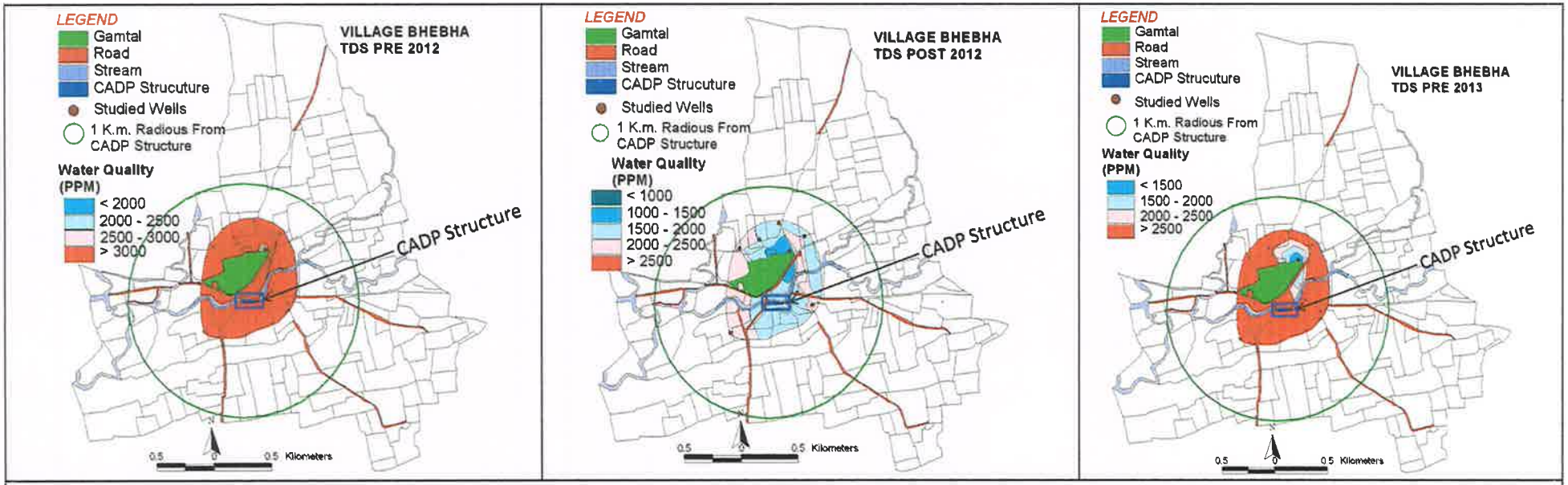


Fig. 2.24 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Bhebha, (Year 2012, 2013)

Analysis of hydrograph and iso-RWL maps show following changes in groundwater of Bhebha village.

- Well hydrograph clearly shows drastic deplation in water levels from pre monsoon season of year 2012 to pre monsoon season of year 2013. (Fig. 2.21and Fig. 2.22).
- Decrease in water level is due to limited thickness of aquifer and increase in withdrawal by farmer after improvement in water quality.
- It is also important to notice that due to low rainfall in year 2012 sufficient recharge may not taken place and hence the depleting trend has shown by hydrographs. Another important justification is the two years monitoring for impact assessment is too early to draw robust conclusions about impact.
- However, change in water quality shows opposite impact than water levels. Iso TDS (Fig. 2.24) shows drastic improvement in groundwater quality over the period. Table 2.30 shows positive change in TDS.
- Therefore, it can say that the WRM structure has improved water quality but that is not reflected in quantity.

Socio Economic Impact: It already seen that in this village, the WRM structure has made very positive impact on water quality and water levels in case of good rainfall, drinking water status has improved in the village. Earlier there were salinity and fluoride problems in drinking water but now ***only fluoride problem and that too in summer only is in groundwater***. No any change has observed in case of assets in village. Table 2.31 shows changes in amenities and assets during before and after construction of structure.

Table 2.31 Before and and After Status of Drinking Water and Asset in Bhebha

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Problem of Drinking Water	Shortage in summer	Shortage in summer
	Source of Drinking Water	Open well & Tube well	Open well & Tubewell
	Quantity of Drinking Water	Sufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Flouride and saliniy	Flouride problem
	Availability for Livestock	yes	yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	10	10
	Cattle Shed	170	170
	Tractor	45	45
	Two Wheeler	150	150
	Diesel Engine	60	50
	Electric Pump	40	50

To understand changes in cropping pattern two methods were adopted i.e. group discussions with the farmers of surrounding area as well as case studies of two farmers of the village. Group discussion clearly shows that there is an increase in production in all the crops in the village. In addition, some farmers have started vegetables during summer season also. (Table 2.32) The cumulative impact assessment of WRM structure has also been checked with the help of two case studies of farmers located in study area. It reflects that, Bhanabhai Makvana has started agriculture in Rabi season and also practicing

vegetable. However, in both the case in existing crop no any changes have notieced especially in case of productivity. (Table 2.33)

Table 2.32 Before and After Changes in Cropping Area and Production in Bhebha

Season	Before Structure			After Structure			Change	
	Crop	Area Ha	Prod. kg/Ha	Crop	Area Ha	Prod. Kg/Ha	Area Ha	Prod. Kg/Ha
Kharif	Cotton	180	2000	Cotton	180	2500	0	500
	Groundnut	250	1700	Groundnut	250	2000	0	300
Rabi	Wheat	120	3000	Wheat	120	3500	0	500
Summer	Pearl Millet	10	2000	Pearl Millet	10	2500	0	500
Vegetable					5	10000	5	10000

Table 2.33 Case Studies on Before and After Changes at House Hold Level Bhebha

Name of the Farmer				Lakhman Harsi Shingan		Bhanabhai Makvana	
Caste				Koli		Koli	
Total Family Members (No)				6		5	
Land holding	**Type**			**Area Ha**		**Area Ha**	
	Irrigated			1		0.5	
	Non Irrigated			0		0	
	Total			1		0.5	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0	0	0.5	3000
			After	0	0	0.5	3000
			Change	0	0	0	0
		Cotton	**Before**	1	2000	0	0
			After	1	2000	0	0
			Change	0	0	0	0
	Rabi	Bajra	**Before**	0.4	4000	0	0
			After	0.4	4000	0	0
			Change	0	0	0	0
	Vegetable		**Before**	0	0	0	0
			After	0	0	0.4	5000
			Change	0	0	0.4	5000
Livestock	**Type**			**No.**		**No.**	
	Buffalo			0		1	
	Bullock			1		0	
Change in Source of Irrigation	**Type**		**Before**	Open Well		Chek Dam	
			After	Open Well		Chek Dam	
	Change in supply		**Before**	Only for Kharif		Only for Kharif	
			After	Kharif & rabi		Kharif & Rabi	
	Irrigation Techniques		**Before**	Flood		Flood	
			After	Flood		Flood	
Income (Profit Rs.)			**Before**	50000		20000	
			After	50000		20000	
Changes in Asset	**House**		**Before**	Pakka House 1 No.		Pakka House 1 No.	
			After	Pakka House 1 No.		Pakka House 1 No.	
	Plaughing equipment		**Before**	Bullock		Bullock	
			After	Bullock		Bullock	
	Lifting Device		**Before**	Ele. Motor 3 HP		Diesel Engine 5 HP	
			After	Ele. Motor 3 HP		Diesel Engine 5 HP	

2.2 AGAKHAN RURAL SUPPORT PROGRAM(I) PROJECT VILLAGES

Under CADP pgogram in coastal area of Saurashtra, Agakhan Rural Support Program (AKRSP) has implemented various activities wehre two villages (01) Kalej and (02) Khera have been selected to assess impact of WRM structure on groundwter ans socio-economic aspects of the villages. Table 2.34 shows village wise salient features of different structure constructed by AKRSP. Constructors of all structures has completed in the year 2012. AKRSP has constructed two percolation tabk in these villages. Village wise detail impact assessment has given here.

Table 2.34 Village Wise Structure Wise Salient Features

Village	Kalej	Khera
Type Of Structure	Percolation Tank /Overflow	Percolation Tank /Overflow
Height Of Structure (M)	2.00	0.30
Lenght of Structure (M)	50	14
Storage Capacity (MCFt)	1.45	0.35
HFL (M)	101.00	100.35
Catchment area (km^2)	6.25	0.49
Objective	Reacharge	Reacharge
Starting year	2011	2011
Completion year	2012	2012
Cost (Rs.)	500800	379000

2.2.1 KALEJ PERCOLATION TANK

General Information: Village Kalej of Mangrol Taluka has total area about 1017.5 Ha. Total population of the village is about 3192 persons. Main occupation in village is agriculture along with animal husbandry. The village has dominant land use under rainfed agriculture (685.8 Ha) followed by irriged agriculture 179 Ha. Table 2.35 shows demographic and land use information of the village. AKRSP(I) has constructed Percolation structure under CADP to improve the groundwater condition in the village.

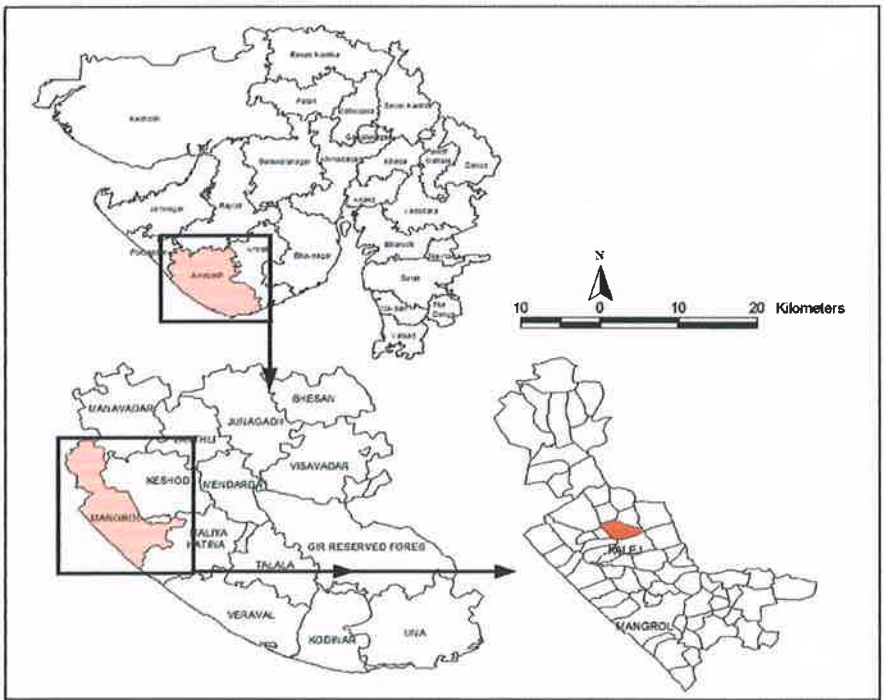
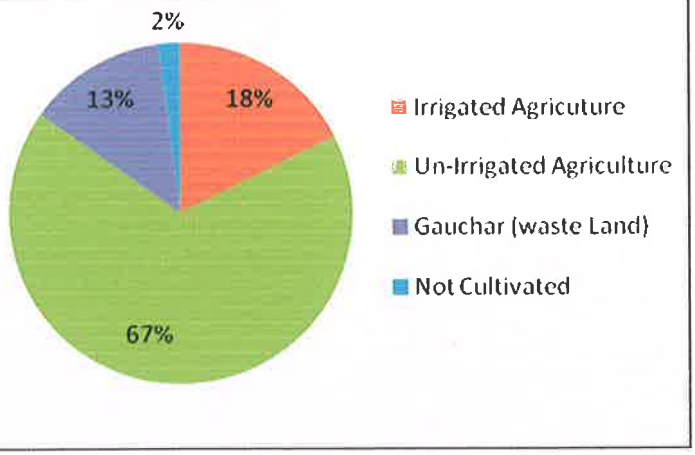


Fig. 2.25 Location Map of Kalej Village

Table 2.35 Demographic and Land use Pattern of Kalej, Tal. Mangrol, Dist. Junagarh

Population	Male	1651
	Female	1541
	Total	**3192**
Land Use (Ha)	Forest	0.0
	Irrigated Agriculture	179.0
	Un-Irrigated	684.8
	Waste Lands	133.6
	Non Cultivation	20.1
	Total	**1017.5**



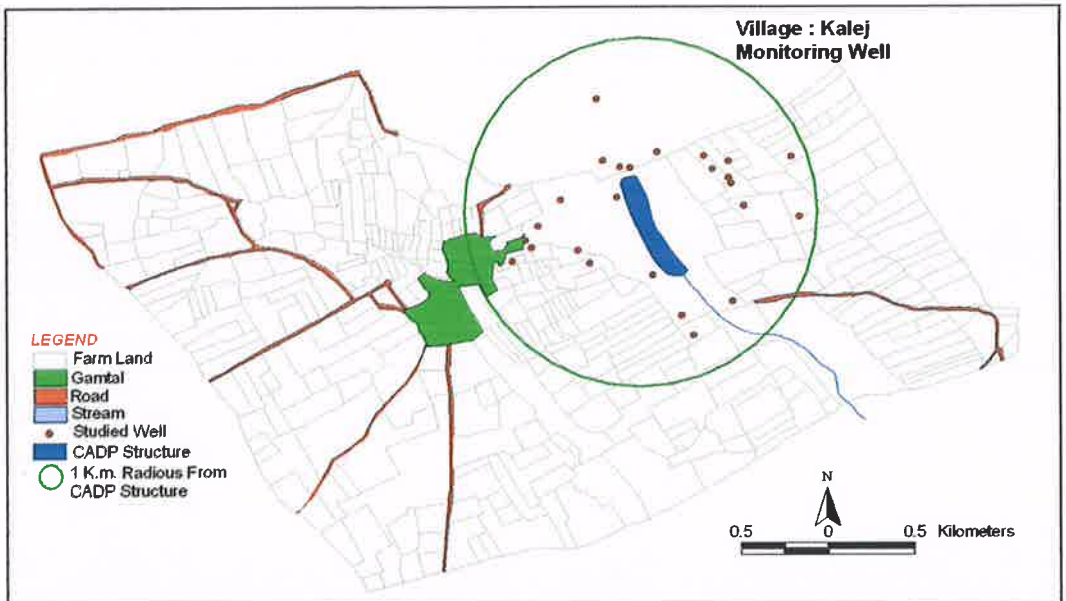


Fig. 2.26 Map Showing Location of WRM structure, Land Use and Monitoring Wells, Vill. Kalej

Plate 2.5 Photpgraphs showing WRM strcuture and Well Inventory in Surronding Area

Geology and Hydro-geology: Geologically the village area shows dominant rock type limestone intercalated with clays of Gaj Formations of Tertiary age. To understand hydro-geological characteristic detailed well inventory were held in village. (Table 2.37). Well inventory clearly shows Limestone is the only aquifer in this area. Summary of wtudied well has been given in table 2.36. Studied well data show most of the well are under dual use of irrigation and drinking purposes. Almost 23 wells have facilities of lifting i.e. Diesel engine (03 No.) and electric motor (20 no.) Depth of the well ranges from 8.6 m to 50 m whereas water level ranges from 7.5 m to 25 m.

Table 2.36 Summary of Well Data, Village Kalej

Total No of Well		25
Use	Only Irrigation	00
	Only Drinking	01
	Drinking& Irrigation	23
	Non Use	01
Pumping Device	Diesel Engine (No)	03
	Electric Motor	20
Total Depth (m)	Max	50
	Min	8.6
Water Level (m)	Max	38
	Min	7.5
Monitoring		25

Well lithologs shows there are three to four layers of limestones occur in wells of varying thickness as the depth increases thickness of limestone is increases. During well inventory discharge rates are also measured in some wells that ranges from 130 LPM to 588 LPM depending upon avialability numbers of limestone layers in the area. (Table 2.38 and 2.39)

Table 2.37 Details of Studied Wells in Village Kalej

Well Code	Owner name	Use	Irri. (Ha)	Depth (M)	WL (M)	Di. M	Lifting Device	
							Type	HP
MK1	Rambhai Mer	Irrigation & Drinking		30	15	3.5	E.M.	5
MK2	Rambhai Mer	Not Ues		35	23.1	5		
MK3	Devabhai	Irrigation & Drinking	1	26.4	20.8	3	E.M.	5
MK4	Ganga Ruda	Irrigation & Drinking	1.6	50	35.5	3.5	E.M.	7.5
MK5	Yadav Vela	Irrigation & Drinking	3	22.7	17.7	3	E.M.	5
MK6	Prabhudas Kandas	Irrigation & Drinking	11.1	18.8	18.3	2	E.M.	5
MK7	Babu Raja	Irrigation & Drinking	2.4	18.7	17.4	3	E.M.	5
MK8	Bachubhai Naran	Irrigation & Drinking	1.6	50	38	3	E.M.	7.5
MK9	Mohan Vishram	Irrigation & Drinking		25.9	19.6	3.5	D.E.	5
MK10	DevshiDevabhai	Irrigation & Drinking	1.6	25.2	22.9	3.5	E.M.	5
MK11	-----	Irrigation		32	18.9	3.5	E.M.	5
MK12	-----	Irrigation & Drinking		35	25.4	4		
MK13	Sana Virabhai	Irrigation & Drinking	0.8	37	30	3	E.M.	5
MK14	Ram Hira	Irrigation & Drinking		33	25	3.5	E.M.	7.5
MK15	Bhikhabhai Vandhiya	Irrigation	4.2	35	27	3.5	E.M.	7.5
MK16	Popat Vishram	Irrigation & Drinking	1.9	32	25	3	E.M.	6
MK17	Gram Panchayat	Drinking		35	25	6.2	E.M.	7
MK18	Mohamad hasham	Irrigation & Drinking	4.9	35	25	3.8	E.M.	7.5
MK19	Naranbhai Pujabhai	Irrigation & Drinking	2	41	31	4	E.M.	10
MK20	Veja Naran	Irrigation & Drinking	2	37	22	3.7	E.M.	5
MK21	Gela Rama	Irrigation & Drinking	2	30	24	3.2	E.M.	6
MK22	-----	Irrigation & Drinking		8.6	7.5	3.5	Diesel	5
MK23	Viram Arjan	Irrigation & Drinking		10.8	8.2	3	Disel	5
MK24	Velji Pola Kayriya	Irrigation & Drinking	0.5	10.1	8.3	2.5	E.M.	5
MK25	Ganga Bhoja	Irrigation & Drinking		11.6	9.7	3.6	E.M.	5

Table 2.38 Details of Aquifer, Village Kalej

Aquifer	Position Wise Thickness (M)				Discharge LPM
	1st	2nd	3rd	4th	
Alluvium	1.00 – 4.6				--
Limestone	5.00	1.4 - 28.6	4.9 – 7.0	1.7-23.0	103-588

Impact on Groundwater: To assess impact of the WRM structure on groundwater, water levels and TDS concentrations in existing wells (25 wells)have monitored seasonally for year 2012 and 2013. In year 2012 all wells were monitored for pre and post monsoon seanos whereas for year 2013 only pre monsoon monitoring has held. (Table 2.40). Based on the monitoring data, analysis has been derived through hydrograph (Fig. 2.27) and thematic maps i.e. iso RWL map (Fig. 2.28), iso TDS map (Fig. 2.30) and groundwater flow map (Fig. 2.29).

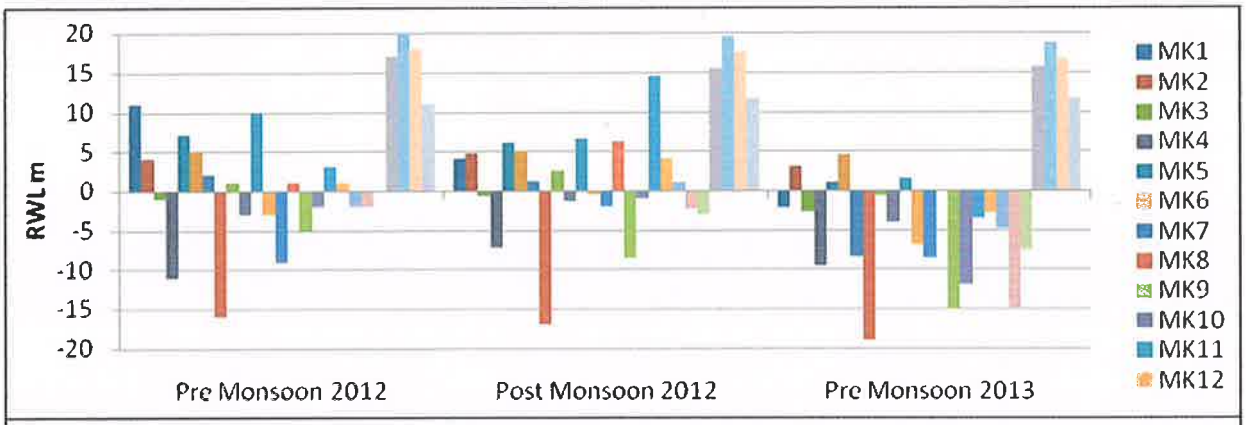


Fig. 2.27 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Kalej, Year 2012, 2013

Following main changes have seen in groundwater during different seasons

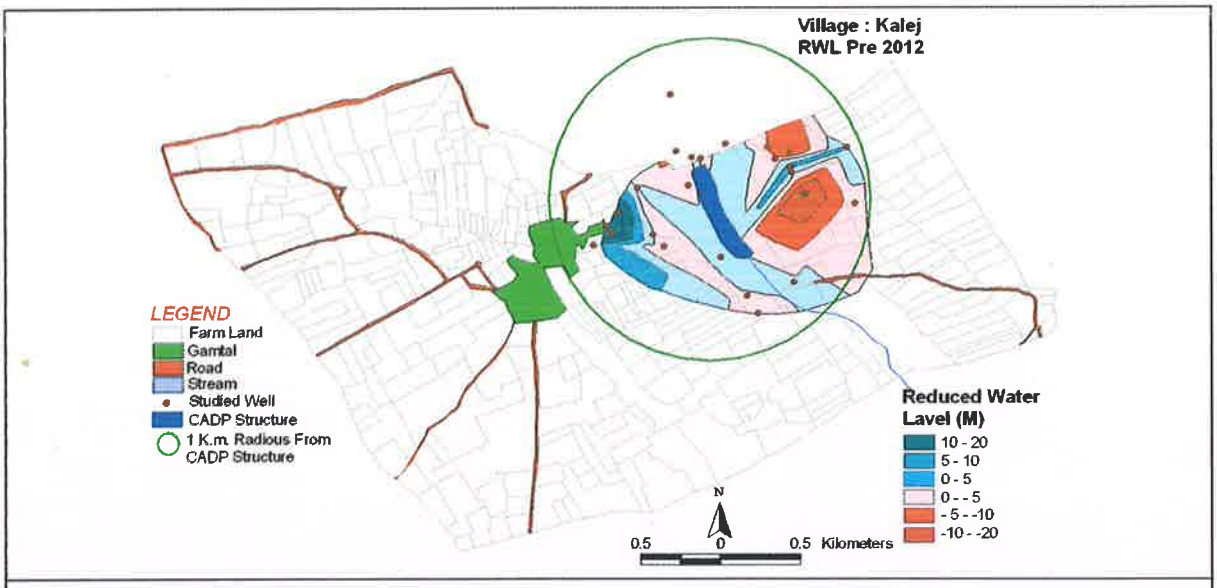
- The seasonal well hydrograph shows there is a rise in water levels from pre monsoon seasons of year 2012 to post monsoon seasons of year 2013. However, there are some wells of deeper water levels do not shows much seasonal fluctuations whereas some shallo wells also shows water levels below AMSL even after mosoon season.
- As per farmer's observations before constructions of the structure only 3 m of water column remains left in wells that now raised up to 3 m of static water levels.
- Iso RWL maps shows there is a subsurface low conditions take place in eastern part of the structure whereas subsurface high condition remains almost same in western part of the structure.
- The groundwater flow is from west to eastern side i.e. towards subsurface low area in all the seasons.
- Iso TDS map of the post monsoon season of year 2012 shows signinicant improvement in water quality i.e. decrease in concentrations of TDS. The average decrease in TDS ranges from 400 ppm to 1400 ppm in some of the wells.

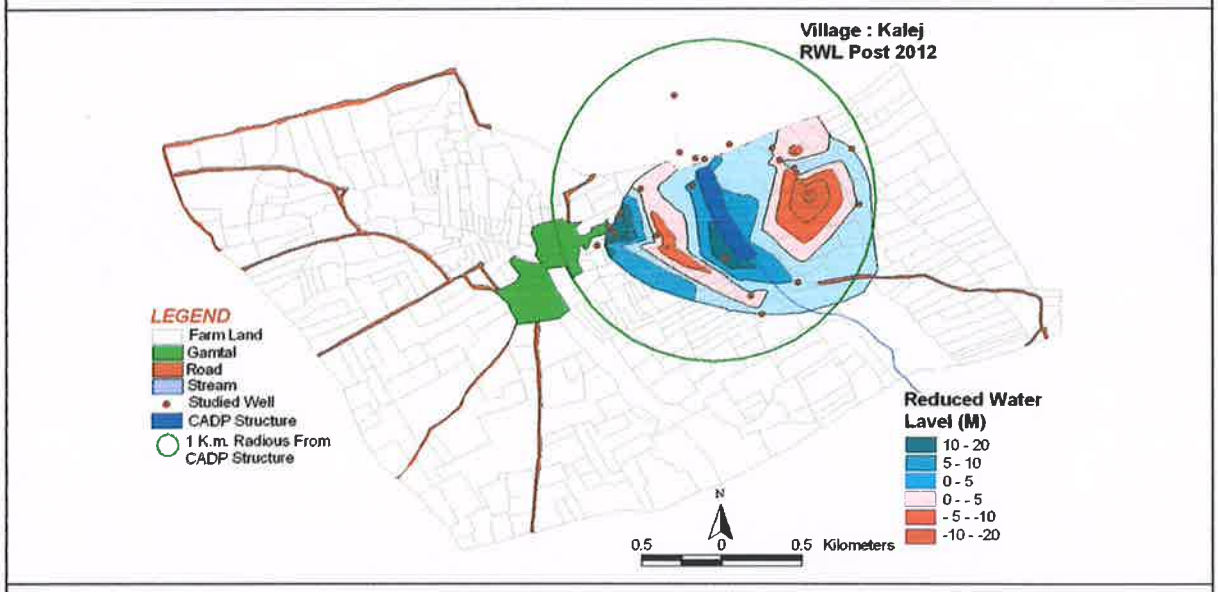
Table 2.39 Well Litholog of Kalej Village

Well Code	Aquifer		Aquifer Position	Litholog Details									TDS ppm	Discharge		Recharge	
	Type	Th (M)		Total Layers	1st	Th. m	2nd	Th. m	3rd	Th. m	4th	Th. m		Hr.	LPM	Hr.	LPM
MK1	Limestone	1.4	U & L	4	Soil	4.6	Limestone	1.4	Clay	14	Limestone	10	570				
MK2	Limestone	5.5	U & L	4	Soil	2	Limestone	5.5	Sandy Clay	4.5	Limestone	23	730				
MK3	Limestone	4.6	U & L	4	soil	1	Limestone	4.6	Clay	5.2	Limestone	15.6	650	2	271	8	68
MK4	Limestone	5.5	U & L	4	Soil	1	Limestone	5.5	Clay	1	Limestone	5.5	800	3	294	12	73
MK5	Limestone	6.8	U & L	4	Soil	1	Limestone	6.8	Clay	2.2	Limestone	12.7	650	2	400	12	67
MK6	Limestone	16.8	L	2	Soil	2	Limestone	16.8					670	0.25	351	12	73
MK7	Limestone	15.9	M & L	3	Soil	1	Limestone	15.9	Clay	1.8			640				
MK8	Limestone	15	U & L	5	soil	1	Limestone	15	Clay	2	Limestone	12	2200	4	442	20	88
MK9	Limestone	4.3	U & L	4	Soil	1	Limestone	4.3	Clay	1.7	Limestone	18.9	760				
MK10	Limestone	5.5	U & L	4	Soil	1	Limestone	5.5	Clay	3.8	Limestone	14.9	700	1.5	588	12	73
MK11	Limestone	6.5	M & L	4	Soil	2	Clay	8.5	Lime Stone	6.5	Clay	8	734				
MK12	Limestone	4	M & L	4	Soil	3	Limestone	4	Clay	13	Lime Stone	15	520				
MK13	Limestone	7	M & L	5	Lst	5	Clay	7	Lime Stone	7	Clay	2	530	8	103	16	52
MK14	Limestone	5.6	U & L	4	Soil	2	Limestone	5.6	Clay	17.4	Lime Stone	8	590				
MK15	Limestone	15.1	U & L	5	Soil	2.7	Limestone	10.1	Clay	12.2	Lime Stone	5	830	8	303		
MK16	Limestone	28.6	L	2	Soil	3.4	Limestone	28.6					1100	2	1684	12	281
MK17	Limestone	21.3	Lower	4	Soil	2.7	Limestone	5.3	Clay	11	Limestone	16	530				
MK18	Limestone	24.1	U & L	5	Soil	1.9	Limestone	5.3	Clay	7	Limestone	2.8	610	8	569	12	379
MK19	Limestone	24.6	U & L	4	Soil	4	Limestone	4.8	Clay	12.4	Limestone	19.8	570	2.5	206	21	240
MK20	Limestone	28.8	U & L	4	Soil	3.2	Limestone	13.8	Clay	5	Limestone	15	480	3	172	4	129
MK21	Limestone	7.7	U & L	4	Soil	2	Limestone	6	Clay	14.3	Limestone	1.7	870	8	129	12	86
MK22	Limestone	4.6	Lower	2	Soil	4	Limestone	4.6					650				
MK23	Limestone	4.9	Lower	3	Soil	4	Limestone	1.2	Limestone	4.9			1200				
MK24	Limestone	6.7	Lower	2	Soil	3.4	Limestone	6.7					1380				
MK25	Limestone	7.9	Lower	2	Soil	3.7	Limestone	7.9					1000	0.3	4465	8	167

Table 2.40 Details of changes in RWL and Water Quality, Village Kalej, 2012

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
MK1	11	4.0	-2.1	570	810	1200
MK2	4	4.7	3.0	730	860	900
MK3	-1	-0.6	-2.7	650	920	1000
MK4	-11	-7.2	-9.6	800	1200	1300
MK5	7	6.0	1.1	650	920	1000
MK6	5	5.0	4.6	670	910	1800
MK7	2	1.2	-8.4	640	910	1100
MK8	-16	-17.0	-19.0	2200	1500	2600
MK9	1	2.5	-0.6	760	1010	1100
MK10	-3	-1.4	-4.0	700	960	1100
MK11	10	6.6	1.6	734	900	900
MK12	-3	-0.5	-6.9	520	710	1100
MK13	-9	-2.0	-8.6	530	700	900
MK14	1	6.2	Nill	590	750	Nill
MK15	-5	-8.6	-15.1	830	1060	1000
MK16	-2	-1.0	-12.0	1100	1500	1500
MK17	3	14.5	-3.5	530	750	900
MK18	1	4.0	-2.9	610	1000	1100
MK19	-2	1.0	-4.9	570	850	900
MK20	-2	-2.3	-15.1	480	720	1000
MK21	0	-3.0	-7.5	870	1090	1000
MK22	17	15.5	15.7	650	2000	2200
MK23	20	19.5	18.6	1200	1800	2000
MK24	18	17.5	16.6	1380	1800	2200
MK25	11	11.7	11.6	1000	1500	2000





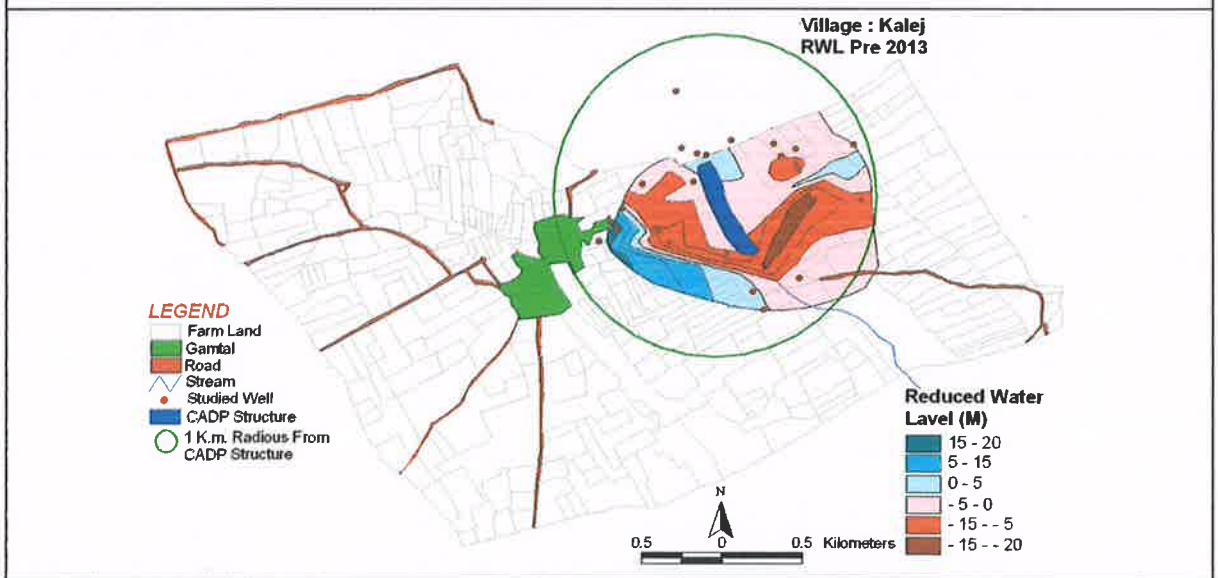


Fig. 2.28 Pre and Post Monsoon Iso RWL Maps of Village Kalej, Year 2012, 2013

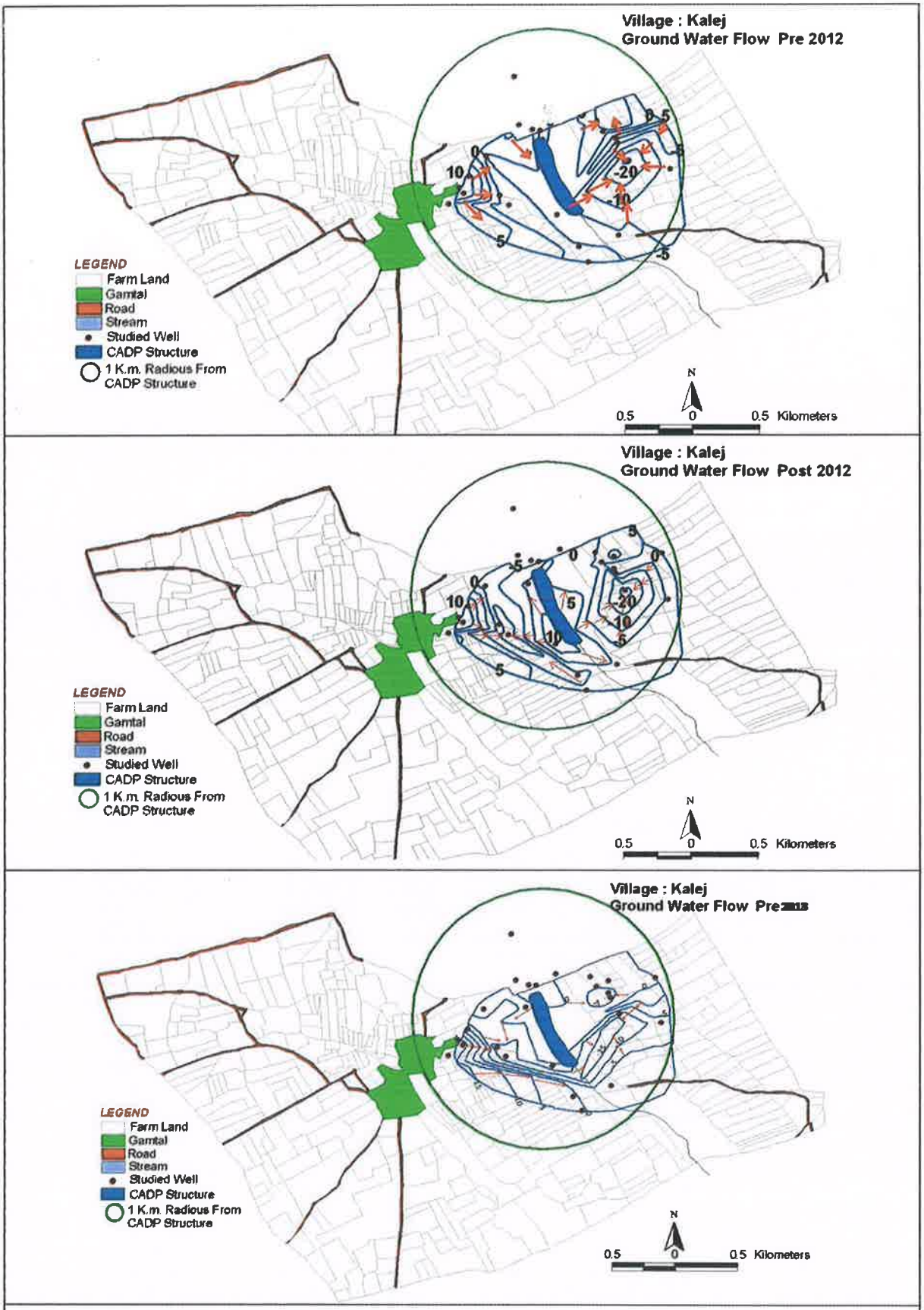


Fig. 2.29 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Kalej, (Year 2012, 2013)

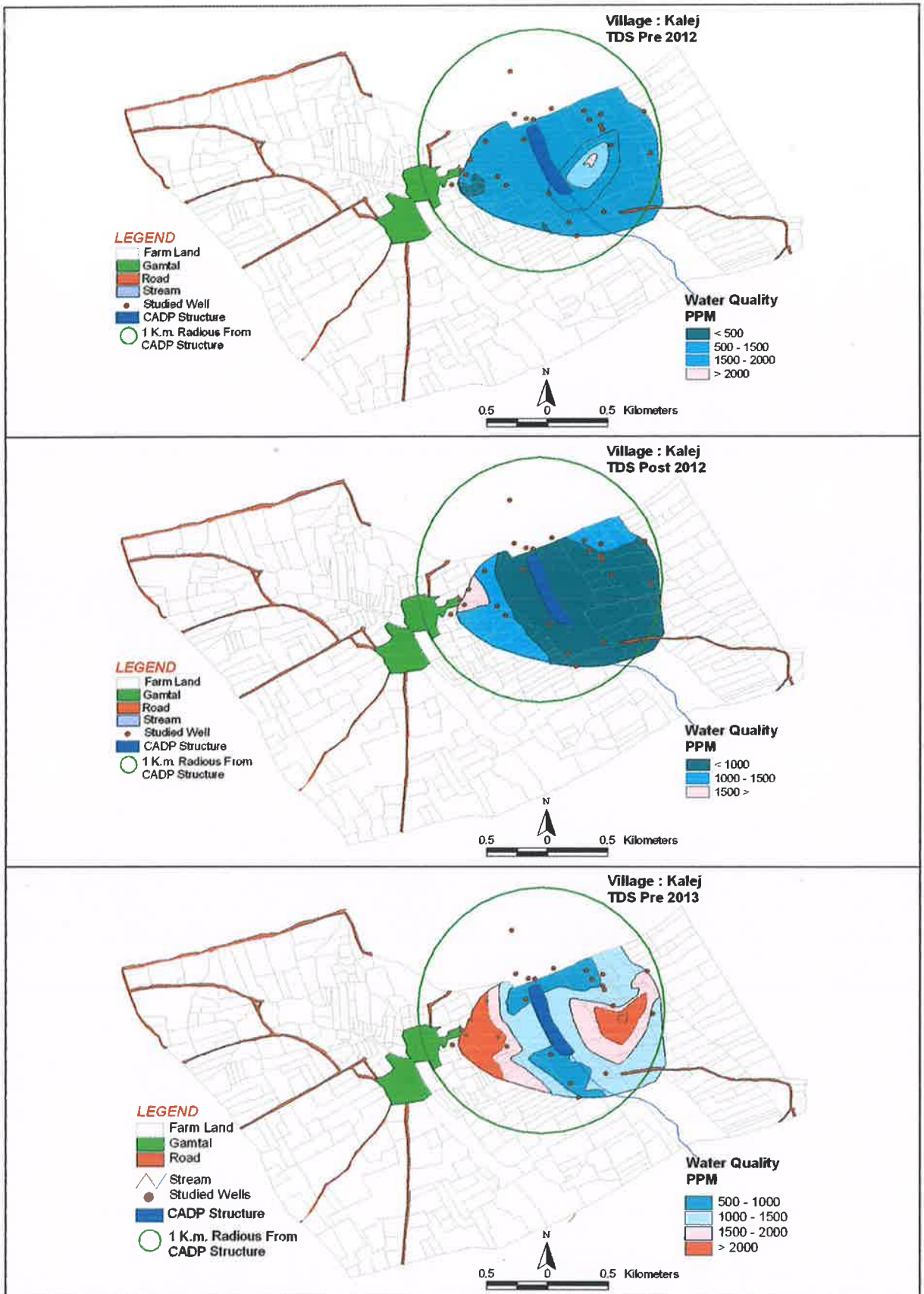


Fig. 2.30 Iso-TDS Map of Pre and Post Monsoon Seasons of Year 2012 and 2013, Vill. Kalej, (Year 2012, 2013)

Socio-Economic Impact: To understand socio-economic impact group discussions on changes in amenities and increase or decrease in assets were made with the people. According to them there is no much change have noticed in these two cases except decrease in salinity in groundwater has increase sustainability of good quality of drinking water within the village. However, due to limited reserve of groundwater and increase in agriculture demand short fall takes place during summer season. Table 2.41 shows changes in amenities and assets during before and after construction of structure.

As per discussions with village groups the groundwater in village has turned saline since last twenty years and hence people have adopted only rainfed farming in village. They do not prefers to use saline water for irrigation since it degrads soil quality. Another observation specific to structure, that no any storage took place in structure due to very low rainfall after its construction in last year (i.e.year 2012).

Table 2.41 Before and and After Status of Drinking Water and Asset in Kalej

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Problem of Drinking Water	Shortage in summer	Shortage in summer
	Source of Drinking Water	Open well and Tube well	Open well and Tubewell
	Quantity of Drinking Water	Sufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Flouride problem, brackish in summer	Only Flouride problem for few period
	Availability for Livestock	Yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	7	8
	Cattle Shed	215	230
	Tractor	60	60
	Two Wheeler	400	500
	Diesel Engine	2	2
	Electric Pump	200	205

AS far as change in cropping pattern is concerned two major changes have seen in the area (01) increase in wheat production in Rabi season and (02) sowing of cumin in about 250 ha area during Rabi season after construction of percolation structure. These two observations clearly supports improvement in groundwater conditions in village. (Table 2.42)

Table 2.42 Before and After Changes in Cropping Area and Production in Kalej

Season	**Before Structure**			**After Structure**			**Change**	
	Crop	**Area Ha**	**Prod. Kg/Ha**	**Crop**	**Area Ha**	**Prod. kg/Ha**	**Crop**	**Area Ha**
Kharif	Sourghum	50	20000	Sourghum	50	20000	0	0
	Groundnut	850	2000	Groundnut	850	2000	0	0
Rabi	Wheat	500	3000	Wheat	500	3500	0	500
	Gram	250	2500	Gram	250	2500	0	0
				Cumin	250	1500	250	1500

Table 2.43 Case Studies on Before and After Changes at House Hold Level Kalej

Name of the Farmer				Bachubhai Naranbhai		Naranbhai Patodiya	
Caste				Koli		Koli	
Total Family Members (No)				5		6	
Land holding	**Type**			**Area Ha**		**Area Ha**	
	Irrigated			1.6		2.4	
	Non Irrigated			0		2	
	Waste land			0		0	
	Total			1.6		4.4	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0	0	1	1200
			After	0	0	1	1200
			Change	0	0	0	0
		Groundnut	**Before**	1.6	600	4.4	2200
			After	1.6	600	4.4	2200
			Change	0	0	0	0
	Rabi	Wheat	**Before**	0.4	800	1	2200
			After	1	2000	1	2200
			Change	0.6	1200	0	0
Livestock		**Type**		**No.**		**No.**	
		Cow		0		2	
		Buffalo		2		0	
		Bullock		2		3	
Change in Source of Irrigation		**Type**	**Before**	Open Well		Open Well	
			After	Open Well		Open Well	
		Change in supply	**Before**	Available for Kharif		Available for Kharif	
			After	Available for Kharif and rabi		Available for Kharif and rabi	
		Irrigation Techniques	**Before**	Flood		Flood	
			After	Flood		Sprinkler	
Income (Profit Rs.)			**Before**	80000		60000	
			After	80000		60000	
Changes in Asset	**House**		**Before**	Pakka House 3 No.		Pakka House 5 No.	
			After	Pakka House 3 No.		Pakka House 5 No.	
	Vehicle		**Before**	Two Wheeler 1		Two Wheeler 1	
			After	Two Wheeler 1		Two Wheeler 1	
	Plaughing equipment		**Before**	Bullock		Bullock	
			After	Bullock		Bullock	
	Lifting Device		**Before**	Ele. Motor 5 HP		Diesel 5 HP	
			After	Ele. Motor 5 HP		Diesel 5 HP	

Table 2.43 Case Studies on Before and After Changes at House Hold Level Kalej (Contd...)

Name of the Farmer				Manishbhai Koli		Devsibhai Koli	
Caste				Koli		Koli	
Total Family Members (No)				5		5	
Land holding	**Type**			**Area Ha**		**Area Ha**	
	Irrigated			1.6		2	
	Non Irrigated			4.4		0	
	Waste land			0.		0	
	Total			6		2	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**production KG/ha**	**Area Ha**	**production KG/ha**
	Kharif	Bajra	**Before**	0	0	0	0
			After	0	0	0	0
			Change	0	0	0	0
		Groundnut	**Before**	6	2000	2	2000
			After	6	2200	2	2200
			Change	0	200	0	200
	Rabi	Wheat	**Before**	0	0	0	0
			After	0	0	0.4	2500
			Change	0	0	0.4	2500
Livestock	**Type**			**No.**		**No.**	
	Cow			0		1	
	Buffalo			2		0	
	Bullock			2		2	
Change in Source of Irrigation	**Type**		**Before**	Open Well		Open Well	
			After	Open Well		Open Well	
	Change in supply		**Before**	Available for Kharif		Available for Kharif	
			After	Available for Kharif and rabi		Available for Kharif and rabi	
	Irrigation Techniques		**Before**	Flood		Flood	
			After	Sprinkler		Flood	
Income (Profit Rs.)			**Before**	70000		70000	
			After	80000		100000	
Changes in Asset	**House**		**Before**	Pakka House 2 No.		Pakka House 1 No.	
			After	Pakka House 2 No.		Pakka House 1 No.	
	Vehicle		**Before**	Two Wheeler 1		Two Wheeler 1	
			After	Two Wheeler 1		Two Wheeler 1	
	Plaughing equipment		**Before**	Bullock		Bullock	
			After	Bullock		Bullock	
	Lifting Device		**Before**	Ele. Motor 7.5 HP		Ele. Motor 5 HP	
			After	Ele. Motor 7.5 HP		Ele. Motor 5 HP	

The impact assessment of WRM structure has also tried to understand at house hold level with the help of four case studies of farmers located in study area. Out of four sample survey changes have been noticed in two cases such as (01) Increase in area under Rabi irrigated wheat crop as well as per ha production in case of Bachubhai Naranbhai whiel (02) Devshibhai Devabhai has started wheat sowing in 4 Bigha (0.4 Ha) during Rabi from year 2013 due to increase in availability of water.

2.2.2 KHERA PERCOLATION TANK

General Information : Village Khera is located in Maliya Taluka of Junagarh district. The total population of the village is about 2406 persons. Main occupation in village is agriculture along with animal husbandry. The village area spreads over about 453.8 Ha. 79 % of total land is characterized by agriculture land. Table 2.44 shows demographic and land use information of the village. AKRSP(I) has constructed Percolation Tank under CADP to improve the groundwater condition in the village.

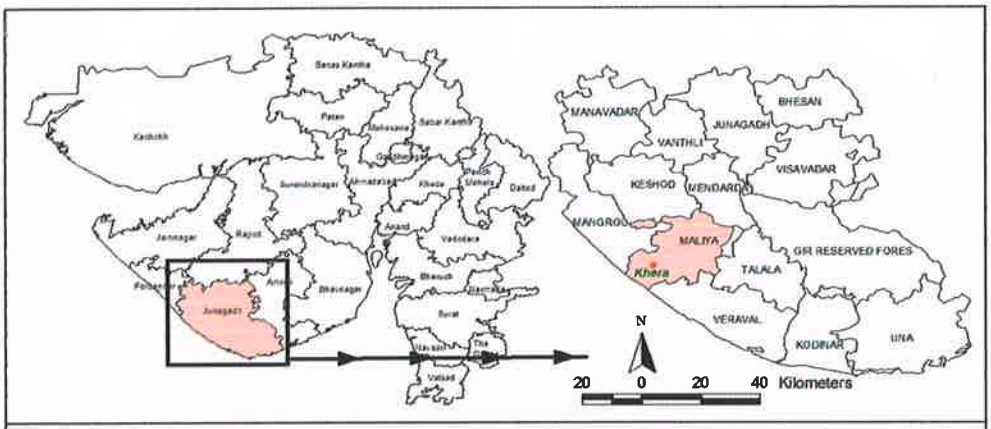


Fig. 2.31 Location Map of Khera Village

Table 2.44 Demographic and Land use Pattern of Khera, Tal. Maliya, Dist. Junagarh

Population	Male	1195
	Female	1211
	Total	**2406**
Land Use (Ha)	Forest	0.0
	Irrigated Agriculture	229.8
	Un-Irrigated	125.3
	Waste Lands	92.1
	Non Cultivation	6.6
	Total	**453.8**

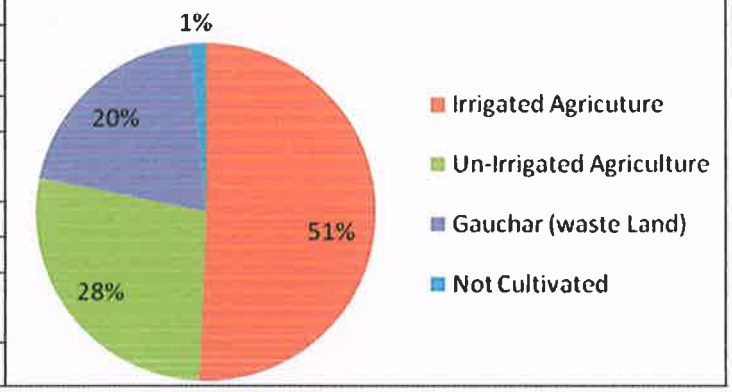


Plate 2.6 Photograph showing WRM Strucutre and Discussion with Villagers

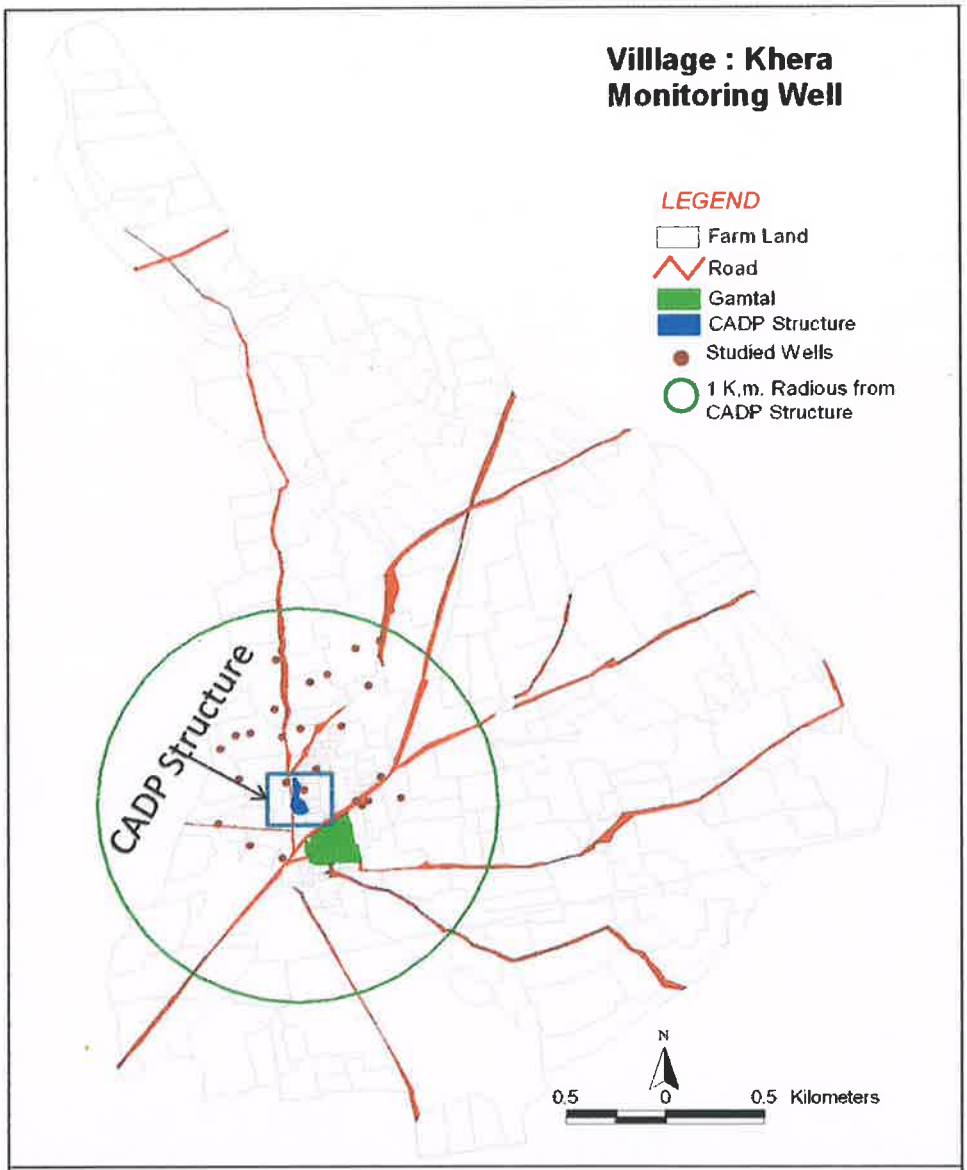


Fig. 2.32 Map Showing Location of WRM structure, Land Use and Monitoring Wells, Vill. Khera

Geology and Hyro-geology: Limestone and clay of Gaj formation of Tertiary age are main rocks overlained by thin alluvium found in the village area. To characterize hydro-geological aspects especially for groundwater levels and quality total 27 wells were studied. Summary of the studied well is given in Table 2.45. only one well is non use well whereas remaining all 26 wells are regularly used for irrigation. Except non used well all well are facilitated by lifting devices. The maximum depth has seen in borewell about 36 m whereas that of open well is around 8 m. Maximum water table depth in study area is at 34 m below ground whereas minimum is at 7 m.

Table 2.45 Summary of Well Data, Village Khera

Total No of Well		27
Use	Only Irrigation	26
	Only Drinking	00
	Drinking& Irrigation	00
	Non Use	01
Pumping Device	Diesel Engine (No)	05
	Electric Motor	21
Total depth of well (m)	Max	36
	Min	08
Water Level (m)	Max	34
	Min	07
Monitoring		27

Table 2.46 Details of Studied Wells in Village Khera

Well Code	Owner name	Use	Irrigation (Bigha)	Ddepth (m)	W. L. (m)	Di.M	Lifting Device	
							Type	hp
1	Lakhaman Jiva Bharda	Irrigation	2.83	26	24	3.00	E.M.	7.5
2	Raiya Hamir Ghodadra	Irrigation	2.02	17	16	3.00	E.M.	5
3	Uka Bachu Vasan	Irrigation	2.43	21	18	3.00	D.E.	5
4	Balakdas Kandas Bavaji	Irrigation	1.62	25	24	3.00	E.M.	7.5
5	Lakha Govind Dadhi	Irrigation	3.24	36	30	3.00	E.M.	7.5
6	Kanu Vashi Vasan	Irrigation	1.21	28	26	3.00	E.M.	7.5
7	Karashan	Irrigation	1.21	30	27	3.00	E.M.	
8	Natha Bogha Parmar	Irrigation	2.63	30	26	3.00	E.M.	7.5
9	Vagha Sidi Vadher	Irrigation	2.23	36	33	3.00	E.M.	7.5
10	Lakha Pancha Dabhi	Irrigation	1.62	34	30	3.00	E.M.	7.5
11	Govind Punja Jethava	Irrigation	2.43	35	30	3.00	E.M.	7.5
12	Kara Devadas Mer	Irrigation	2.83	34	31	3.00	E.M.	7.5
13	Vasi Devasi Vaja	Irrigation	3.04	32	29	3.00	E.M.	7.5
14	Jadav Rana Barada	Irrigation	3.24	33	31	3.00	E.M.	7.5
15	Babu Parabat Mer	Irrigation	4.05	36	30	4.00	E.M.	7.5
16	Veja lakha Mer	Irrigation	3.24	25	20	3.00	E.M.	5
17	Haja Lakha Mer	Irrigation	2.63	30	26	3.00	E.M.	7.5
18	Meraman Bhikha Vaja	Irrigation	2.43	25	18	4.00	E.M.	7.5
19	Bhikhu Ruda Dabhi	Irrigation	3.24	26	25	3.00	E.M.	5
20	Karasan Sidi Vadher	Irrigation	3.04	20	19	3.00	D.E.	5
21	Natha Manda Vadher	Irrigation	4.05	25	22	4.00	D.E.	5
22	Ramsi Sidi Vadher	Irrigation	3.44	22	21	3.00	D.E.	5
23	Bhima Govind Vadher	Irrigation	2.23	16	15	3.00	D.E.	5
24	Jiva Karashan Vadher	Not in Use	3.04	35	32	3.00	E.M.	7.5
25	Kanji Saraman Vaja	Irrigation	3.04	8	7	2.50		
26	Lakhaman Ghodadra	Irrigation	3.64	9	8	3.00	E.M.	5
27	Dhiru Mepa Ghodadra	Irrigation	2.63	35	34	3.00	E.M.	7.5

Well wise details are given in Table 2.46 Limestone occurs as aquifer in most of the wells. Further, well litholog data shows limestone occurs at various depth in wells generally two to three layers of limestone occurs in the village. The hardness of the limestone increases along with dpeht that results in decrese in porosity and ultimately decrease in yield.

Table 2.47 Details of Aquifer, Village Khera

Aquifer	Position Wise Thickness (M)		
	1st	2nd	3th
Alluvium	1.00 – 4.0		
Lime Stone	1.00 – 15.0	1.5 – 19.5	17.0 – 18.0

Table 2.48 Well Litholog of Khera Village

Well Code	Litholog Details									TDS ppm
	Total Layers (No.)	1st	Th. M	2nd	Th. m	3rd	Th. M	4th	Th. m	
1	4	Soil	2.00	L.St.	3.00	Clay	3.00	L.St.	18	630
2	2	Soil	2.00	L.St.	15.00					600
3	2	Soil	2.00	L.St.	19.00					620
4	4	Soil	4.00	L.St.	1.50	Clay	2.00	L.St.	17.5	1080
5	3	Soil	3.00	L.St.	4.00	Clay	29.00			720
6	3	Soil	4.00	L.St.	2.00	Clay	20.00			1000
7	2	Soil	3.00	Clay	27.00					770
8	3	Soil	3.00	L.St.	12.00	Clay	15.00			840
9	3	Soil	2.00	L.St.	13.00	Clay	21.00			610
10	3	Soil	2.00	L.St.	11.00	Clay	17.00			600
11	3	Soil	2.00	L.St.	13.00	Clay	15.00			1000
12	3	Soil	4.00	L.St.	15.00	Clay	15.00			800
13	3	Soil	2.00	L.St.	10.00	Clay	20.00			950
14	3	Soil	3.00	L.St.	12.00	Clay	18.00			910
15	3	Soil	4.00	L.St.	15.00	Clay	17.00			1000
16	3	Soil	3.00	L.St.	5.00	Clay	17.00			900
17	3	Soil	4.00	L.St.	16.00	Clay	10.00			830
18	3	Soil	4.00	L.St.	11.00	Clay	10.00			920
19	2	Clay	13.00	L.St.	12.00					950
20	3	Soil	2.00	L.St.	6.00	Clay	12.00			600
21	3	Soil	1.50	L.St.	19.50	Clay	4.00			850
22	3	Soil	1.00	L.St.	15.00	Clay	6.00			800
23	2	Soil	2.00	L.St.	13.00					770
24	2	L.St.	15.00	Clay	20.00					1400
25	2	L.St.	3.50	L.St.	4.50					930
26	3	Soil	2.00	L.St.	3.00	Clay	4.00			700
27	2	L.St.	1.00	Clay	23.00					800

Impact on Groundwater: Impact on groundwater due to implementation of percolation tank in village Khera has assessed with different methods i.e. by computing hydro-graphs (Fig. 2.33), preparation of trend showing maps such as Iso RWL maps (Fig. 2.34), Iso TDS (Fig. 2.36) maps and map of groundwater flow direction (Fig. 2.35) as well as comperative analysis of water levels and water quality in different seasons. In addition to all this approaches people's view have also considered for observed changes. Following are major impacts observed in village Khera after the construction of structure.

- Raise in water levels up to 1 m has observed in OWs no 4,6,9,11, and 22 whereas 2 m rise in OW no 16 from pre monsoon season of year 2012 to pre monsoon season of year 2013 (Fig. 2.33 and Table 2.49)
- Similarly decrese in TDS concentrations (more than 160 ppm) in pre to pre monsoon seasons has observed in OW no 6, 12 and 22.
- Iso-RWL maps shows increasing areas of subsurface low conditions in north of the structure i.e. RWL zone of 5-10 m (Fig. 2.34)
- Furthere Iso-RWL maps clearly shows water table remain maintained withing RWL zone of 20-30 m in immediate area of CADP WRM structure. This stable situation may be due to groundwater flows in to this zone from all directions. (Fig. 2.35)

- Iso TDS zoning shows in all the seasons TDS remains less than 1500 ppm however, in post mosoon season of year 2012 in some area the concentration increases more than 1500 ppm, eventhough the maximum TDS concentration in the area is not more than 2000 ppm

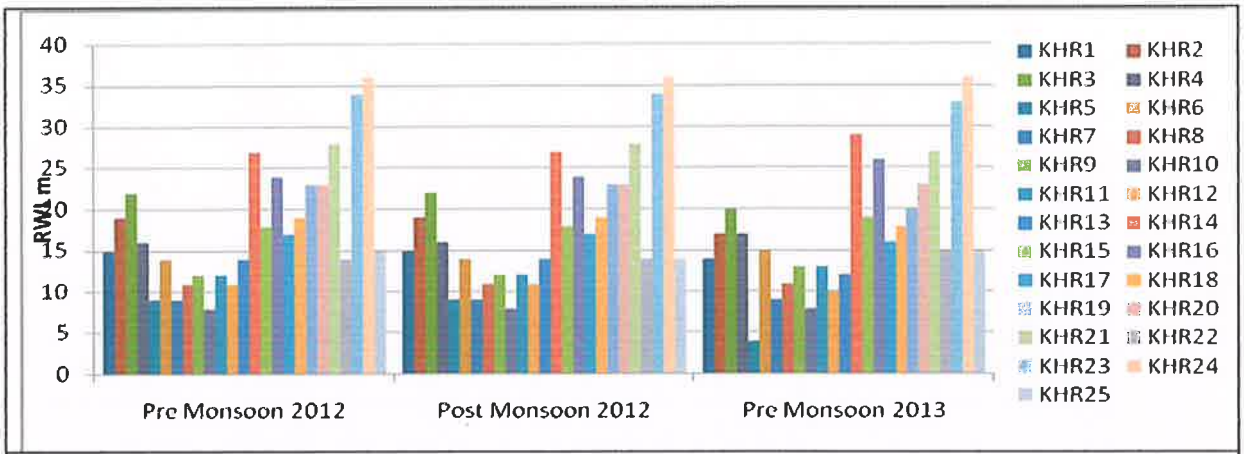


Fig. 2.33 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Khera, Year 2012, 2013

Table 2.49 Details of changes in RWL and Water Quality, Village Khera, 2012

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
1	15	15	14	630	680	730
2	19	19	17	600	1080	---
3	22	22	20	620	940	940
4	16	16	17	1080	1040	1200
5	9	9	4	720	1070	1030
6	14	14	15	1000	820	820
7	9	9	9	610	1230	1250
8	11	11	11	600	990	1100
9	12	12	13	1000	1030	1260
10	8	8	8	800	1090	1090
11	12	12	13	950	980	1030
12	11	11	10	910	750	750
13	14	14	12	1000	1060	1300
14	27	27	29	900	930	980
15	18	18	19	830	890	1230
16	24	24	26	920	1120	1320
17	17	17	16	950	910	1030
18	19	19	18	600	790	850
19	23	23	20	850	1020	1320
20	23	23	23	800	1100	1260
21	28	28	27	770	880	900
22	14	14	15	1400	1080	1220
23	34	34	33	930	1990	1990
24	36	36	36	700	980	980
25	15	14	15	800	1050	1050

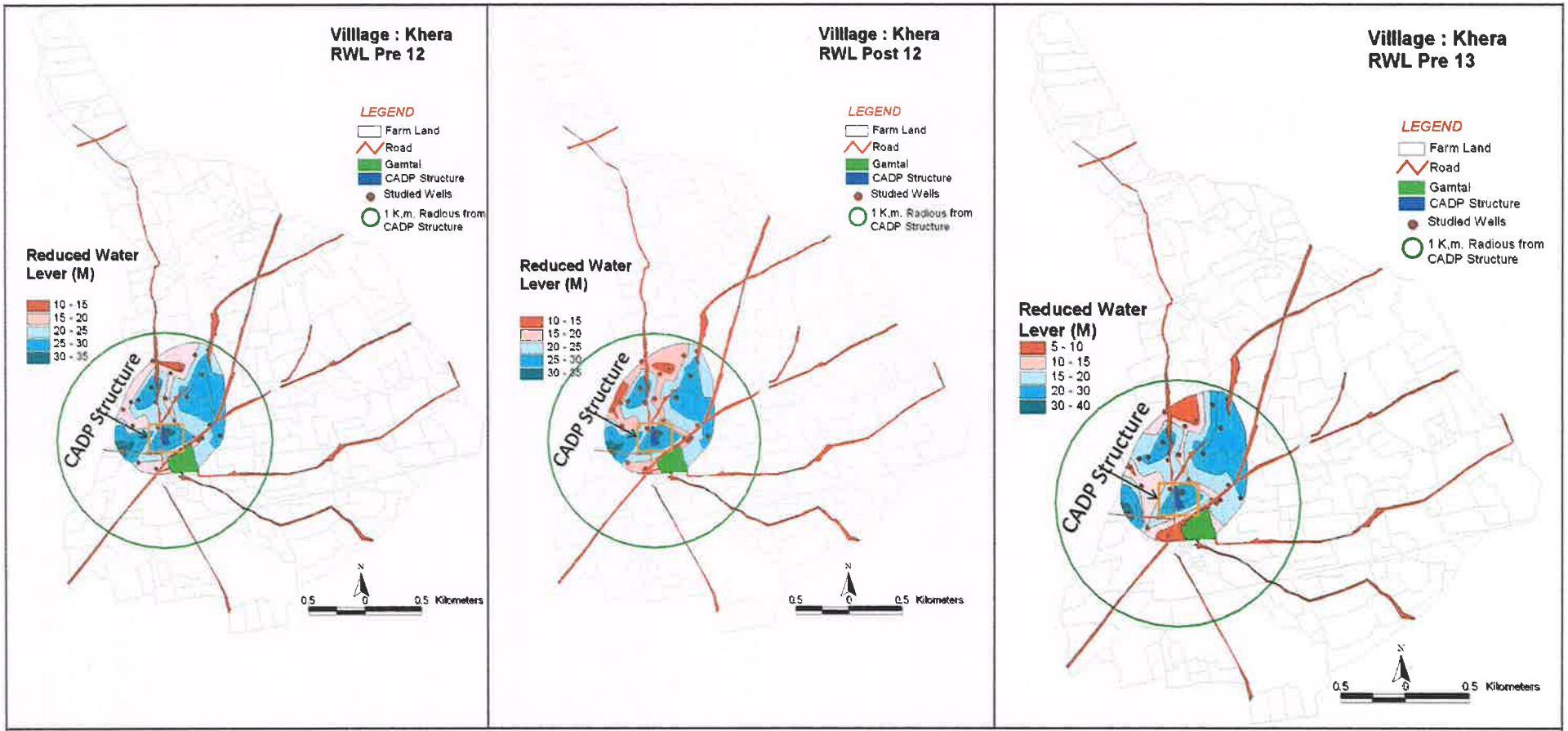


Fig. 2.34 Pre and Post Monsoon Iso RWL Maps of Village Khera, Year 2012, 2013

Fig. 2.35 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Khera, (Year 2012, 2013)

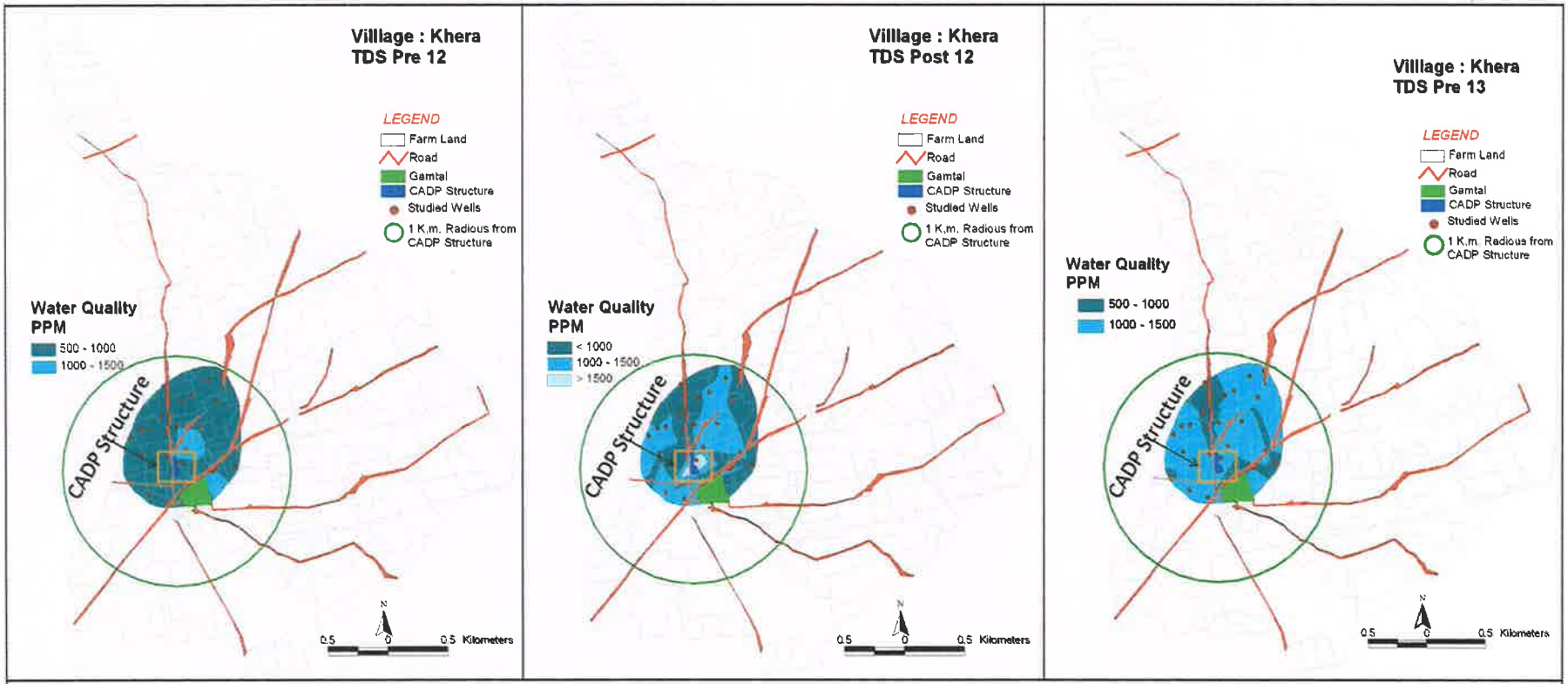


Fig. 2.36 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Khera, (Year 2012, 2013)

Socio-Economic Impact: Socio-economic impact of the WRM structure has also been understood by holding group discussions with village people and sampe house hold surveys of farmers having their land within the studry area. The facts came out as a results of group discussions are (01) there is an average 2.5 to 3 m rise in water level in around one km areas of structure; (02) drinking water tube well is also benefited in term of quality due to its location in downstream side of structure; (03) due to recharge water quality has gradually improved; (04) full availability of water is now in summer season also, earlier there was a shortfall of water this has helped farmer to secure their crops in winter and summer seasons; and (05) increase in per hacter productivity in all the crops. (Table 2.51)

Table 2.50 Before and and After Status of Drinking Water and Asset in Khera

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Seasonal Problem	Shortage in summer	Available in summer
	Source	Open well and Tube well	Open well and Tubewell
	Quantity	Insufficient	Sufficient
	Accessibility	Tape	Tape
	Quality	Brakish in summer Flouride problem	Flouride problem
	For Livestock	Yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	10	10
	Cattle Shed	300	300
	Tractor	10	10
	Two Wheeler	200	200
	Diesel Engine	50	50
	Electric Pump	170	175

Table 2.51 Before and After Changes in Cropping Area and Production in Khera

Season	**Before Structure**			**After Structure**		**Change**	
	Crop	**Area Ha**	**Prod. Kg/Ha**	**Area Ha**	**Prod. Kg/Ha**	**Area Ha**	**Prod. Kg/Ha**
Kharif	Groundnut	1200	2000	1200	2200	0	200
Rabi	Wheat	800	3000	800	3500	0	500
Summer	Green gramm	100	1500	100	1800	0	300
	Pearl Millet	100	2500	100	3000	0	500
	sesame	100	1500	100	2500	0	1000

To understand impact at house hold level three farmer's survey has held. (Table 2.52) according to this survey two farmers now have water availability for all three seasons whereas one farmer still have no water availability during summer. It is important to notice that the farmers have water in all seasons have also changed their irrigation method from flood irrigation to now sprinkler method. As far as increase in productivity, in case two farmers i.e. Karshanbhai and Ajitbhai groundnut production per hacter has increased up tp 800 and 200 Kg/Ha respectively.

Table 2.52 Case Studies on Before and After Changes at House Hold Level Khera

Name of the Farmer				Karshanbhai Vasan		Ajitbhai Dabhi		Kanji Koli	
Total Family Members (No)				4		7		5	
Land holding	Type			Area Ha		Area Ha		Area Ha	
	Irrigated			3.6		1		1	
	Non Irrigated			0		0		0	
	Waste land			0		0		0	
	Total			3.6		1		1	
Change in Crop	Season	Crop	Period	Area Ha	Prod. KG/ha	Area Ha	Prod. KG/ha	Area Ha	Prod. KG/ha
	Kharif	Bajra	Before			1	1200	0	0
			After			1	1200	0	0
			Change	0	0	0	0	0	0
		Groundnut	Before	3.6	1200	1	1100	1	2000
			After	3.6	2000	1	1300	1	2000
			Change	0	800	0	200	0	0
	Rabi	Wheat	Before	2	880	1	3000	0.7	2200
			After	2	880	1	3500	0.7	2500
			Change	0	0	0	500	0	300
		Bajra	Before	0.6	2000	0	0	0.4	5000
			After	0.6	2000	0	0	0.4	5000
			Change	0	0	0	0	0	0
		Sorghum	Before	0.4	2000	0	0	0	0
			After	0.4	2000	0	0	0	0
			Change	0	0	0	0	0	0
	Summer	Sesame	Before	0.4	1200	0	0	0	0
			After	0.4	1200	0	0	0.6	1000
			Change	0	0	0	0	0.6	1000
Livestock	Type			No.		No.		No.	
	Cow			1		0		0	
	Buffalo			1		0		1	
	Bullock			2		0		0	
Change in Source of Irrigation	Type		Before	Open Well		Open Well		Open Well	
			After	Open Well		Open Well		Open Well	
	Change in supply		Before	Available for Kharif		Available for Kharif		Available for Kharif only	
			After	Available for all seasons		Available for Kharif & rabi		Available for all seasons	
	Irri. Method		Before	Flood		Flood		Flood	
			After	Sprinkler		Flood		Sprinkler	
Income (Profit Rs.)			Before	150000		60000		70000	
			After	200000		75000		80000	
Changes in Asset	House		Before	Pakka 2 No.		Pakka 2 No.		Pakka 1 No.	
			After	Pakka 2 No.		Pakka 2 No.		Pakka 1 No.	
	Vehicle		Before	Two Wheeler 1 No		Two Wheeler 1 No		------	
			After						
	Plaughing equipment		Before	Bullock		Bullock		Bullock	
			After	Bullock		Bullock		Bullock	
	Lifting Device		Before	Ele. M. 7.5 HP		Ele. M 5 HP		D. E. 5 HP	
			After	Ele. M. 7.5 HP		Ele. M 5 HP		D. E. 5 HP	

2.3 VIVEKANAND RESEARCH AND TRAINING INSTITUTE PROJECT VILLAGES

Under CADP pgogram in coastal area of Saurashtra, Shri Vivekanand Research and Training Institute (VRTI) has implemented various activities in four villages (01) Ganjavadar; (02) Untiya; (03) Fachariya and (04) Pichhadi of Rajula Taluka have been selected to assess impact of WRM structure on groundwter ans socio-economic aspects of the villages. Table 2.53 shows village wise salient features of different structure constructed by AKRSP. Constructors of all structures has completed in the year 2012. AKRSP has constructed two percolation tabk in these villages. Village wise detail impact assessment has given here.

Table 2.53 Village Wise Structure Wise Salient Features

Village	Ganjavadar	Untiya	Pichhadi	Fachariya
Type Of Structure	Spillway	Checkdam	Checkdam	Checkdam
Height (M)	1.3	2.16	1.47	1.25
Lenght (M)	12	14	13	25.15
Bund Lenght (M)	33.5	16	36.25	0
Storage capacity (MCM)	0.09	0.22	0.1	0.14
HFL (M)	1	1	0.75	0.8
Catchment Area (Ha)	300	300	400	600
Objective	Reacharge	Reacharge	Reacharge	Reacharge
Starting year	2011	2011	2011	2011
Completion year	2011	2011	2011	2011
Cost (Rs.)	469080	255331	251900	323600

2.3.1 GANJAVADAR SPILLWAY

General Information: A spillway has constructed by VRTI in village Ganjavadar of Rajula Taluka of Amreli District for groundwater recharge purpose. (Fig. 2.37 and 2.38) Total population of the village is about 156 persons. The total land area of the village is 430.45 ha. About 87 % of the total land is under rainfed or un irrigated agriculture areas. Table 2.54.

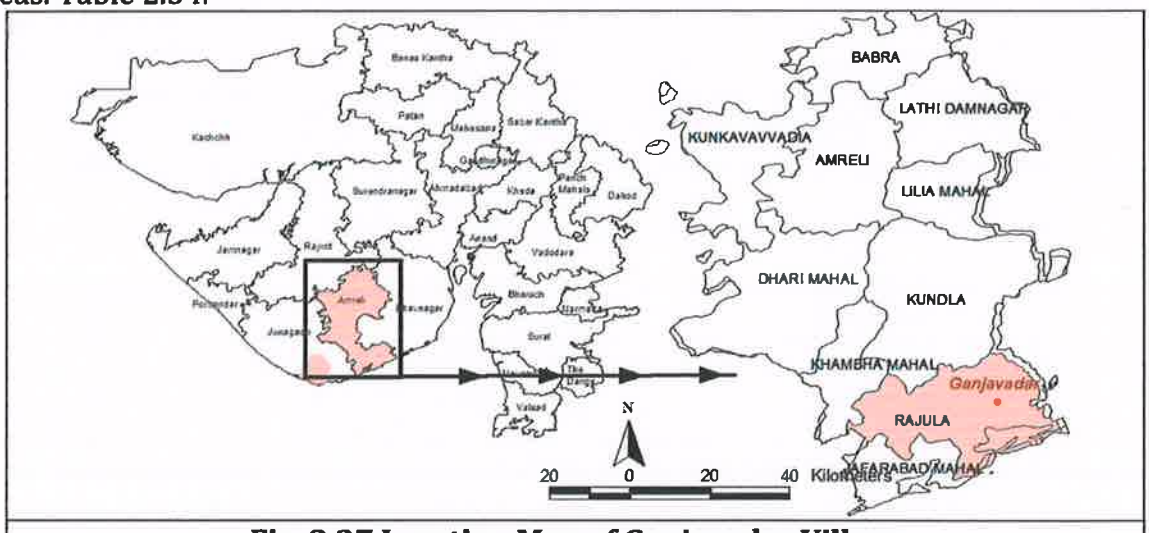
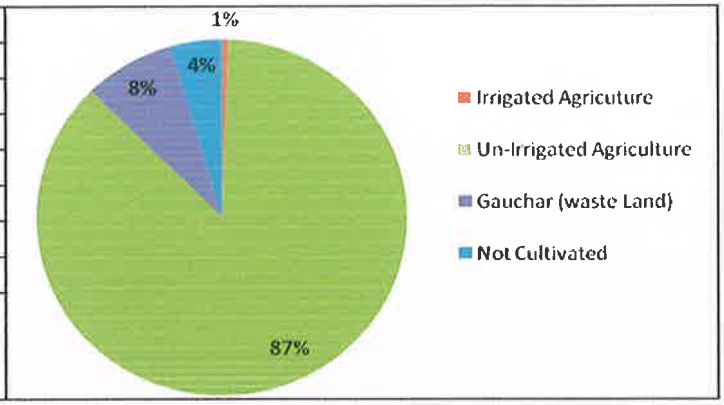


Fig. 2.37 Location Map of Ganjavadar Village

Table 2.54 Demographic and Land use Pattern of Ganjavadar, Tal. Rajula, Dist. Amreli

Population	Male	81
	Female	75
	Total	**156**
Land Use (Ha)	Forest	0
	Irr.Agri.	2.37
	Un-Irrigated	374.51
	Waste Lands	34.27
	Non Cultivation	19.30
	Total	**430.45**



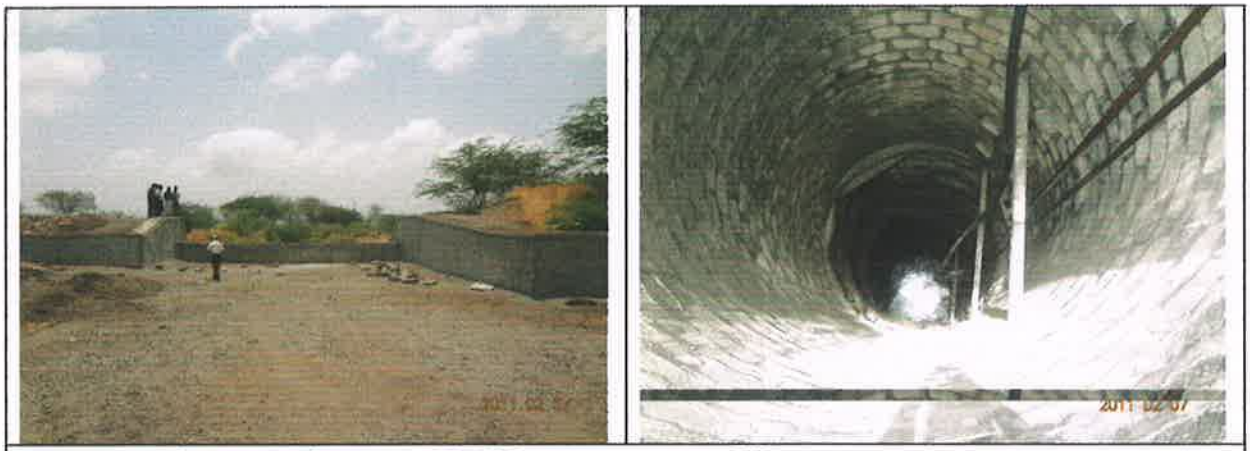


Plate 2.7 Photographs show WRM Strucutre and Water Level in Observation Well

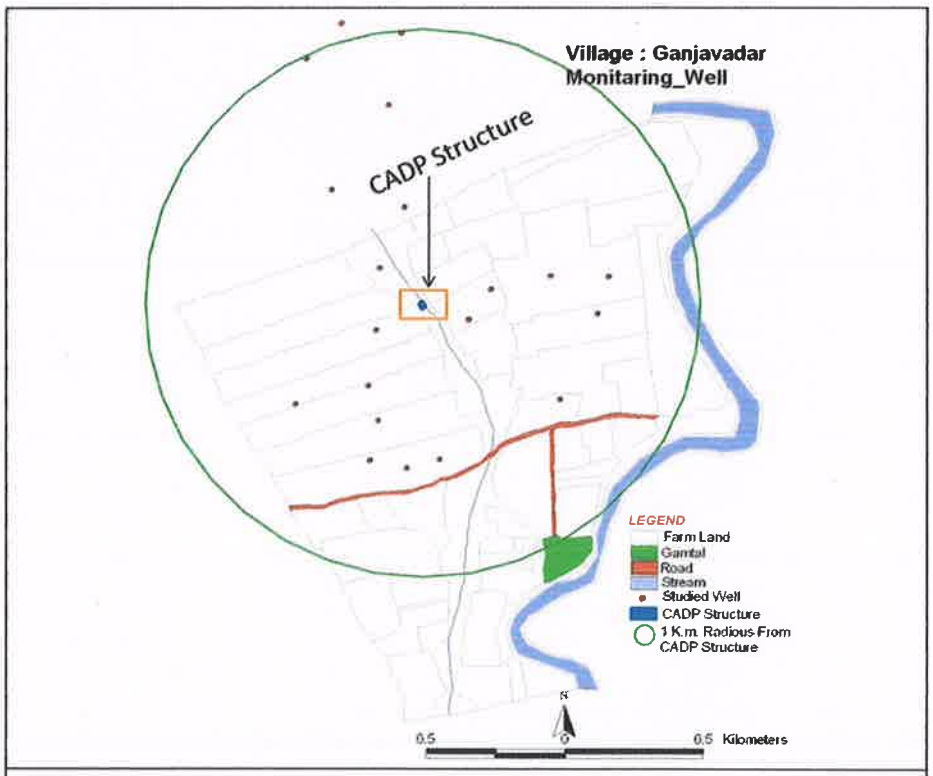


Fig. No. 2.38 Location Map of Studied Wells Vill. Ganjavadar

Geology and Hyro-geology: Geologically the Ganjavadar area shows Deccan Trap basalt as dominant geological formation. At places the basalt is coverd with moderately thick (average 5 m) clayey and sandy alluvium. Terrain wise the are can characterizes undulating pediment area. To understand subsurface geological condition and hydro-geological characters of the area 21 wells have studied. (Table 2.55, 2.56 and 2.57) Use wise all the wells are used for dual purposes of irrigation and drinking water supply. Maximum depth of the well in the area is about 30 m whereas minimum is about 18 m. Depth of water table in the area ranges from 12 m to 19 m.

Table 2.55: Summary of Well Data, Village Ganjavadar

Total No of Well		21
Use	Only Irrigation	00
	Only Drinking	01
	Drinking& Irrigation	21
	Non Use	00
Pumping Device (No)	Diesel Engine	20
	Electric Motor	01
Total depth of well (m)	Max	30
	Min	18
Water Level (m)	Max	19
	Min	11.8
Monitoring		21

Table 2.56 Details of Studied Wells in Village Ganjavadar

Well Code	Owner name	Use	Irrigation (Ha)	Total Depth (M)	W.L. (M)	Di. M	Lifting Device	
							Type	hp
RG1	Dalabhai Ram	Irri. & Drinking	3.4	22	11.8	3.5	D.E	8
RG2	Laxmanbhai Rajabhai	Irri. & Drinking	0.5	20.2	14	3.5	D.E	10
RG3	Raja Pasabha Hejadiya	Irri. & Drinking	3.4	24.3	12.8	4	D.E	10
RG4	Gangajibhai Hadabhai	Irri. & Drinking	4.0	30	16	3	D.E	8
RG5	panchabhai Ahir	Irri. & Drinking	3.0	25	17.1	3	E.M.	6.5
RG6	Bachubhai Hadabhai	Irri. & Drinking	2.0	27.5	19	3.6	D.E	8
RG7	Gangajibhai Hadabhai	Irri. & Drinking	2.0	27	18	3	D.E	8
RG8		Irri. & Drinking	3.0	25	13.4	3	D.E	6
RG9	Pitha Sukhabhai Vagh	Irri. & Drinking	3.0	25	12.9	3	D.E	10
RG10	Jivanbhai Samatbhai	Irri. & Drinking	1.4	23	13	3.5	D.E	5
RG11	Alabhai Lakhabhai	Irri. & Drinking		22.6	13.9	2.6	D.E	10
RG12	Ajubhai Mulubhai	Irri. & Drinking	4.0	20.9	14.4	3.5	D.E	10
RG13	Rambhai Bagabhai	Irri. & Drinking	2.4	23.5	13	3	D.E	8
RG14	Jadurbhai Mulubhai	Irri. & Drinking	5.0	25	12.5	3.5	D.E	6
RG15	Sadurbhai Mulubhai	Irri. & Drinking	5.0	18	12.8	3.4	D.E	8
RG16	Jinabhai Vagh	Irri. & Drinking		26.6	12.8	3	D.E	8
RG17	Mulubhai Arjanbhai	Irri. & Drinking		23	13.5	4	D.E	10
RG18	Jinabhai Ambhai	Irri. & Drinking	5.2	18.5	13.5	3.5	D.E	8
RG19	Hamirbhai Desurbhai	Irri. & Drinking	2.0	21.5	14.7	3	D.E	6
RG20	Arjanbhia Mulabhai	Irri. & Drinking	5.4	21.1	13.2	4	D.E	8
RG21	Hamirbhai Vagh	Irri. & Drinking	3.0	23.2	13.4	3.5	D.E	10

Weathered and fracture basalts is only aquifer in the study area having thickness varies from 3 m to 20 m and 16 m to 22 m respectively. Well litholog (Table 2.58) clearly shows existance of two aquifers in some wells. Weathered basalt has discharge capacity ranges from 565 LPM to 1031 LPM dependeing on severity of weathering while in case of fracture basalt it is about 361 to 924 LPM.

Table 2.57: Details of Aquifer, Village Ganjavadar

Aquifer	Position Wise Thickness (M)			Discharge LPM
	1st	2nd	3rd	
Alluvium	1.00 – 5.6	--	--	--
Weathered Basalt	--	3.2 - 27	--	565-1031
Fractured Basalt	--	16.1 – 22.4	14.8-21.2	361-924

Impact on Groundwater: Impact on groundwater due to implementation of spill way in village Ganjavadar has assessed with different methods i.e. by computing hydro-graphs (Fig. 2.39), preparation of trend showing maps such as Iso RWL maps (Fig. 2.40), Iso TDS (Fig. 2.42) maps and map of groundwater flow direction (Fig. 2.41) as well as comperative analysis of water levels and water quality in different seasons. In addition to all this approaches people's view have also considered for observed changes. Following are major impacts observed in village Ganjavadar after the construction of structure.

Due to failure due to leakage of structure in Ganjavadar village it is very difficult to assess impact of structure in Ganjavadar. However depleting trend of RWL is may be regular withdrawal of groundwater. Similarly there is alos very marginal changes have seen all are on account of regular use of groundwater.

Table 2.58 Well Litholog of Ganjavadar Village

Well Code	Litholog Details							Discharge		Recharge	
	Layer (No.)	1st	Th. M	2nd	Th. M	3rd	Th. M	Hr.	LPM	Hr.	LPM
RG1	2	All.	4.7	F. Basalt	17.3			3	924	2.5	1109
RG2	2	All.	1.9	F. Basalt	18			1.5	1923	12	240
RG3	2	All.	3.3	W. Basalt	21			5	879	2	2198
RG4	2	All.	3	W. Basalt	27						
RG5	2	All.	5.6	W. Basalt	19.4			0.25	9137	24	95
RG6	3	All.	6.3	F. Basalt	21.2						
RG7	2	All.	3	W. Basalt	24			5	565	12	236
RG8	2	All.	3.4	Fr. Basalt	21.6						
RG9	2	All.	2.2	W. Basalt	22.8			1	2685	8	336
RG10	2	All.	3.7	W. Basalt	19.3			3	1031	5	619
RG11	3	All.	2	W. Basalt	3.7	F. Basalt	16.9				
RG12	2	All.	4.8	F. Basalt	16.1			4	641	8	321
RG13	2	All.	5	W. Basalt	18.5						
RG14	3	All.	3	W. Basalt	4.1	F. Basalt	17.9	8	361	4	721
RG15	2	All.	4.2	W. Basalt	13.8						
RG16	2	All.	4	F. Basalt	22.4						
RG17	3	All.	2	W. Basalt	3.2	F. Basalt	17.8				
RG18	2	All.	2	W. Basalt	16.5			4	661	3	881
RG19	3	All.	1	W. Basalt	3.6	F. Basalt	16.9	5	85	3	141
RG20	2	All.	2.5	W. Basalt	18.6			4	973	7	556
RG21	3	All.	1	W. Basalt	7.4	F. Basalt	14.8				

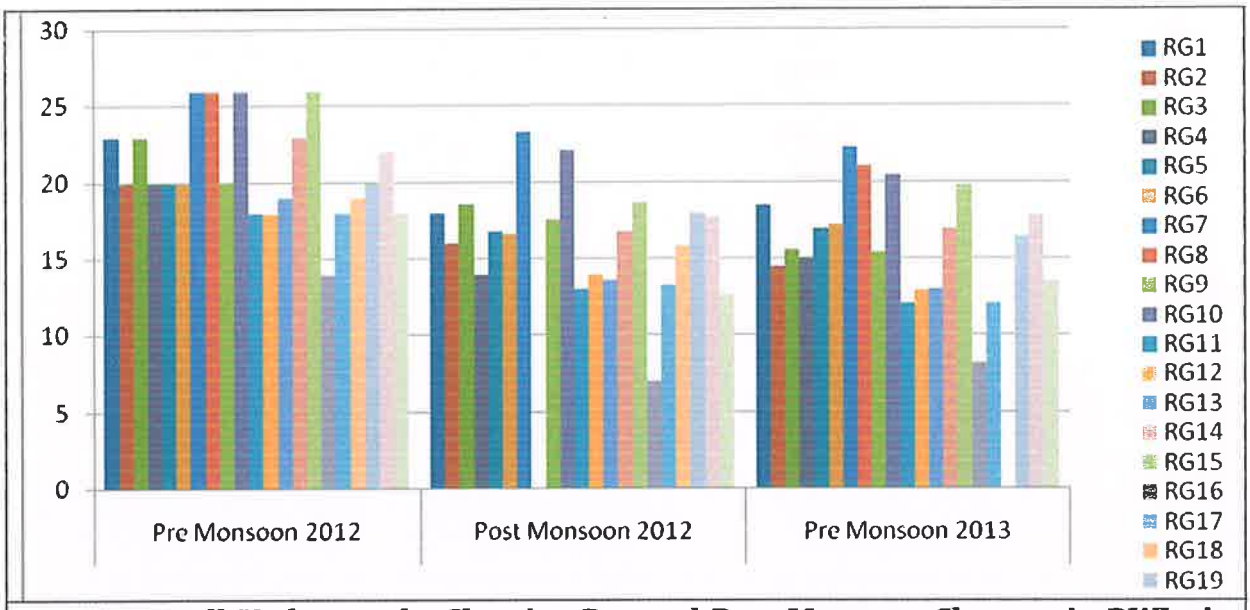


Fig. 2.39 Well Hydrographs Showing Pre and Post Monsoon Changes in RWLs in Observations Wells of Village Ganjavadar, Year 2012, 2013

Table 2.59: Details of changes in Water Level and Water Quality, Village Ganjavadar, 2012, 2013

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
RG1	23	18.0	18.5	1040	1500	1700
RG2	20	16.0	14.5	620	620	800
RG3	23	18.6	15.6	880	1180	1200
RG4	20	14.0	15.0	780	1210	1200
RG5	20	16.8	17.0	980	1600	1400
RG6	20	16.6	17.2	890	1600	1200
RG7	26	23.3	22.3	1020	1150	1800
RG8	26	Nill	21.1	710	Nill	1100
RG9	20	17.6	15.4	560	980	1100
RG10	26	22.1	20.5	810	1150	1200
RG11	18	13.0	12.1	900	1350	1300
RG12	18	14.0	12.9	600	1010	1000
RG13	19	13.6	13.0	830	1210	1200
RG14	23	16.8	17.0	950	1300	1400
RG15	26	18.7	19.8	920	1250	1400
RG16	14	7.0	8.2	1150	1250	1400
RG17	18	13.3	12.1	820	1130	1100
RG18	19	15.9	Nill	720	1090	Nill
RG19	20	18.0	16.5	840	1080	1100
RG20	22	17.7	17.8	920	1350	1300
RG21	18	12.7	13.5	990	1280	1400

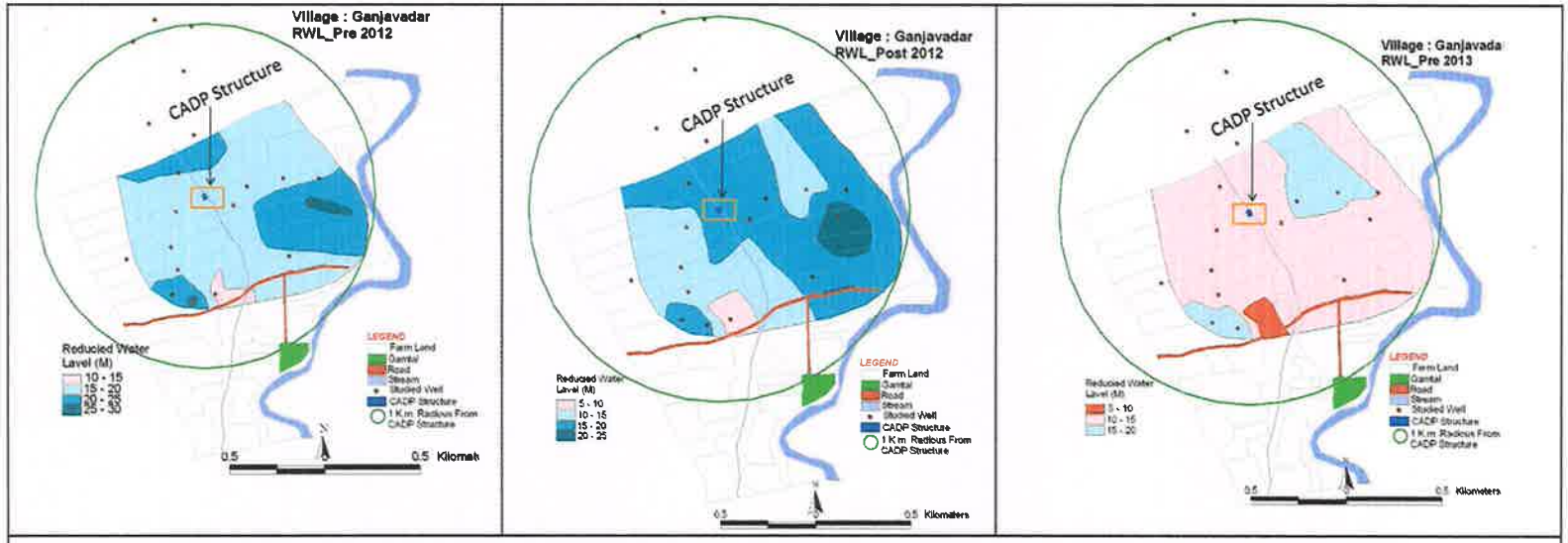


Fig. 2.40 Pre and Post Monsoon Iso RWL Maps of Village Ganjavadar, Year 2012, 2013

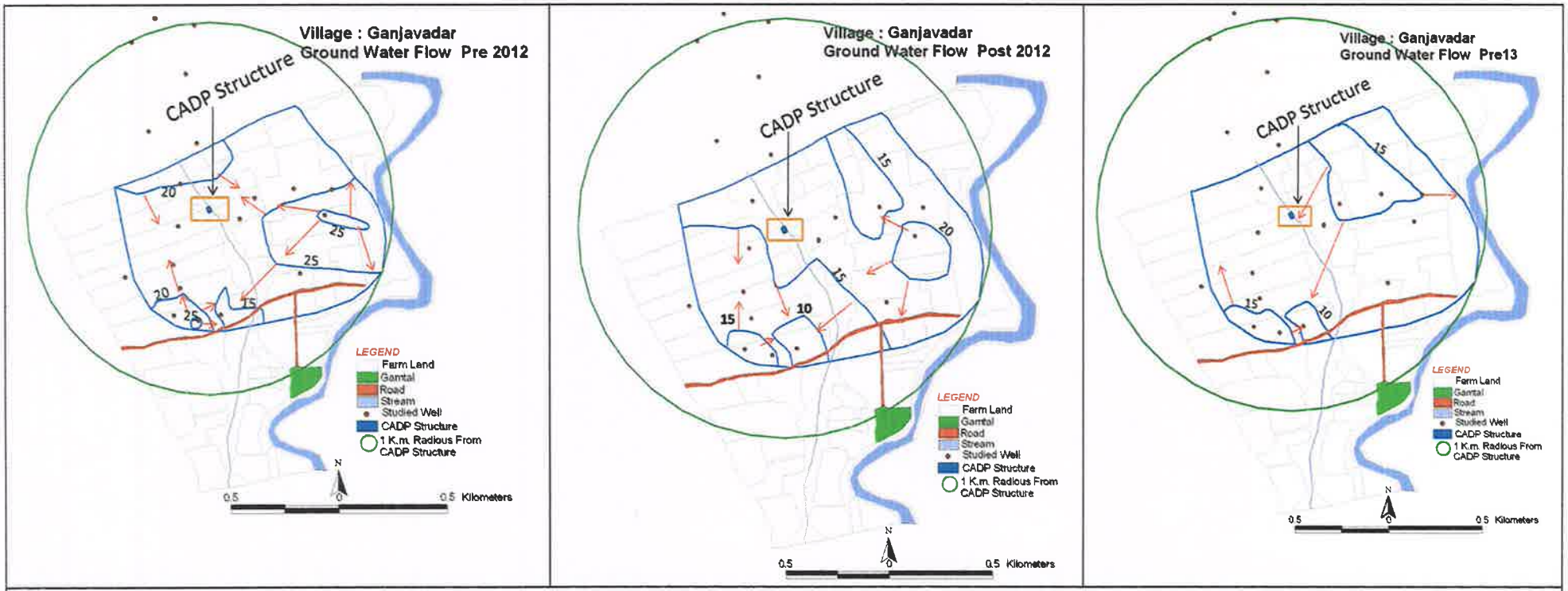


Fig. 2.41 Groundwater Flow Directions During Pre and Post Monsoon Seasons, Vill. Ganjavadar, (Year 2012, 2013)

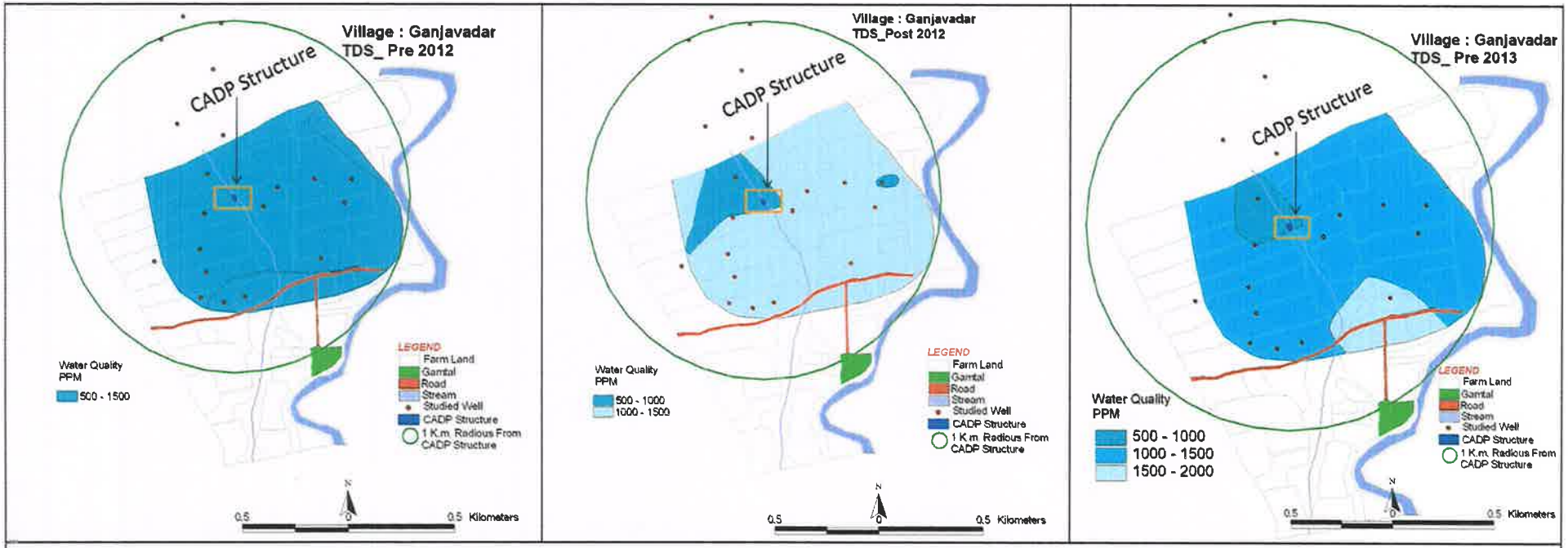


Fig. 2.42 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Ganjavadar, (Year 2012, 2013)

2.3.2 UNTIYA CHECKDAM

General Information: A recharge checkdam has constructed by VRTI in village Untiya of Rajula Taluka of Amreli District for groundwater recharge purpose. (Fig. 2.43 and 2.44) Total population of the village is about 771 persons. The total land area of the village is 238.86 ha. About 81 % of the total land is under rainfed or un irrigated agriculture areas. Table 2.54.

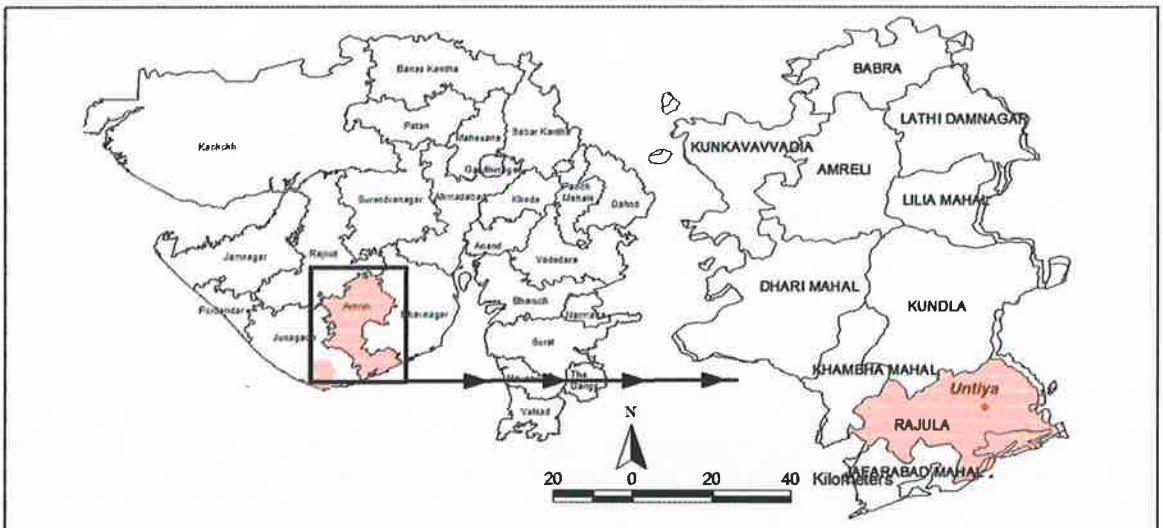


Fig. 2.43. Location Map of Untiya Village

Table 2.60 Demographic and Land use Pattern of Ganjavadar, Tal. Rajula, Dist. Amreli

Population	Male	390
	Female	381
	Total	**771**
Land Use (Ha)	Forest	0.00
	Irr.Agri.	1.69
	Un-Irrigated	193.38
	Waste Lands	8.92
	Non Cultivation	34.87
	Total	**238.86**

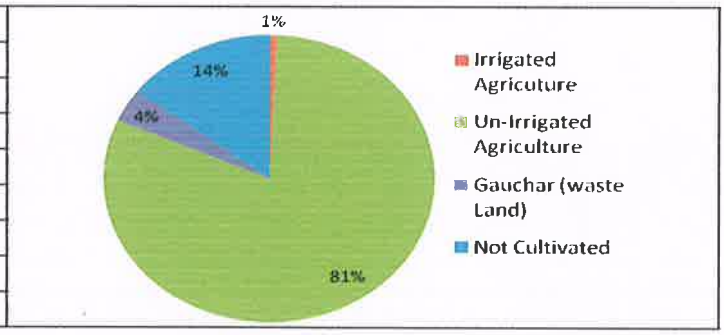


Plate 2.8 Photographs show WRM Strucutre in Village Untiya

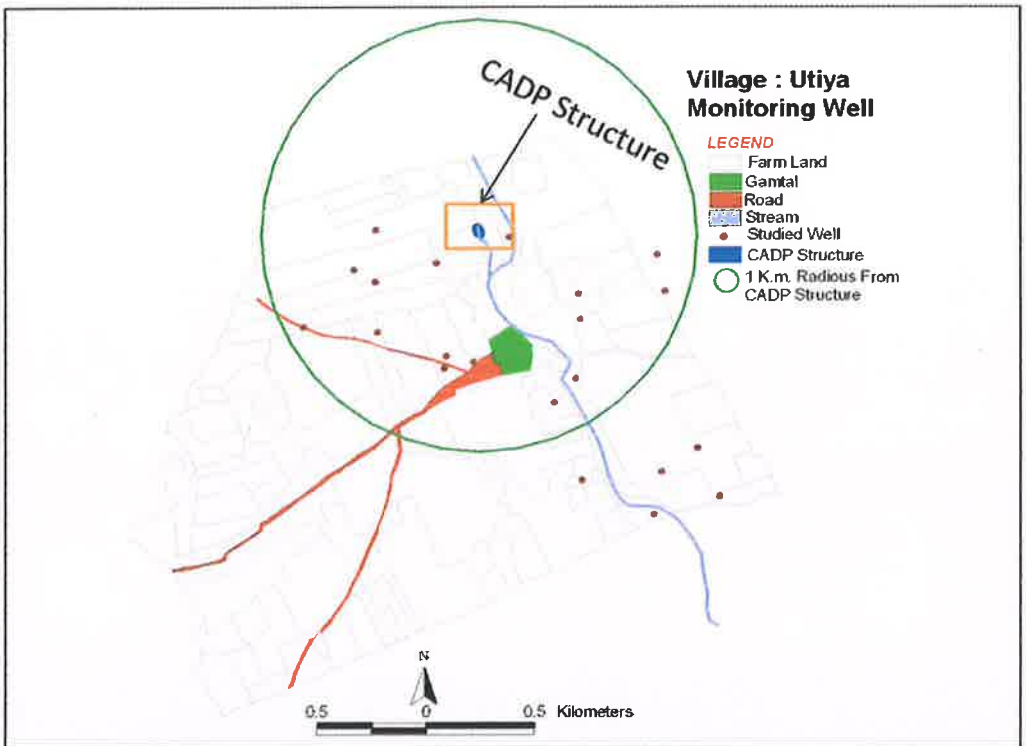


Fig. 2.44 Location Map of Studied Wells Vill. Untiya, Year 2012

Geology and Hyro-geology: Geologically the Untiya village shows Deccan Trap basalt with thin layers of alluvium (mainly black cottone soil). At places the basalt is capped with lateritization (*Tasudo*). Based on lithological observations in wells the thickness of different rock layers has measured as 1 to 8 M for soil; 4 to 20 m of weathered basalt and 12 to 17 m of fracture basalt. Weathered and fractured zones of basalts characterizes as good aquifer system for this area.

Table 2.61: Summary of Well Data, Village Untiya

Total No of Well		**21**
Use	Only Irrigation	00
	Only Drinking	01
	Drinking& Irrigation	20
	Non Use	00
Pumping Device (No.)	Diesel Engine	14
	Electric Motor	05
Total depth of well (m)	Max	26.6
	Min	8.55
Water Level (m)	Max	17.3
	Min	5.5
Monitoring		21

Well inventory of existing 21 wells have carried out during study to understand groundwater conditions in village. Most of the wells are functional in village and uses for irrigation as well as drinking purposes. There is one well exclusively use for drinking purpose. (Table 2.61) well wise details of ownerships, lifting device etc and lithologs are given in Table 2.56 and 2.57 respectively. Discharge of an aquifer has been measured during well inventory study, it varies depending upon thickness, and extent of weathering and fractures. However, the range of discharge for weathered basalt is 245 LPM to 746 LPM whereas it is for fractured basalt is about 895 LPM. (Table 2.57) It is important to notice that both the aquifer are phreatic in nature.

Table 2.62 Details of Studied Wells in Village Untiya

Well Code	Owner name	Use	Irr. (Ha)	T. Depth (m)	W. L. (M)	Di.M	Lifting Device	
							Type	hp
RU1	Punabhai Parmar	Irri. & Drinking	1.3	8.55	6.8	4.8	D.E.	8
RU2	Badhabhai Ahir	Irri. & Drinking	3.0	15.3	10.4	3	D.E.	8
RU3	Alabhai Ahir	Irri. & Drinking	4.4	13.4	9	3	D.E.	8
RU4	Lakhmanbhai Ahir	Irri. & Drinking	4.0	16.9	9.6	3	D.E.	8
RU5	Naranbhai Myatra	Irri. & Drinking	1.9	20	9.65	3	D.E.	8
RU6	Sadulbhai Nakabhai	Irri. & Drinking	2.4	22.8	12.4	3.5	D.E.	8
RU7	Naranbhai Myatra	Irri. & Drinking	3.0	21.2	12.9	4	D.E.	8
RU8	Vijanandbhai	Irri. & Drinking	1.4	20		2.5	E. M.	5
RU9	Nansurbhai	Irri. & Drinking	3.0	25	16	3	E. M.	5
RU10		Irri. & Drinking		23.2	15.2	3		
RU11		Irri. & Drinking		23.1	17.1	3.5	E. M.	5
RU12		Irri. & Drinking		25	16.8	3.5	D.E.	8
RU13	Harshukhbhai Bhagwan	Irri. & Drinking		24	17.3	3.5		
RU14	Harshukhbhai Lakhantra	Irri. & Drinking		20	14.4	3	E. M.	7.5
RU15	Baghabhai Lakhntra	Irri. & Drinking	2.0	21.1	17.1	3.5	D.E.	8
RU16	Gandabhai Lakhntra	Irri. & Drinking		17.1	13.1	3	D.E.	10
RU17		Irri. & Drinking	4.0	26.6	13	3	D.E.	8
RU18		Irri. & Drinking	3.0	23.2	13.8	3.5	D.E.	10
RU19		Irri. & Drinking		24	14.3	3.5	D.E.	10
RU20	Shankarbhai Bhagat	Irri. & Drinking	2.0	20	5.5	2.5	D.E.	5
RU21	Gram Panchayat	Irri. & Drinking		20	17.3	5	Sub.M.	7.5

Table 2.63 Well Litholog of Untiya Village

Well Code	Litholog							Discharge		Recharge	
	Layers (No.)	1st	Th. M	2nd	Th. M	3rd	Th. M	Hr.	LPM	Hr.	LPM
RU1	2	Soil	1.3	Laterite	11.25			2	1696	8	424
RU2	2	Soil	3.9	F. Basalt	11.4			1.5	895	7	192
RU3	2	Soil	2	W. Basalt	11.4						
RU4	2	Soil	2	W. Basalt	14.9			4	439	8	219
RU5	2	Soil	3.7	W. Basalt	16.8			8	247		
RU6	2	Soil	4	W. Basalt	18.8						
RU7	3	Soil	2.9	W. Basalt	5.1	F. Basalt	13.2				
RU8	2	Soil	5	W. Basalt	15			5	245	8	153
RU9	3	Soil	3	W. Basalt	5	F. Basalt	17				
RU10	3	Soil	5.5	F. Basalt	17.7						
RU11	2	Soil	3	W. Basalt	20.1						
RU12	2	Soil	5.4	W. Basalt	19.6						
RU13	2	Soil	3.9	W. Basalt	20.1						
RU14	2	Soil	1	W. Basalt	19			3	746	8	280
RU15	2	Soil	3.5	F. Basalt	17.6			1	2821	12	235
RU16	3	Soil	2.9	F. Basalt	2.7	W. Basalt	12.4				
RU17	2	Soil	8.1	F. Basalt	18.5						
RU18	2	Soil	7.1	F. Basalt	16.1						
RU19	3	Soil	2.1	W. Basalt	8	F. Basalt	13.9				
RU20	2	Soil	2	W. Basalt	18						
RU21	3	Soil	3	W. Basalt	4	F. Basalt	13				

Impact on Groundwater: Impact on groundwater due to construction of check dam has studied with the help of observations of wells for three successive seasons i.e. pre

and post monsoon seasons of year 2012 and pre monsoon season of year 2013. The observation data were interpreted in the from of hydro-graph, (Fig 2.45) Iso RWL maps, Groundwater flow maps and Iso TDS maps. In addition, observations of village people were also considered to report impact of the WRM structure in Untiya village. Table 2.58 shows seasonal changes in water level and water quality recorded from observation wells.

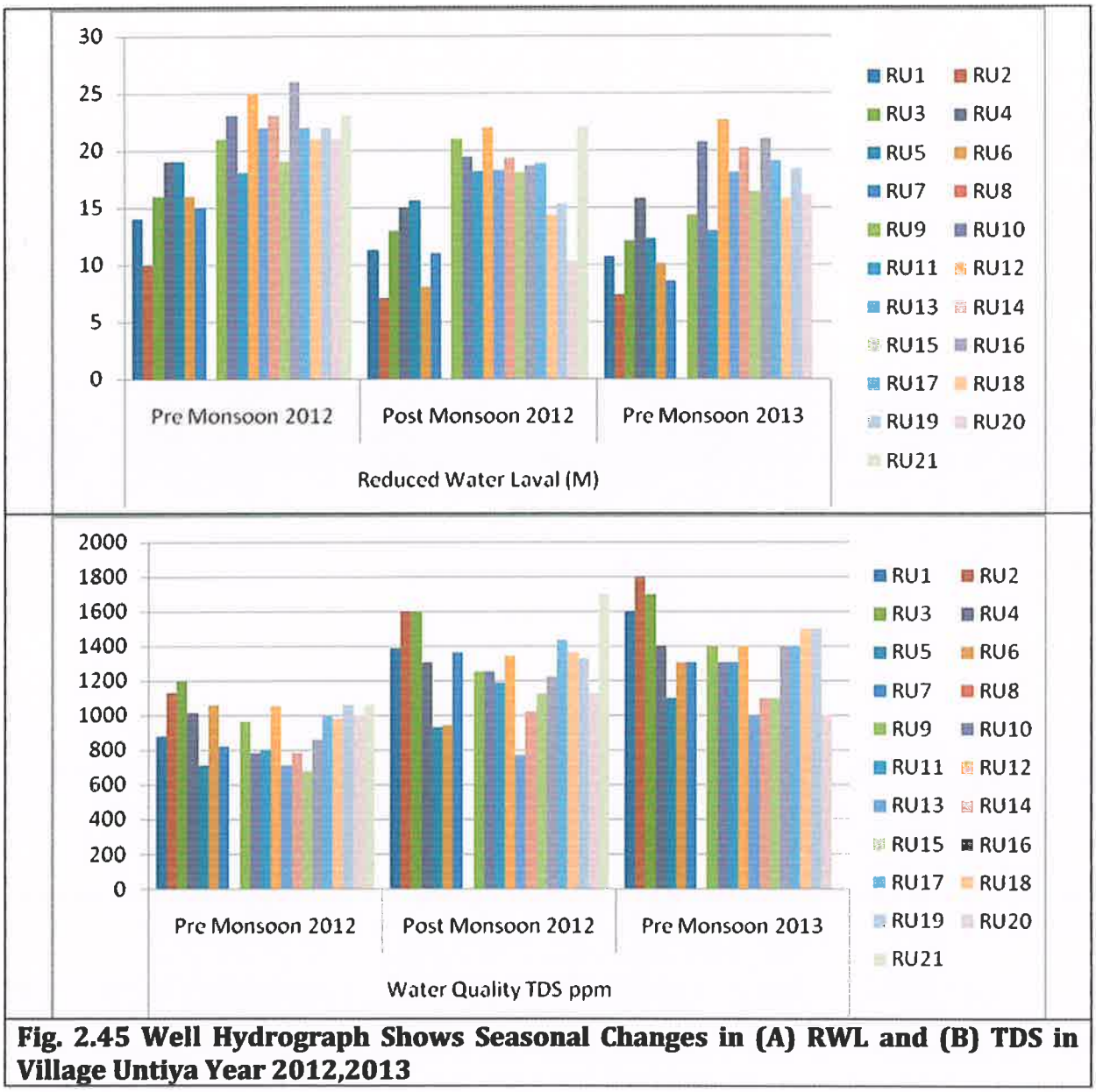


Fig. 2.45 Well Hydrograph Shows Seasonal Changes in (A) RWL and (B) TDS in Village Untiya Year 2012,2013

Based on observation data and its interpretation following changes can be seen in village Untiya in case of groundwater

- Water levels show gradual decreasing trends in all three seasons and in most of the wells
- TDS concentration gradually increases in groundwater.
- Iso RWL map of post monsoon season of year 2012 shows depletion in water table near WRM structure. This may be due to extraction of groundwater during Kharif season

- Iso TDS maps for all season shows gradual increase in TDS concentration in groundwater this may be the result of groundwater exploitations in the area.
- The fact of withdrawal during Kharif season has been proven by village people also and according to them due to recharge from structure water level and quality have improved that the farmers of the area now can provide critical irrigation to their crops in Kharif season.

Table **2.64: Details of Changes in Water Level and Water Quality, Village Untiya, 2012**

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
RU1	14	11.3	10.7	880	1390	1600
RU2	10	7.1	7.4	1130	1600	1800
RU3	16	12.9	12.1	1200	1600	1700
RU4	19	15.0	15.8	1010	1300	1400
RU5	19	15.6	12.3	710	930	1100
RU6	16	8.0	10.1	1060	940	1300
RU7	15	11.0	8.5	820	1360	1300
RU8	Nill	Nill	Nill	Nill	Nill	Nill
RU9	21	21.0	14.3	960	1250	1400
RU10	23	19.4	20.7	780	1250	1300
RU11	18	18.1	12.9	800	1190	1300
RU12	25	22.0	22.6	1050	1340	1400
RU13	22	18.2	18.0	710	770	1000
RU14	23	19.3	20.2	780	1020	1100
RU15	19	18.0	16.4	680	1120	1100
RU16	26	18.6	21.0	860	1220	1400
RU17	22	18.8	19.0	1000	1430	1400
RU18	21	14.3	15.8	980	1360	1500
RU19	22	15.3	18.3	1060	1330	1500
RU20	21	10.3	16.1	1000	1120	1000
RU21	23	22.1	Nill	1060	1700	Nill

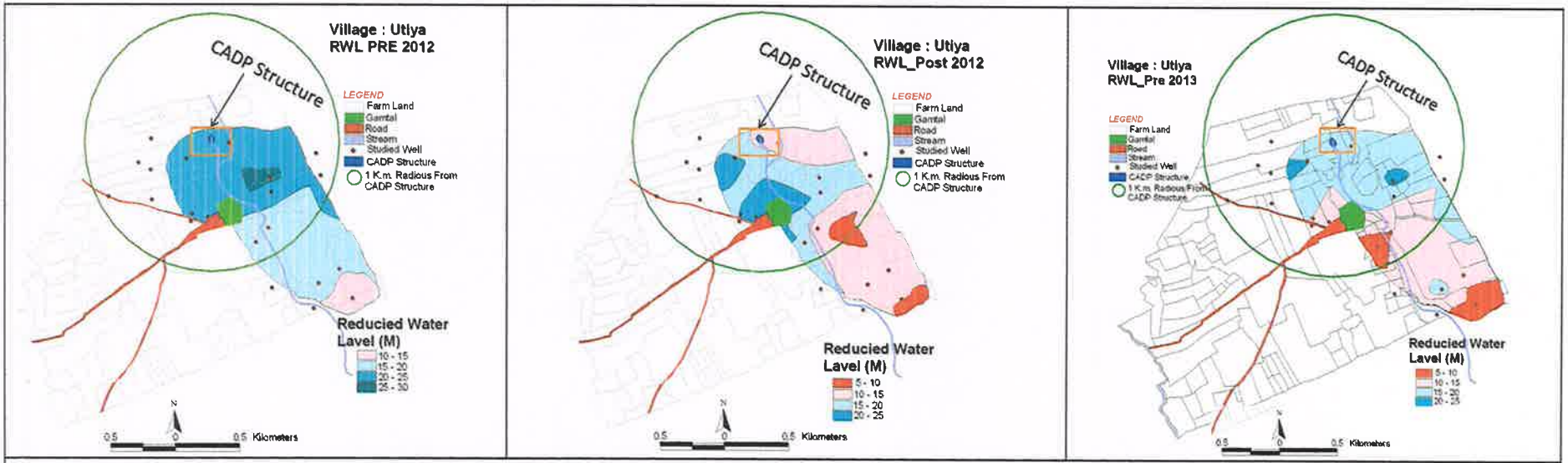


Fig. 2.46 Pre and Post Monsoon Iso RWL Maps of Village Untiya, Year 2012, 2013

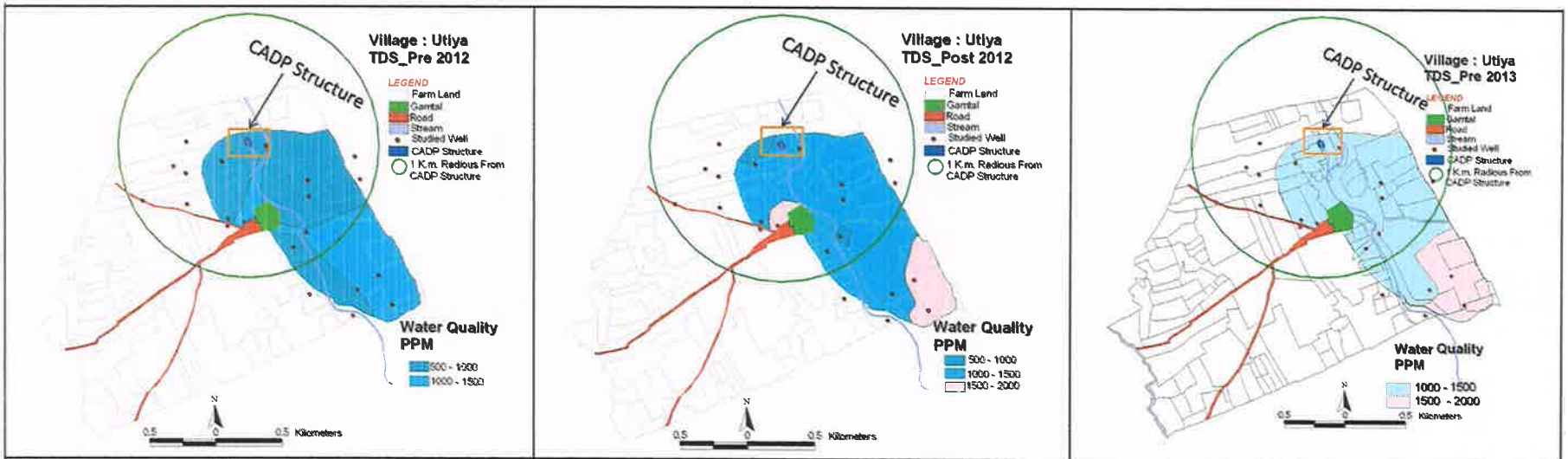


Fig. 2.47 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Untiya, (Year 2012, 2013)

Socio-Economic Impact: Socio-economic impact of the WRM structure has also been understood by holding group discussions with village people and sampe house hold surveys of farmers (3 farmers) having their land within the studry area. The facts came out as a results of group discussions are (01) there is an average 1 to 2 m rise in water level in around one half km areas of structure; (02) short fall of drinking water is still exist in village during summer season; (03) due to recharge water quality has gradually improved at levels that farmer can utilize it for Kharif season; (04) in case of good rainfall condition village have water for three seasons if not than for critical irrigation during Rab; (05) there is no any significant improvement in quality for drinking water; and (06) crop pattern shows changes in crop type during Kharif season earlier groundnut was important crop for Kharif season but now it is gradually replacing by sorghum. (Table 2.65 and 2.66)

Table 2.65 Before and and After Status of Drinking Water and Asset in Untiya

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Seasonal Problem	Shortage in summer	Shortage in summer
	Source	Hand pump and Open well	Hand pump and Open well
	Quantity	Insufficient	Insufficient
	Accessibility	Door step Hand pump	Door step Hand pump
	Quality	Flouride problem, brackish in summer	Flouride problem, brackish in summer
	For Livestock	yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	4	4
	Cattle Shed	140	160
	Tractor	8	8
	Two Wheeler	100	100
	Diesel Engine	100	100
	Electric Pump	3	7

Table 2.66 Before and After Changes in Cropping Area and Production in Untiya

Season	Before Structure			After Structure			Change	
	Crop	Area Ha	Prod. Kg/Ha	Crop	Area Ha	Prod. Kg/Ha	Area Ha	Prod. Kg/Ha
Kharif	Cotton	160	2500	Cotton	160	2500	0	0
	Pear Millet	40	3000	Pear Millet	40	3000	0	0
	Groundnut	200	2000	Sorghum	200	2500	0	0

To understand impact at house hold level three farmer's survey has held. (Table 2.67) according to this survey one farmers (Jivanbhai Parmar) sows cotton during Kharif and wheat during Rabi season while Tapubhai practices Kharif crops and vegetable (especially Onion). Any of case study does not show much increase in production per hacter.

Table 2.67 Case Studies on Before and After Changes at House Hold Level Untiya

Name of the Farmer				Jivanbhai Parmar		Tapubhai Ahir		Jikarbhai Ahir	
Caste				General		General		General	
Total Family Members (No)				4		4		4	
Land holding	Type			Area (Ha)		Area (Ha)		Area (Ha)	
	Irrigated			2		2		8	
	Non Irrigated			0		1		0	
	Waste land			0		0		0	
	Total			2		3		8	
Change in Crop	**Season**	Crop	Period	**Area Ha**	**Prod. KG/ha**	**Area Ha**	**Prod. KG/ha**	**Area Ha**	**Prod. KG/ha**
	Kharif	Bajra	Before	0	0	0.5	2000	0	0
			After	0	0	0.5	2000	0	0
			Change	0	0	0	0	0	0
		Cotton	Before	2	1500	2	2500	6	2500
			After	2	1700	0	2500	6	2500
			Change	0	200	0	0	0	0
	Rabi	Wheat	Before	1.5	400	0	0	0	0
			After	1.5	400	0	0	0	0
			Change	0	0	0	0	0	0
	Vegetable	Onion	Before	0	0	1	25000	0	0
			After	0	0	1	25000	0	0
			Change	0	0	0	0	0	0
Livestock		Type		0		0		0	
		Cow		0		1		1	
		Buffalo		1		1		3	
		Oxe		0		0		0	
Change in Source of Irrigation		Type	Before	Open well		Open well		Open well	
			After	Open well		Open well		Open well	
		Change in supply	Before	Three season water in good rainfall other wise two season		Three season water in good rainfall other wise two season		Three season water in good rainfall other wise two season	
			After	No Change		No Change		No Change	
Income (Profit Rs.)			Before	20000		20000		120000	
			After	20000		20000		120000	
Changes in Asset	**House**		Before	Pakka house		Pakka house		Pakka house	
			After	Pakka house		Pakka house		Pakka house	
	Vehicle		Before	Byke		Byke		Byke	
			After	Byke		Byke		Byke	
	Plaughing equipment		Before	Bullock		Bullock		Bullock	
			After	----		----		Tractor	
	Lifting Device		Before	D E. 5 HP		D E. 5 HP			
			After	D E. 5 HP		D E. 5 HP		E.M 7.5 HP	

2.3.3 PINCHHADI CHECKDAM

General Information: A checkdam construction activities has been implemented in village Pinchhadi of Jafrabad Taluka, Amreli District by Shri Vivekanand Research and Treaining Institute, Amreli unit. (Fig. 2.48 and 2.49) The checkdam has cost about 2,52,900 Rs and completed in the year 2011. Total population of the village is about 462 persons. The village spreads over about 633 Ha area where, dominant landuse is rainfed agriculture (446 Ha). Another dominant landuse type of village is non cultivation (21 % of total land) lands. (Table 2.68)

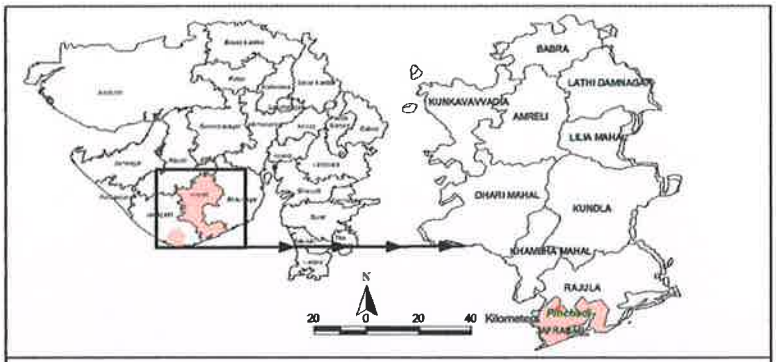


Fig. 2.48 Location Map of Pinchhadi Village

Table 2.68 Demographic and Land use Pattern of Pinchhadi, Tal. Jafrabad, Dist. Amreli

Population	Male	227
	Female	235
	Total	**462**
Land Use (Ha)	Forest	0.00
	Irr.Agri.	7.00
	Un-Irrigated	446.00
	Waste Lands	45.00
	Non Cultivation	135.15
	Total	**633.15**

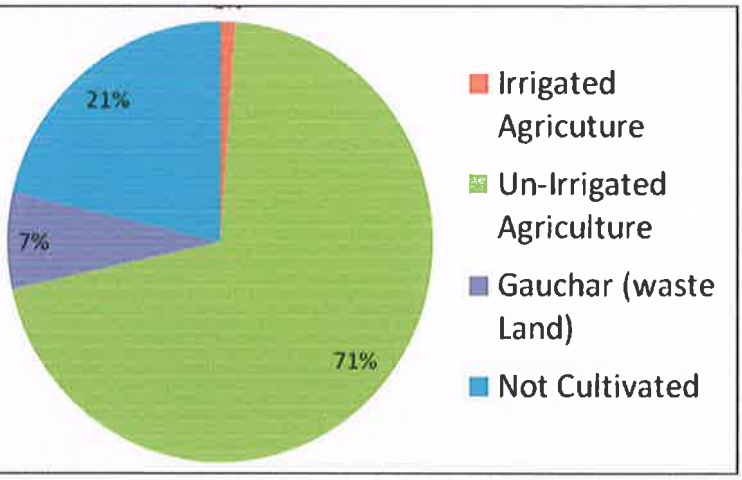


Plate 2.9 Photographs show WRM Strucutre and Water Levels in Vill. Pinchhadi

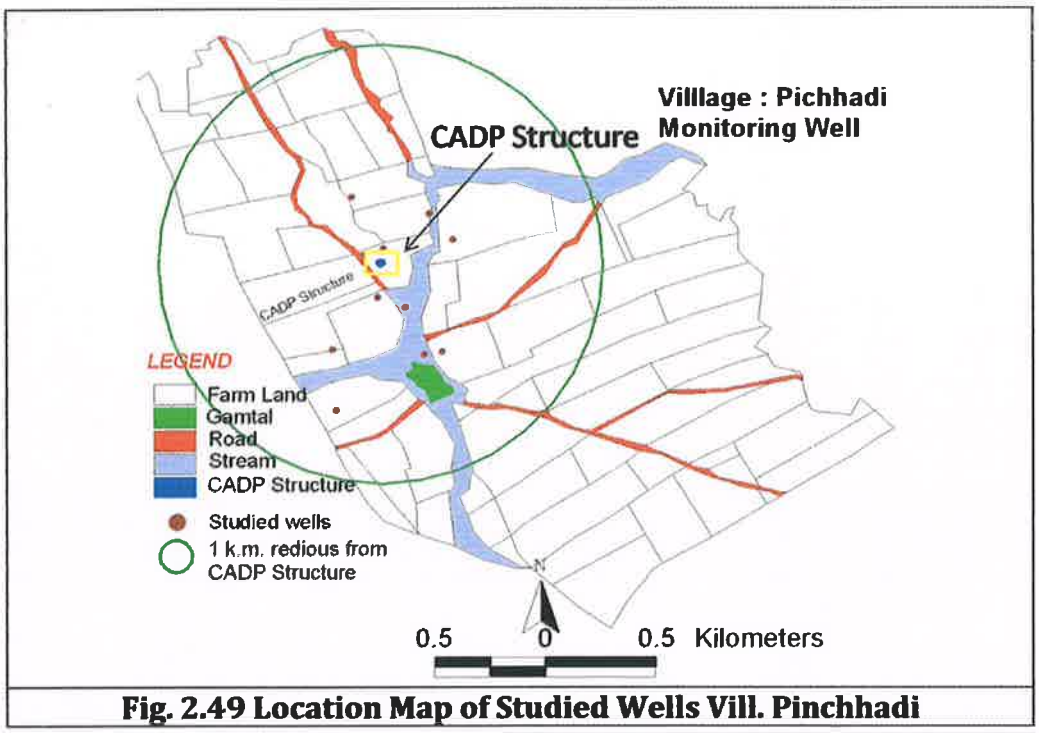


Fig. 2.49 Location Map of Studied Wells Vill. Pinchhadi

Geology and Hyro-geology: Geologically the area represents types of basalts of Deccan Trap formations. Weathered, fractured and compact basalts mainly occur in the village area. Well inventory data shows at places basalt is covered with 5 to 7 m thick alluvium characterized by clayey alluvium.

Table 2.69: Summary of Well Data, Village Pinchhadi

Total No of Well		11
Use	Only Irrigation	00
	Only Drinking	01
	Drinking& Irrigation	10
	Non Use	00
Pumping Device	Diesel Engine (No)	00
	Electric Motor	11
Total depth of well (m)	Max	27
	Min	15.4
Water Level (m)	Max	25.7
	Min	15.2
Monitoring		11

Table 2.70: Details of Studied Wells in Village Pinchhadi

Well Code	Owner name	Use	Irri. (Ha)	Total Depth (M)	W. L. (M)	Dia. (M)	Lifting Device	
							Type	HP
JP1	Panchayat	Drinking	0	22.5	20.8	6	S.M	5
JP2	Vinubhai Gangajaliya	Irri. & Drinking	25	18.2	16.3	3.8 X2.6	S.M	5
JP3	Javalben Gangajaliya	Irri. & Drinking	10	19.9	15.6	3.7	S.M	5
JP4	Mohanbhai Savjibhai	Irri. & Drinking	25	19.9	17.8	4.0X5.0	S.M	7.5
JP5	Shambhubhai	Irri. & Drinking	25	27.0	24.00	4.2X3.1	S.M	7.5
JP6	Dhanjibhai	Irri. & Drinking	10	17	16.4	3.2	S.M	5
JP7	Bhanubhai	Irri. & Drinking	30	22.2	19.5	4.3	S.M	5
JP8	Hathibhai Dhakhada	Irri. & Drinking	29	20.4	18.3	2.5X3.1	S.M	5
JP9	Madhubhai Sojitra	Irri. & Drinking	20	24.3	25.7	3.6	S.M	5
JP10	Kalabhai Padmabhai	Irri. & Drinking	5	20.7	17	3.6	S.M	5
JP11	Dhirubhai Bhagvanbhai	Irri. & Drinking	10	15.4	15.2	3.3X3.2	S.M	5

There are total eleven wells were studied and monitored to understand hydro-geological potential of the area. Most of the wells are utilizing by community for dual purposes like irrigation and drinking whereas only one Panchayat well is exclusively used for drinking purpose. (Table 2.69) Well wise details show that all the well have facility for water withdrawal as submarcible pump of capacity ranging from 5 to 7.5 HP. The maximum depth of the well is 27 m where as minimum is 15.4 m. similarly mzximum depth of water level in village is at 25.7 m whereas minimum is 15.2 m. (Table 2.70) Further consultations with the farmers during well inventory reveals that the wells become empty within 1 to 2 hrs that takes about 3 to4 hrs for filling and achieve pre pumping status of water levels. The more time for recharge the aquifer indicates its poor transmissibility and low yied.

Impact on Groundwater: To characterize hydro-geology of the area, to understand impact of WRM structure of Pinchhadi village, in terms of seasonal water level behavior, groundwater flows and water quality all the wells were monitored for three season of year 2012 and 2013. (Table 2.71)

Table 2.71: Details of changes in Water Level and Water Quality, Village Pinchhadi, Year 2012, 13

Well Code	Reduced Water Laval (M)			Water Quality TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
JP1	29.2	30.50	27.5	980	940	Nill
JP2	37.7	38.00	36.2	990	1006	1060
JP3	41.4	42.50	37.1	980	960	Nill
JP4	37.2	37.20	35.4	1030	1100	1120
JP5	28.9	31.60	26.6	1050	1060	1090
JP6	40.6	40.90	40.4	1070	980	1000
JP7	33.3	32.80	31.4	990	1130	1140
JP8	30.7	31.20	30.1	970	1110	1130
JP9	28.3	30.00	30.0	910	940	950
JP10	34.0	34.10	31.8	740	1030	1020
JP11	36.8	37.50	37.3	820	960	950

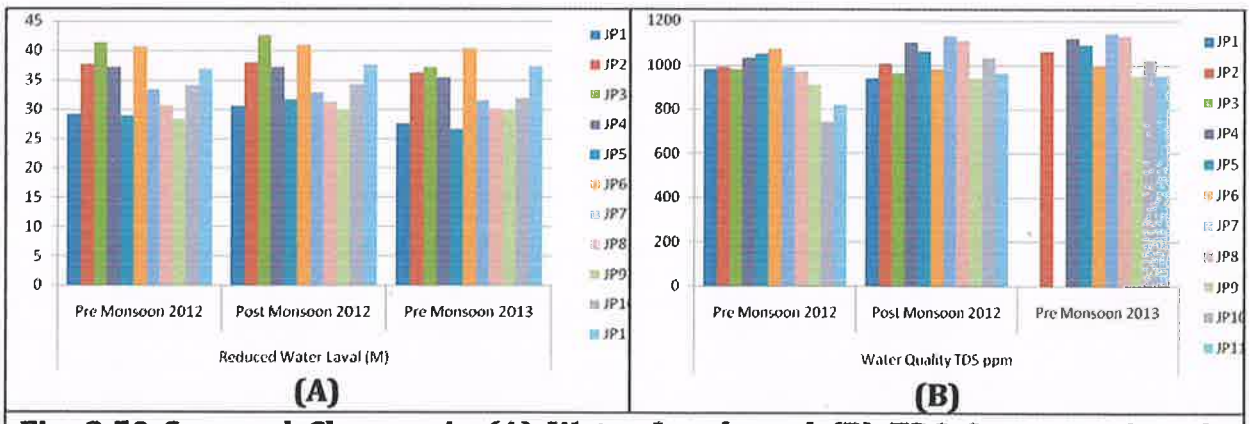


Fig. 2.50 Seasonal Changes in (A) Water Levels and (B) TDS Concnetrations in Wells of Pinchhidi (Year 2012,13)

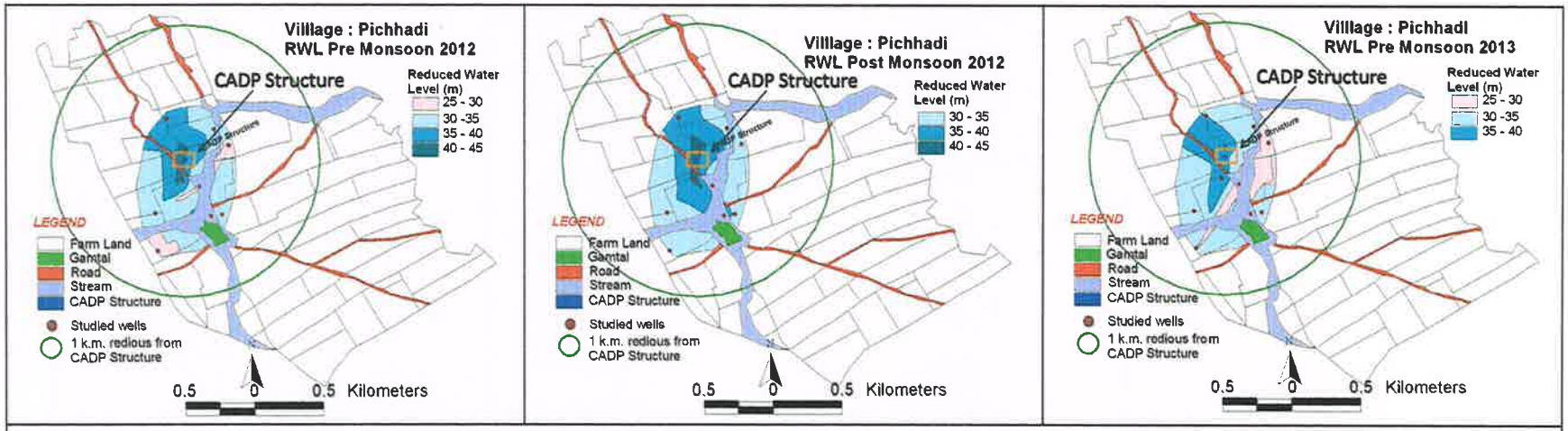


Fig. 2.51 Pre and Post Monsoon Iso RWL Maps of Village Pichhadi, Year 2012, 2013

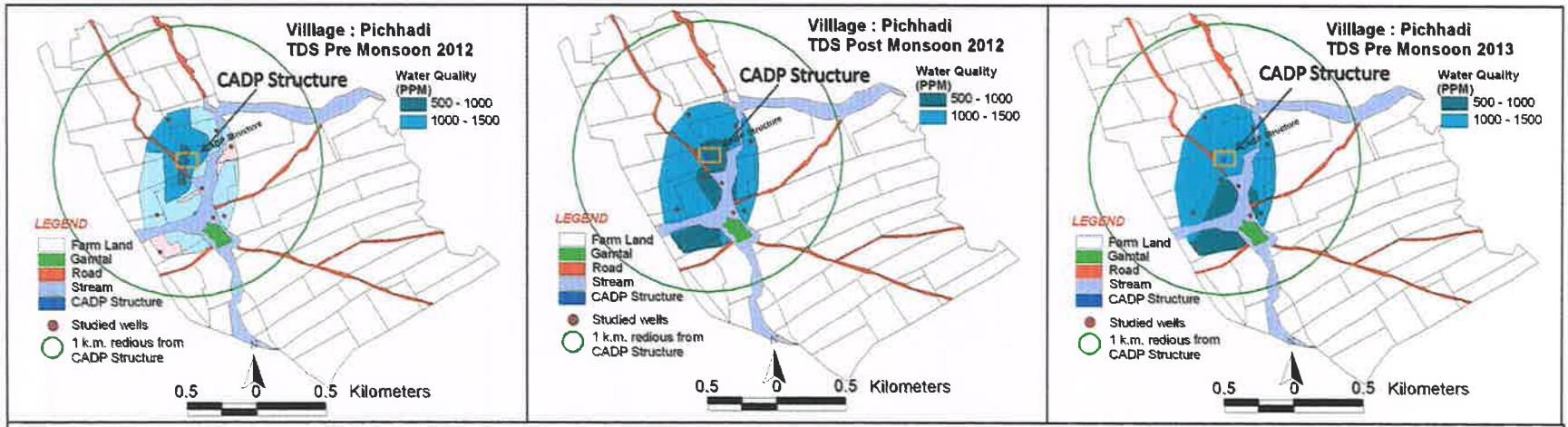


Fig. 2.52. Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Pichhadi, (Year 2012, 2013)

Analysis of observation records has carried out with the help of computation of hyderograph and various trend showing maps such as Iso - RWL (Fig. 2.51) and Iso - TDS (Fig. 2.52) maps. In addition to this exercise consultations with farmers have also held to verify the analysis. Following are main impacts have observed in groundwater

- Post monsoon water level rise and dilution in TDS concentrations have increased in comare to previous years.
- No significant changes have seen from Pre monsoon to pre monsoon seasons of successive years
- According to village people due to increased recharge from structure now they have sufficient volume for Kharif protective irrigation during low rainfall year whereas, some groundwater is available for Rabi season for at least 50 % of land in area around the structure.

Socio-Economic Impact: Socio-economic impact of the WRM structure has also been understood by holding group discussions with village people and sampe house hold surveys of farmers (3 farmers) having their land within the studry area. The facts came out as a results of group discussions are

- There is an average 1 to 2 m rise in water level in around one km areas of structure
- Short fall of drinking water is still exist in village during summer season
- If the structure remains full for one month after monsoon, than about 50 % of farmers sow wheat and mustards during Rabi season
- Due to this structure farmers in area around one km radius have at least one crop surety of Kharif season
- There is no any significant improvement in quality for drinking water (Table 2.72 and 2.73)

Table 2.72 Before and and After Status of Drinking Water and Asset in Pinchhadi

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Seasonal Problem	Shortage in summer	Shortage in summer
	Source	Hand pump and Open well	Hand pump and Open well
	Quantity	Insufficient	Insufficient
	Accessibility	Door step Hand pump	Door step Hand pump
	Quality	Flouride problem, brackish in summer	Flouride problem, brackish in summer
	For Livestock	yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	4	4
	Cattle Shed	102	102
	Tractor	15	15
	Two Wheeler	100	100
	Diesel Engine	Do not have proper information	
	Electric Pump		

Following changes have notieced in cropping pattern after construction of structure

- Average 1000 kg/hs production has increased in cotton crop
- Peal millet sowing has decreased
- Sorghum during Kharif and Guwar as vegetable crop sowing is icreasing gradually

- Groundnut and cotton are till continuing crops

Table 2.73 Before and After Changes in Cropping Area and Production in Pinchhadi

Season	Before Structure			After Structure		Change	
	Crop	Area Ha	Prod. Kg/Ha	Area Ha	Prod. Kg/Ha	Area Ha	Prod. Kg/Ha
Kharif	Cotton	300	4000	300	5000	0	1000
	Pear Millet	30	3000	---	---	---	---
	Groundnut	100	3000	80	3000	0	0
	Sorghum	---	---	50	80000	50	80000
Rabi	Wheat	200	5000	200	5000	0	0
Vegetable	Guwar	---	---	2	16000	2	16000

To understand impact at house hold level three farmer's survey has held. (Table 2.74) following conclusions can be draw according to this survey

- Each farmer shows various different levels of availability of water in different season i.e fully available in Kharif to fully available in Rabi season
- Two farmers have changed irrigation method from flood irrigation to Sprinkler (Hasmukhbhai) and sprinkerl for groundnut irrigation (Vishnubhai)
- In case of Mansukhbhai unit production has increased in groundnut (500 kg/ha), cotton (1000 kg/ha) and gram (300 kg/ha) crops. According to him this increase is due to improvement in groundwater condition.

Table 2.74 Case Studies on Before and After Changes at House Hold Level Pinchhadi

Name of the Farmer				Hasmukhbhai Parshad		Vinubhai Patel		Mansukhbha Patel	
Caste				Patel		Patel		Patel	
Total Family Members (No)				5		5		5	
Land holding	Type			Area Ha		Area Ha		Area Ha	
	Irrigated			4		2		4	
	Non Irrigated			0		1		0.7	
	Waste land			1		0		0.3	
	Total			5		3		5	
Change in Crop	**Season**	**Crop**	**Period**	**Area Ha**	**Prod. KG/ha**	**Area Ha**	**Prod. KG/ha**	**Area Ha**	**Prod. KG/ha**
	Kharif	Groundnut	Before	3	2500	1	2500	3	2500
			After	3	2500	1	2500	3	3000
			Change	0	0	0	0	0	500
		Cotton	Before	1	2000	1	3000	2.4	4000
			After	1	2500	1	3000	2.4	5000
			Change	0	500	0	0	0	1000
	Rabi	Wheat	Before	1	2500	0.5	2500	1.2	2000
			After	1	2500	0.5	2500	1.2	2000
			Change	0	0	0	0	0	0
		Gramm	Before	1	1000	0.5	1500	1.2	1200
			After	1	1200	0.5	1500	1.2	1500
			Change	0	200	0	0	0	300
	Summer	Sesame	Before	1	1200				
			After	1	1200				
			Change	0	0				

Table 2.74 Case Studies on Before and After Changes at House Hold Level Pinchhadi (contd..)

Name of the Farmer				Hasmukhbhai Parshad	Vinubhai Patel	Mansukhbha Patel
Livestock	Type			No.	No.	No.
	Cow			2	1	0
	Buffalo			1	1	1
	Bullock			2	2	2
Change in Source of Irrigation	Type		Before	Open Well	Open Well	Open Well
			After	Open Well	Open Well	Open Well
	Change in supply		Before	Available for Kharif only	Fully Available for Kharif	Kharif full and Rabi critical
			After	Available for Kharif only	Available for critical irr. for Rabi	Fully Available for in Rabi
	Irrigation Techniqus		Before	Flood	Flood	Flood
			After	Sprinkler	Sprinkler in Groundnut	Flood
Income (Profit Rs.)			Before	150000	80000	100000
			After	230000	100000	110000
Changes in Asset	House		Before	Pakka House 2 No.	Pakka House 1 No.	Pakka House 1 No.
			After	Pakka House 2 No.	Pakka House 1 No.	Pakka House 1 No.
	Vehicle		Before	Two wheeler 1 No	Two wheeler 1 No	Two wheeler 1 No
			After	Two wheeler 1 No	Two wheeler 1 No	Two wheeler 1 No
	Plaughing equipment		Before	Bullock Plough	Bullock Plough	---
			After	Tractor	Tractor	Tractor
	Lifting Device		Before	Ele. Motor 7 HP	Ele. Motor 6.5 HP	Ele. Motor 7.5 HP
			After	Ele. Motor 7 HP	Ele. Motor 6.5 HP	Ele. Motor 7.5 HP

2.3.4 FACHARIYA CHECKDAM

General Information: A checkdam construction activities has been implemented in village Pinchhadi of Jafrabad Taluka, Amreli District by Shri Vivekanand Research and Treaining Institute, Amreli unit. (Fig. 2.53 and 2.54) The checkdam has cost about 3,23,600 Rs and completed in the year 2011.

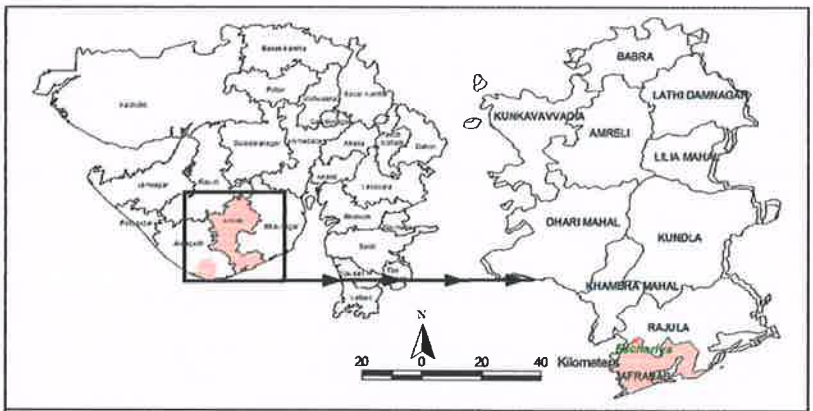


Fig. 2.53 Location Map of Fachariya Village

Total population of the village is about 896 persons. The village spreads over about 901 Ha area where, dominant landuse is rainfed agriculture (710 Ha). Another dominant landuse type of village is waste land (14 % of total land) lands. (Table 2.69)

Table 2.75 Demographic and Land use Pattern of Fachariya, Tal. Jafrabad, Dist. Amreli

Population	Male	433
	Female	463
	Total	**896**
Land Use (Ha)	Forest	0.00
	Irr.Agri.	22.00
	Un-Irrigated	710.00
	Waste Lands	126.02
	Non Cultivation	43.17
	Total	**901.19**

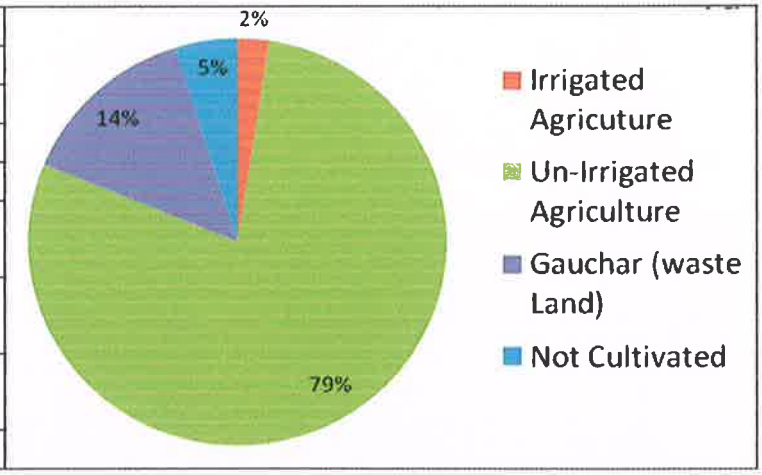


Plate 2.10 Photographs show WRM Strucutre and Water Levels in Vill. Fachariya

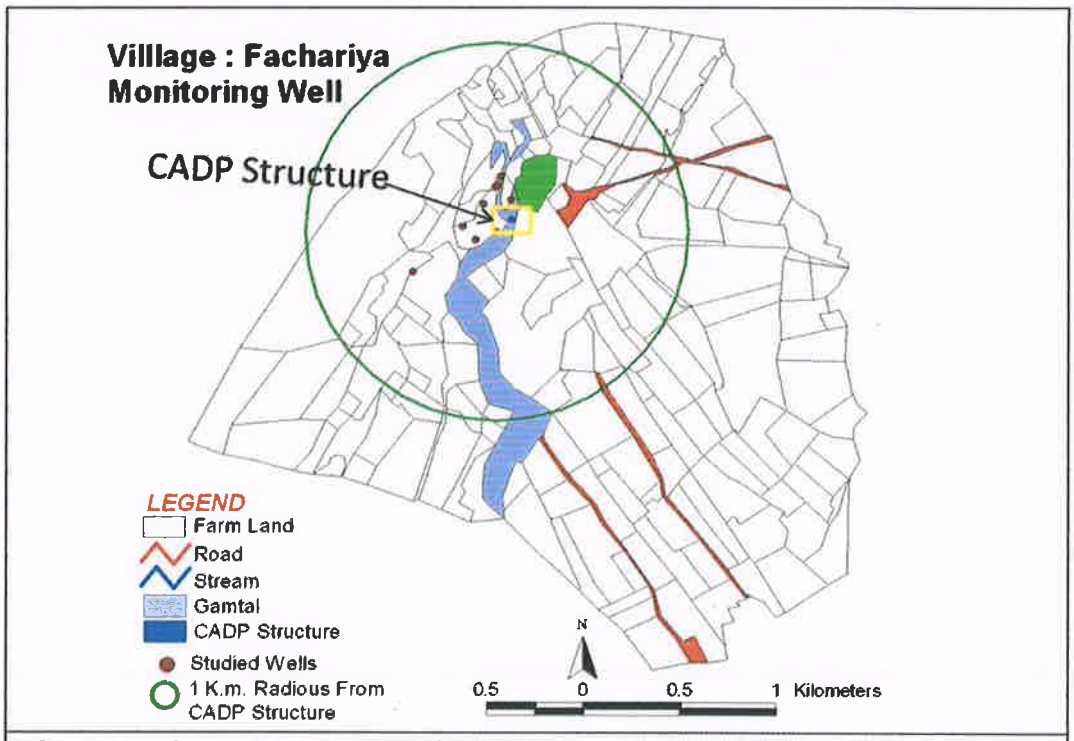


Fig. No. 2.54 Location Map of Studied Wells Vill. Fachariya, Year 2012

Geology and Hyro-geology: To study hydrogeological characterstics of area around WRM structure total eight wells were studied and monitored for three season starting from Pre monsoon of year 2012 to pre monsoon of year 2013. Table 2.76 shows summarized information of all wells whereas Table 2.77 shows well wise information such as use, total depth, water levels lifting device etc. well inventory and surface geological studies clearly says about uniform geological condition in village area. The dominant rock type basalat of Deccan trap formation controls hydro-geological situations. Depth of the well in study area ragnes from 12.3 m to 25 m whereas maximum and minimum depths of water level are 23.2 m and 9.5 m respectively. Thickness and exposure of fractured and weatherd zones of basalts facilitates recharge and discharge in and from aquifer. Consultations with well owners revels most of the well become empty after pumping of 0.5 hr to 2 hr while 6 to 12 hrs time requires for the same amount of water inflow into well.

Table 2.76: Summary of Well Data, Village Fachariya

Total No of Well		08
Use	Only Irrigation	00
	Only Drinking	02
	Drinking& Irrigation	06
	Non Use	00
Pumping Device	Diesel Engine (No)	06
	Electric Motor	01
Total depth of well (m)	Max	25
	Min	12.3
Water Level (m)	Max	23.2
	Min	9.5
Monitoring		08

Table 2.77 Details of Studied Wells in Village Fachariya

Well Code	Owner	Use	Irrigation (Ha)	Total depth (m)	W.L. (M)	Dia (M)	Lifting Device	
							Type	hp
JF1	Dhirubhai Vadaliya	Irri. & Drinking	0.2	18	17	2.6	D. E.	6
JF2	Vitthalbhai Vadaliya	Irri. & Drinking	0.2	23	21	3.5	D. E.	6
JF3	GP well-1 Near ESR	Drinking	0.0	12.3	0	2.9		0
JF4	Prafulbhai Bavabhai	Irri. & Drinking	2.0	24.2	23.2	4	D. E.	6
JF5	Himatbhai Vadaliya	Irri. & Drinking	5.6	22.2	17.1	4	D. E.	8
JF6	GP well-2 Near River	Drinking	0.0	22.3	21.8	4.5	Sub.M	7.5
JF7	Bhimajibhai Narshibhai	Irri. & Drinking	3.0	13.3	9.5	3.7	D. E.	6
JF8	Bhikhabhai Vekariya	Irri. & Drinking	5.2	25	15.5	3.4	D. E.	6

Table 2.78 Well Litholog of Fachariya Village

Well Code	Litholog Details				
	Layers (No.)	1st	Th. (M)	2nd	Th. (M)
JF1	2	Top Soil	6	Highly weathered Basalt	11
JF2	2	Top Soil	3.8	Compact weathered Basalt	19.2
JF3	2	Top Soil	8.9	Weathered Basalt	3.4
JF4	2	Top Soil	8.6	Compact weathered Basalt	14.6
JF5	2	Top Soil	7.2	Compact weathered Basalt	15
JF6	2	Top Soil	5.55	Compact weathered Basalt	16.75
JF7	2	Top Soil	2.4	Weathered Basalt	10.9
JF8	2	Top Soil	2.7	Weathered Basalt	22.3

Impact on Groundwater: To understand impact of WRM structure (Checkdam) on groundwater, seasonal observations of wells have held to monitor water levels and TDS concentrations. The observed data were than analyzed with the help of hydrographs and Iso RWL and Iso TDS maps for study area.

Table 2.79: Details of changes in Water Level and Water Quality, Village Fachariya, 2012, 13

Well Code	Reduced Water Laval (M)			TDS ppm		
	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013	Pre Monsoon 2012	Post Monsoon 2012	Pre Monsoon 2013
JF1	64.3	67.80	63.7	880	240	280
JF2	60.1	64.40	59.3	870	460	490
JF3	78.0	71.00	66.2	840	520	570
JF4	61.7	63.20	61.4	860	420	440
JF5	74.9	76.70	76.3	1020	440	470
JF6	53.5	55.60	53.5	690	580	590
JF7	65.5	70.70	64.2	610	380	410
JF8	58.5	59.80	50.5	630	425	450

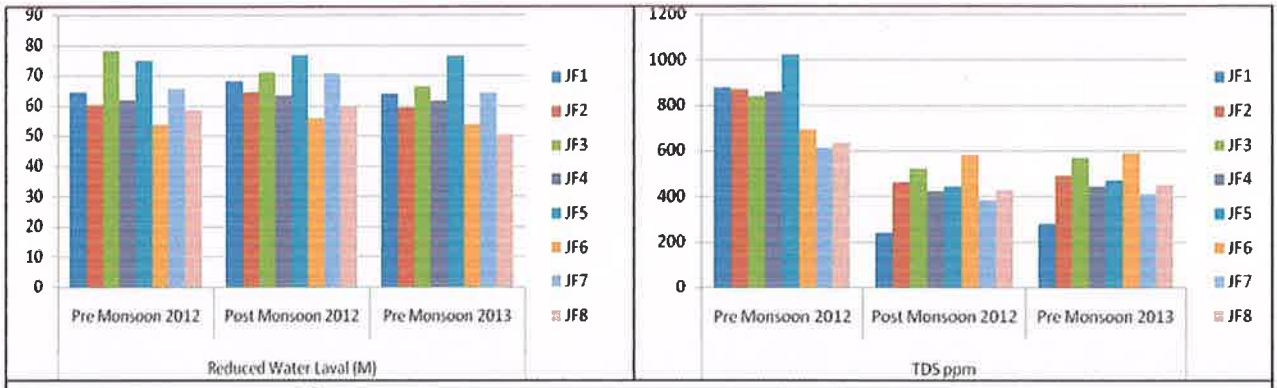


Fig. 2.55 Seasonal Changes in (A) Water Levels and (B) TDS Concnetrations in Wells of Fachariya (Year 2012,13)

Based on hydrographs, maps and consultations with people following impact on groundwater can be summarized

- Significan changes in groundwater quality has seen in all the wells from pre monsoon of year 2012 to same of year 2013
- Water level condition except few wells shows almost stable condition.
- In general water quality in wells is very good for all the seasons and it is within permissible limits of TDS concentrations for drinking water.
- According to village people the water level before the structure was at 13.5 m that now raised upto at 3.5 m

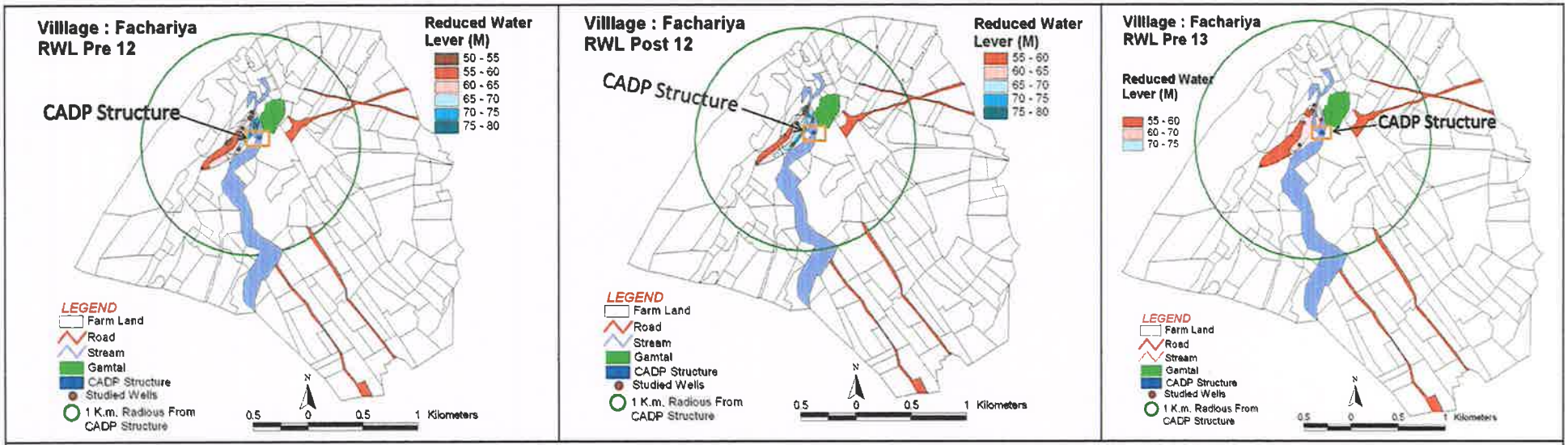


Fig. 2.56 Pre and Post Monsoon Iso RWL Maps of Village Fachriya, Year 2012, 2013

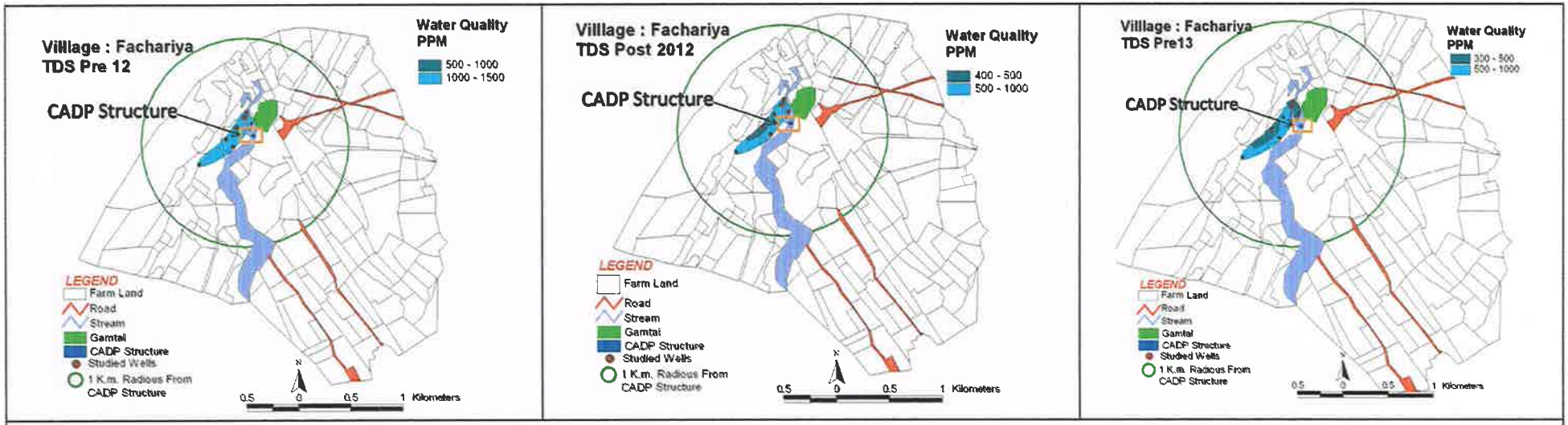


Fig. 2.57 Iso-TDS Map of Pre and Post Monsoon Seasons of year 2012 and 2013, Vill. Fachriya, (Year 2012, 2013)

Socio-Economic Impact: Socio-economic impact of the WRM structure has also been understood by holding group discussions with village people and sampe house hold surveys of farmers (2 farmers) having their land within the studry area. The facts came out as a results of group discussions are

- There is an average 6 m rise in water level in around two km radius areas of structure
- Short fall of drinking water is still exist in village during summer season
- If the structure remains full for one month after monsoon, than about 50 % of farmers sow wheat and mustards during Rabi season
- Due to this structure farmers in area around one km radius have at least one crop surety of Kharif season (Table 2.80 and 2.81)

Table 2.80 Before and and After Status of Drinking Water and Asset in Fachariya

Drinking Water Availability	**Details**	**Before Structure**	**After Structure**
	Seasonal Problem	Shortage in summer	Shortage in summer
	Source	Open well	Open well
	Quantity	Sufficient	Sufficient
	Accessibility	Tap	Tap
	Quality	Flouride problem, brackish in summer	Flouride problem in summer
	For Livestock	yes	Yes
Assets (No.)	**Type**	**Before Structure**	**After Structure**
	Four Wheeler	3	3
	Cattle Shed	150	150
	Tractor	20	20
	Two Wheeler	100	100
	Diesel Engine	50	50
	Electric Pump	70	90

To understand impact at house hold level three farmer's survey has held. (Table 2.82) following conclusions can be draw according to this survey .

- Average 1000 kg/ha increased in cotton and 300 kg/ha in groudnnut
- Farmers are now sowing Green gramm and pearl millets
- Partial vegetable crop sowing has now started in village
- Availability of water has increased in case of both the farmer i.e fully available in Kharif and Rabi season
- Per ha production of groundnut and cotton crop has also increased
- Jaysukhbhai use his land for all three seasons for crop sowing.

Table 2.81 Before and After Changes in Cropping Area and Production in Fachariya

Season	**Before Structure**			**After Structure**		**Change**	
	Crop	**Area Ha**	**Prod. kg/Ha**	**Area Ha**	**Prod. kg/Ha**	**Area Ha**	**Prod. kg/Ha**
Kharif	Cotton	200	1500	200	2500	0	1000
	Sourghum	50	20000	50	20000	0	0
	Groundnut	250	1700	250	2000	0	300
Rabi	Wheat	250	3000	230	3000	-20	0
	Cumin			20	1000	20	1000
Summer	Green Gramm			10	1000	10	1000
	Peal Millet			10	2500	10	2500
Vegetable				3	10000	3	10000

Table 2.82 Case Studies on Before and After Changes at House Hold Level Fachariya

Name of the Farmer				Jaysukhbhai Vaghasiya		Bhagvanbhai Devrajbhai	
Caste				Patel		Patel	
Total Family Members (No)				5		6	
Land holding	Type			Area Ha		Area Ha	
	Irrigated			2.4		8	
	Non Irrigated			0		2	
	Waste land			0		0	
	Total			2.4		10	
Change in Crop	Season	Crop	Period	Area Ha	Production KG/ha	Area Ha	Production KG/ha
	Kharif	Groundnut	Before	1.8	2000	2	2000
			After	1.8	2000	2	2500
			Change	0	0	0	500
		Cotton	Before	0.6	2000	6	2500
			After	0.6	2500	6	2800
			Change	0	500	0	300
	Rabi	Wheat	Before	0.2	2000	0.4	2500
			After	0.2	2000	0.5	3000
			Change	0	0	0.1	500
		Fodder (Sorghum)	Before	0.4	40000	1	25000
			After	0.4	40000	1	25000
			Change	0	0	0	0
	Summer	Sesame	Before	0	1200	0	0
			After	0	1200	0	0
			Change	0	0	0	0
Livestock		Type		No.		No.	
		Cow		0		0	
		Buffalo		2		3	
		Bullock		2		4	
Change in Source of Irrigation		Type	Before	Open Well		Open Well	
			After	Open Well		Open Well	
		Change in supply	Before	Only for Kharif		Only for Kharif	
			After	Increase in Rabi		For Kharif and Rabi	
		Irrigation Techniqus	Before	Flood		Flood	
			After	Sprinkler		Flood	
Income (Profit Rs.)			Before	70000		200000	
			After	85000		200000	
Changes in Asset	House		Before	Pakka House 2 No.		Pakka House 2 No.	
			After	Pakka House 2 No.		Pakka House 2 No.	
	Vehicle		Before	Two wheeler 1 No		0	
			After	Two wheeler 1 No		0	
	Plaughing equipment		Before	Bullock Plough		Tractor+Bullock	
			After	Bullock Plough		Tractor+Bullock	
	Lifting Device		Before	Ele. Motor 5 HP		Ele. Motor 5 HP	
			After	Ele. Motor 5 HP		Ele. Motor 5 HP	