IWMI-TATA WATER POLICY RESEARCH PROGRAM

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Creative Destruction: Is that How Gujarat is Adapting to Groundwater Depletion?

A Synthesis of 30 ITP Studies

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'Creative Destruction:' Is that How Gujarat is adapting to Groundwater Depletion? Synthesis of 30 ITP Field-Studies

Tushaar Shah
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Preamble

Water crisis in the state is deepening. This is because of limited water resources are increasingly not in a position to meet the requirements arising from population growth and development process. At the same time Water Resources Development efforts are governed on quality and quantity of rainfall, geo hydrological conditions, quality of infrastructure (electricity) and cooperation between government and Non Government Organisations. Water problems also have great deal of spatial variability. In Saurashtra due to hard rock formation the possibility of holding large quantity of water is quite remote. In North Gujarat there is over exploitation of groundwater leading to severe deterioration of quality of water. This has created grievous situation in Sabarkantha and Mehsana Districts. South Gujarat is blessed with good rainfall. Hence, extraction of groundwater is comparatively less. However, due to topological conditions major quantity of rainwater of South Gujarat goes away to sea. There is a problem of water logging in Surat and Valsad Districts of South Gujarat. At the same time the coastal areas of both the districts have the problem of water quality – especially salinity ingress.

In order to understand the various facets of Ground Water Economy, a Collaborative Research Study was undertaken by the SPIESR with International Water Management Institute (IWMI). In this collaborative study, 30 participants – mainly College and University teachers from Social Science discipline were asked to submit the research proposals related to particular aspects of Ground Water Economy. The study attempted to analyze the nature and magnitude of problems related to groundwater, impact of groundwater on rural agricultural economy, the local solutions evolved by the people, water conservation efforts with the help of Government and NGOs. Two days Workshop was organized to provide guidelines and necessary changes were incorporated in their research proposals. First Workshop was held on 14th and 15th October 2001. Follow up Workshop was organized on 8th and 9th of January, 2002 where each of the participants presented the draft of the paper and received comments from the invited experts.

The paper presents the synthesis of the papers submitted by the participants related to Ground Water Economy. Majority of the papers were based on analysis of field data and people's perception regarding the issues related to groundwater. List of papers submitted by the participants is appended.

Impact of Ground Water Use and Agricultural Economy

Ground Water Use has increased in a very significant way. Insufficient use of canal water is one of the factors for increasing use of groundwater in agriculture. Increasing availability of ground water has definitely increased yield rate, crop intensity and sometimes change in cropping pattern. Some of the studies have also reported increase in agriculture employment and agricultural income.

Study[1] of two villages of Padra Taluka of Baroda district has shown that extraction of groundwater and its use in agriculture has resulted into the increase in irrigation cost. The study has also indicated that over extraction of groundwater has resulted into the loss of groundwater availability and it also affected the quality (in terms of increase in salinity).

Analysis of field data from Sabarkantha, Banaskantha and Mehsana districts has revealed that erratic rainfall, geo-hydrological conditions, insufficiency of canal water for irrigation have led to the over exploitation of groundwater. The study based on Sabarkantha[2] district has shown that number of tubewells in Prantij Taluka has increased at an alarming rate during the past 20 years. There were three tubewells during 1964-65, which increased to 619 in 1996-97. Similarly, the number of bore wells has also increased over the time. For example, in Pogalu there were 300 borewells in 1994-95, which increased to 500 in 1996-97.

Another study[3] of Sabarkantha District noted that due to introduction of Watershed Development Programme in Malpur Taluka of Sabarkantha district, the number of employment days increased from 173 in 1995-96 to 186 in 2000-2001. Similarly, the agriculture income also rose due to increase in water availability. The studies have observed the rise in crop productivity, increase in crop intensity. However, rise in each of this varies significantly across space.

During the field visit it was observed that the people were aware of the consequences of the increasing water use but they were reluctant to exercise its judicious use. It was also noted that Non Government Organizations were not active in the district for water conservation efforts.

Table 1: Nature of Ownership of Wells in Selected Villages of Palanpur Taluka

Category	Tube Wells (No)	Open Wells (No)
1. Individual	-	55 (90.0)
2. Family/Partnership	20 (83.0)	6 (10.0)
3. Government	4 (17.0)	-
TOTAL	24 (100.0)	61 (100.0)

Note: Figures in Bracket denotes Percentage to Total
Source: H.T. Patel, 2002.

Districts of North Gujarat suffer acutely of water shortage. As noted above, the withdrawal of groundwater is higher than the recharge in these districts. It is because of shortage of water for irrigation that has prompted the development of water market in the region. The examination of groundwater market in Banaskantha[4] revealed that the large farmers are involved in sale of water. The water table has gone down from 600 to 700 feet in 1996-97 to more than 1200 feet in some parts of the district. As a result, the cost of construction of tubewells has gone beyond the means of an individual farmer and hence, water market is taking a shape of Group Marketing Society. At the same time available water from the tubewells can cater the water requirement of more than one farmer and hence they join hands to form an enterprise resembling a joint stock company for the construction of tubewells and water supply. Majority of such tubewell owners are relatives and friends of each other. As indicated

in Table-1 out of the 24 total tubewells 20 tubewells are in joint ownership. There were 61 open wells that were individually owned by the farmers. Table also indicates that the majority of open wells are owned by small farmers whereas tubewell owners (joint ownership) are invariably large farmers. (Table-2.) The cost of construction of such a tubewell is shared among the farmers based on the size of land holdings. Some portion of income accrued from the sale of water is used for operation and maintenance of tube wells.

Table 2: Nature of Ownership of Wells according to the category of Farmers in selected Villages of Palanpur Taluka

Category	Tubewells	Open wells
Large Farmers	17 (71.0)	19 (31.0)
Small Farmers	3 (12.0)	42 (69.0)
Government	4 (17.0)	-
TOTAL	24 (100.0)	61 (100.0)

Note: Figures in Bracket denotes Percentage to Total
Source: H.T. Patel, 2002

Water is sold/purchased in two ways – either in terms of share in production of crops for which the water is supplied or the number of hours of water supply. Water demand also varies across the crops and seasons. Larger part of the water is purchased for the wheat followed by *Raydo*. The study revealed that maximum water is supplied for "ALFALFA" – a fodder. This fodder takes on an average 32 watering during the year. The demand for water for irrigation purpose is increasing. At the same time the water table is going down and therefore small farmers can no longer afford to extract water at an affordable cost Hence, majority of the small farmers have to purchase water from the tubewell owners.

The study of Umreth Taluka of Kheda District[5] showed that in water trade large number of small and marginal farmers sell water to relatively large farmers. This implies that since groundwater is available at a relatively lesser depth and lower cost compared to Banaskantha District, small farmers are in a position to sell water from their open wells/tubewells. The water sold by these farmers is an additional source of income. This study has not indicated the share of water sale to the total agricultural output. However, the study of Banaskantha revealed that turnover from water sale was around 4% in case of large farmers and around 6% in case of small marginal farmers of their agricultural output..

Umreth study has also pointed out the impact of irregular and inadequate power supply on agricultural activities. It indicated that because of irregular power supply farmers had to depend on diesel machines for lifting water for irrigation purpose and this was costlier than lifting water through electric supply. Both these studies indicate that water trade is independent of size of land holding but largely related with water availability and power supply.

Another study attempted to analyze the relationship between water scarcity and its socio-economic impact in coastal area. Water scarcity in the study villages of Mahuva Taluka[6] affected adversely the agricultural employment and income generation. However, there was no significant impact on education and health. This

may be because drinking water supply (through tankers) is taken care of by district/Taluka authorities. A study which attempted to analyze the impact of water scarcity on women in Kanpar village of Vallabhipur Taluka[7] has shown that water scarcity increased the burden of women to bring potable water for domestic consumption. It also indicated that water scarcity has adversely affected the education of female children.

The respondents observed that due to lack of water conservation efforts and insufficient rain, the water level in wells of selected villages had gone down in 30 wells that were studied. There was no empty wells during 1991. The number of such wells increased to four in 1995 and further increased to 18 during 2001. Due to nearness to the sea, salinity has increased in the area that has adversely affected in a significant way the area under cultivation, agriculture production and agriculture employment. However, possible adverse impact on children's education and migration was curbed due to availability of drinking water through tankers.

Contrary to this, a study[8] in the same area, having water conservation structure called `Bandhara', had positive impact on agricultural activities and eased the problem of drinking water. The study noted the decline in salinity because of construction of Bandhara in the coastal villages. The cultivators in these area reported that there was decline in salinity and in some cases the decline considerable. Decline in salinity is based on people's perception and needs to be scientifically verified and tested. Bandhara may be an ideal water conservation structure to overcome water scarcity in coastal areas. .

Most of the water conservation structures are concentrated in Saurashtra area. This may be because the people's perception about water crisis and for self evolved solutions. Periodical water scarcity led people to find out affordable and reliable solutions for water scarcity. The Non Government Organizations became active, generated awareness among the people and provided technical support to erect water conservation structure. This led to the development of check dams in Saurashtra. It may also be mentioned that major portion of Saurashtra is topologically suitable for erection of check dams. As a result there have been more than 13000 check dams erected by the end of 2000.[9] These efforts need to be intensified. A rough and ready estimate shows that the total requirement of check dams in Saurashtra & Kutch are close to three lakhs. The investment requirements would be around Rs. 2300 crores.[10] In such cases investment is shared in the ratio of 60:40 by Government and People. The people's share is mainly in terms of labour.

The joint efforts of constructing check dams have not only helped in terms of increase in water availability but in many cases eased social tensions among the different castes. The increased water availability has reduced hardships faced by women for fetching drinking water. It is necessary to mention the pivotal role played by some of the NGOs, namely Aga Khan Rural Support Programme (AKRSP) and Shree Vivekanand Research & Training Institute (VRTI) in creating necessary water harvesting structures and generating awareness among the people about the water use in the villages of Saurashtra and Kutch. Government efforts also supported water conservation programmes particularly in Saurashtra and Kutch by initiating an elaborate programme of constructing check dams. Government of Gujarat implemented "Sardar Patel Sahabhagi Jal SanchayYojana" to encourage people for

co-operation in mass movement related to groundwater recharge activities through construction of check dams.

Table 3: Cropping Pattern of Selected Villages of Jamkhambhalia

Crop	Before Check Dam 1995-96 (Area in Hectare)	After Check Dam 2000-01 (Area in Hectare)	Percentage Increase in Area
1. Groundnut	178 (60.1)	243 (55.4)	36.5
2. Wheat	59 (19.9)	83 (18.9)	40.7
3. Cummin	10 (3.4)	14 (3.2)	40.0
4. Tuver	41 (13.9)	29 (6.6)	- 30.0
5. Grass	8 (2.7)	18 (4.1)	125.0
6. Bajari	-	9 (2.1)	New Crop
7. Garlic	-	14 (3.2)	New Crop
8. Chana	-	16 (3.6)	New Crop
9. Maize	-	4 (0.8)	New Crop
10. Cotton	-	9 (2.1)	New Crop
TOTAL	296 (100.0)	439 (100.0)	143 (48.3)

Note: Figures in Brackets denote percentage to the Total.
Source: Ashvin J Raval, 2002

Jamkhambhaliya study[11] indicates (Table-3) that check dams led to increase in crop intensity. Main crops viz. Groundnut and Wheat have maintained their relative importance in cropping pattern, despite inclusion of new crops viz. Garlic, Chana etc.

In a scientific assessment and monitoring of Groundwater near to check dams for two consecutive years showed that water level in Aug-2001 to Aug. 2000 rose by 8.14 m to 6.40 m. in Jamnagar district, 2.35 m in to 5.81 m. in Surendranagar district and 4.57 m to 5.79 m. in Rajkot.[12] This is also supported by a study of Jamkhambalia Taluka. According to this study water table in all the wells at village level increased significantly due to the construction of check dams. After the construction of check dam the data revealed that in all 102 wells the water table rose by 5 ft to 25 ft. Table-4.

The study indicated that due to the checkdams the duration of water availability in selected villages of Jamkhambhalia taluka had also increased. As shown in Table-5, majority of respondents stated that previously water was available for seven to nine months, now, after the checkdams, majority of respondents stated that water was available throughout the year.

Table 4: Distribution of Wells according to the level of increase in water level – In selected Villages of Jamkhambhalia Taluka (In feet)

Increase in Water level	No. of Wells
< 5	2
	(2.0)
6 - 10	23
	(22.5)
11 - 20	49
	(48.0)
21 - 25	21
	(20.6)
> 25	7
	(6.9)
TOTAL	102 (100.0)

Note: Figures in bracket denote percentage to total.
Source : Ashvin J Raval, 2002.

Table 5: Duration of Increase in Water Availability due to Checkdams : Perception of Respondents in Jamkhambhalia Taluka

Duration	Before Check Dam (Numbers of Respondents)	After Check Dam (Number of Respondents)
5 to 6 Months	26 (24.1)	-
7 to 9 Months	44 (40.7)	-
10 to 11 Months	38 (35.2)	31 (28.7)
12 Months	-	77 (71.3)
TOTAL	108 (100.0)	108 (100.0)

Note: Figures in Brackets denote Percentages to Total
Source: Ashvin J Raval, 2002.

Would nearness of a well to checkdam raise the water level? We tried a statistical relationship between the increase in water level and the distance of the well from the check dam. Ordinary Least Square (OLS) method was applied taking increase in water level (for the well) as dependent variable (Y) and distance of well from the check dam (X) as an independent variable.

$$Y = 16.13 + 0.0006X \qquad (1)$$

Both the coefficients have theoretically correct signs but the correlation coefficient (R^2) was estimated to be 0.0008. That means the assumed positive relationship between these two variables is not supported by the observations. This may be because of topological conditions of the wells.

The above relationship also suffers from measurement errors, since the distance as well as the water level are not accurately measured. At the same time increase of water level in a particular well is "an average effect of other check dams in the

vicinity of the well." Hence it was assumed that the 'average increase in water level' in a representative well at a village level is positively related with number of checkdams in a village. This assumption nullifies the topological factor affecting the water level. Therefore, another hypothesis regarding the increase in water level and number of check dams was tested by assuming a direct relationship between "the average increase in water level of a representative well in a village" as a dependent variable (Y) and "number of check dams in a village" as an independent variable (X). OLS method was used to test this hypothesis. The regression equation is as below:

$$Y = 15.14+0.26X \qquad (2)$$

The coefficients have theoretically correct signs. Lower value of R^2 (0.11) implies that the data do not support the hypothesis regarding the increase in water level. However, improved value of R^2 is observed in this equation 2. The lower ratio of R^2 may be due to many factors apart from error of measurement, and non inclusion of other variables like capacity of storing of water of individual well etc. might also be affecting the increase in water level. Jamkhambhalia study also observed that due to perennial availability of water the land value increased. Thus the water conservation efforts in Saurashtra have definitely helped the farming community in increasing the cropping intensity, increase in yield rate, introduction of new crops, increase in asset value and easing the drinking water crisis. NGOs in some cases have not been successful in generating awareness among the people regarding the water crisis and uniting them for the common cause. This was primarily due to the societal fibre at the village level. Organized Pani Committee somewhat surprisingly showed absence of commitment for the maintenance of check dams. This was noticed during the field visits to villages of Jamkhambhalia taluka.

Issues Related to Drinking Water

There were four papers that attempted to analyze the issues and problems related to drinking water in Gujarat. One of the papers attempted to analyze the drinking water crisis in urban areas – particularly that of Rajkot city.[14] The study revealed that with all existing water supply mechanism the city is facing a drinking water crisis. No more than 15% of additional water requirement could be generated even if efficiency of existing systems were improved and roof top harvesting taken on extensive scale.

Another study[15] attempted to analyze drinking water problem of Memnagar – part of Ahmedabad Municipal Corporation agglomeration. For all practical purposes Memnagar is a part of Ahmedabad city. The growth of population in Memnagar during the last decade resulted into increase of demand of water. It also noted that water table of bore wells had gone quite rapidly. The study noted that private bores (owned by Housing Cooperative Societies) were more than the public bores (owned by Memnagar Nagar Palika). Some of the residents received water exclusively from public water supply system or private water supply system and some received from both the systems. Study noted that private water distribution system supplied more water to the citizens than the water supplied by public distribution system. The study estimated the water supply as 180 Litres Per Capita Per Day (LCPD) while the demand/consumption was estimated to be 106 LCPD.

It is difficult to estimate the wastage of water. The difference between water supply and water consumption does not give correct estimate of wastage of water since the surplus water can be stored. If the water storing capacity is nil then the difference between the water supply and water consumption can be defined as wastage of water. What are the factors causing the wastage of water at household level? Wastage at domestic level may be caused by excess water supply, water consumption pattern and type of residence, (flat, tenements, bunglows, slums etc.) size of family etc. For this an attempt was made to understand the factors affecting the wastage of water. OLS method was attempted taking per capita wastage of water as a dependent variable (Y) and size of the family (X1) & per capita water supply (X2) as independent variables. The relationship was estimated as below:

$$Y = -91.02 - 0.839\ X1 + 0.986 * X2 \qquad (3)$$
$$(-0.457) \quad (15.071)$$
$$R^2 = 0.79$$

Figures in bracket denote `t' values

* Significant at 1 Percent level.

The estimated coefficients have theoretically correct signs. However, the variable `size of the family' was not found to be significant. While the variable `per capita supply of water' was quite significant.

The other type of relationship was pertaining to wastage of water and type of residence. The three separate regression equations were estimated using OLS method. Two separately for households living in flats, as well as households living in tenements. The third equation was estimated by pooling all the observations (households). The estimated equations are as below:

Household living in Flats

$$Y = -25.389 + 0.73^{**} \qquad (4)$$
$$(5.28)$$
$$R2 = .55$$

** Implies significant at 1% level.

Figures in bracket denote the "t" value

Household living in Tenements

$$Y = -106.89 + 1.009\ X^{**} \qquad (5)$$
$$R^2 = .85$$

** Implies significant at 1% level.

All the Households

$$Y = -95.72 + 0.986\ X^{**} \qquad (6)$$
$$R^2 = .79$$

** Implies significant at 1% level.

Value of R^2 indicates that hypothesis regarding the linear relationship between per capita wastage and per capita supply is supported by the observations, i.e., increase in per capita supply of water increases wastage. The values of slope parameter vary according to the different types of residence. Result indicates that residents living in flats waste comparatively less water than the people living in tenements, bunglows

etc. Further, the study pointed out that per household operation and maintenance cost of privately operated bore wells is higher compared to publicly operated bore wells. Recovery charges for operation maintenance of privately operated bore wells are higher than the operation and maintenance cost. However, it is reverse in case of publicly operated bore wells where the operation and maintenance charges are higher than the charges recovered from the residents.

The third paper addressed the drinking water problem in village Shilaj to the city of Ahmedabad.[15] The village community is provided water by the public bores or public distribution system. Some of the households have their own private water supply arrangement. Keeping the same definition of wastage as discussed above, study estimated that there was 33 percentage of wastage of water by domestic users (Table-6). Comparison of the estimates of wastage arrived at by Memnagar study and this study, clearly indicates that domestic users of semi urban area waste more water than the domestic users of water living in rural area. Village Panchayat level officers' state that water is supplied to the villagers for the whole day. This however was not confirmed during the meeting with some of the villagers, particularly those at a favorable location. The old tubewells that were constructed in late 70s are now abandoned and new tubewells were dug 8 years back. The water level in the tubewell is decreasing every year. However, no measures are taken for reducing hours of water supply. The electricity supply for drinking water purpose is 'free' in the rural areas. Since the cost towards the power supply is borne by the State Government there is a high level of subsidy on rural water supply. Is it possible to rationalize the level of subsidy? What are the factors one should consider before subsidizing water supply for drinking purpose in rural area? These aspects should be studied.

Table 6: Wastage of Water in Domestic Consumption

Area	Per Capita Supply of Water per day (In Litres)	Per Capita Consumption of Water per day (In Litres)	Per Capita Wastage of Water per day (In Litres)
MEMNAGAR	180	106	74
SHILAJ	70	47	23

Source:Dilip H Parikh, 2002
Swati Dave and Ila Shah, 2002

The study also attempted to test the hypothesis regarding the positive relationship between wastage of water and water supply using OLS method. For this, per family wastage of water (Y) was assumed to have positive relationship with per family water supply (X). The estimated equation is as given below:

$$Y = -086.66 + 0.60\ X^{**} \qquad (7)$$
$$(15.58)$$
$$R^2 = .77$$

** Implies significant at 1% level.

The result implies that with increase in water supply, wastage of water is likely to increase. The results of "Memnagar & Shilaj" studies indicate that water supply needs to be controlled in order to control wastage of water.

Fourth study pertained to drinking water problems in the coastal area of Jallalpore Taluka[16] of Navsari District. State has 1600 Kms. of coastal line. Salinity ingress and water scarcity have resulted into out migration. The villages selected for the study have mainly rainfed agriculture activities. Since the villages are at the tail end of Ukai's irrigation system they do not receive enough surface water for irrigation purpose. The quality of groundwater is not suitable for cultivation as well as for drinking purpose. During the field visits to one of the villages, it was observed that drinking water facilities consisting of well and storage capacity, constructed by the government were subsequently handed over to the Village Panchayat. Gram Panchayat on an average charges Rs. 10/- per household per month. However, people do not pay even these small charges regularly. Some of the villagers stated that the quality of water deteriorates during the summer and they have to purchase drinking water from the market – which costs much higher than the monthly charge of water levied by the village Panchayat. All this creates problems for operation and maintenance of overhead tank that badly needs repair. People generally can afford to pay more for water, if forced.

Interestingly in one of the villages in South Gujarat, it was observed that the people of particular community (Patel's) united for getting quality water by erecting a Bisleri Plant. The cost of getting **quality water for drinking purpose** was stated to be 10 paise per liter. It was decided to distribute five liters of water per day per person. The water is not supplied to the respective household at the doorstep but water is to be collected from the water works office. The operation maintenance cost of this plant is mostly covered by selling the water at a little higher price during some special occasions.

The foregoing discussions brings out clearly the contrast between the community determined system for solving the drinking water problem viz. a viz. officially supported system.

Drinking water problem in Mehsana District was analyzed by two studies.[17&18] One of the studies extended the scope of analysis by assessing the impact of fluorine on animals while the other analyzed the impact of excessive fluorine on human beings only. In the first study it was observed that number of villages having excessive fluorine in drinking water had increased over the time in the district. This shows negligence on the part of the State Government to find out some permanent solution to provide drinking water facility in the villages. Both the studies have brought out that people above the age of 35 are more prone to the sufferings of excessive fluorine content in drinking water. Studies have brought out clearly that affected people have to be contended with loss of employment hours and income. The other study observed that number of children suffering due to excessive fluorine content in drinking water had increased since last five years. The Study also observed that fluorosis in the family adversely influenced the children education.. During the field visit the information was gathered pertaining to the impact of excessive florine content water on animal health from the animal owning households. Many of the respondents asserted that animals were also affected due to intake of this water. This affects the

animal's teeth and legs. This observation was also supported by some veterinary doctors. Both the studies observed that preventive machinery was not adequate to fight against the fluorosis. Fluorosis is incurable and hence, preventive measures are essential. The government generally provides drinking water in these areas through water tankers. However, very recently the water supply through Dharoi canal has been initiated which needs to be monitored for quality and quantity of water supplied.

Trends and Issues in Groundwater Economy

All the studies pointed out the increase in use of groundwater. Rate of groundwater extraction is noted to be higher in many cases than the rate of recharge of water. Increasing demand of water has increased the water conservation efforts particularly in water scarce region like Saurashtra and Kutch. As a result number of check dams in Saurashtra and Kutch have increased. This development raised the water level in open wells resulting in increased water availability leading to higher crop intensity, changes in cropping pattern and introduction of new crops. This has often resulted to the increase of land values. Drinking water crisis in water scarce villages of Saurashtra and Kutch has overcome to a considerable extent and the quality of water also improved in most cases. Improvement of quality and access to drinking water have been particularly beneficial to women folk. The water conservation efforts have also been instrument for the positive change in the social fabric of the rural society.

The location of water conservation structure, particularly that of check dams, depends on Geo-Hydrological conditions of a region, rainfall and such other factors. For construction and maintenance of these assets, factors like commitment of people, support of Non Government Organizations in providing technical guidance and generating awareness at a village level, and financial support of the government are important.

In catchment area of some of the check-dams the water utilization has also increased with increased availability. Water utilization has increased either in terms of increase in numbers of watering to a crop or in terms of enhancing cultivation of water intensive crops. This was observed in case of field data available from Jamkhambalia taluka, Padara taluka. (Table -7) Farmers have a tendency to give more water to crops than recommended by experts. The farms of selected villages of Padra taluka and that of Jamkhambhalia taluka are no exception to this tendency. Similarly, as the water availability has increased in Jamkhambhalia taluka large number of farmers give more number of watering to the cultivation of summer groundnut and wheat. In Palanpur taluka it was observed that the number of watering for fodder crop (ALFAFA) is very high. Ownership of water source generally accentuated this tendency. From Padara and Palanpur talukas farmers owning tubewells often supplied more than required number of watering to the crops compared to non-tubewell owner farmers. A study related to wastage of water in Bardoli Taluka[19] also substantiated the relationship between water availability and wastage of water in Sugarcane cultivation. Water use across the space thus varies depending upon location and ownership pattern.

Table 7: Distribution of Respondents according to Category of Watering across the Crops

		Padra taluka watering				Jam Khamabaliaya taluka Watering			
Sr.No.	**Name of Crop**	**Less than Normal (No)**	**Normal (No)**	**More than Normal (No)**	**Total**	**Less than Normal (No)**	**Normal (No)**	**More than Normal (No)**	**Total**
1	Wheat	0	1	16	17	-	5	57	62
2	Vegetables	3	1	50	54	-	-	-	-
3	Cotton	24	9	12	45	-	-	-	-
4	Tobacco	0	0	50	50	-	-	-	-
5	Summer Groundnut	-	-	-	-	11	-	95	106

Note: Standard Norms of Watering for Wheat Crop was obtained from Gujarat Agricultural University;Ahmedabad while the same for other crops was based on informal discussion with villagers and District Agricultural Officers.

Wheat — *`Eight' times during the crop season*
Vegetables — *`Ten to Eleven' times during the crop season*
Cotton — *`Nine' times during the crop season*
Tobacco — *`Eight to Ten' times during the crop season*
Groundnut (Summer) — *`Eleven' times during the crop season*

** This pattern was obtained after the construction of check dam.*

Source: Sarah Ahmed, 2002
Ashvin J Raval, 2002

Water markets are active in water scarce as also in water rich areas. In Palanpur taluka (water scarce) water sale is dominated by big farmers who own tubewells. In Umreth taluka (water rich) water sale is dominated by small farmers who have open wells. Often small farmers are able to act as water sellers in water abundant areas.

Despite Gujarat being a water scarce region, wastage of water is not uncommon both in farming and in domestic use. Wastage is a function of water availability and subsidy structure. This is more so in the case of power subsidy.

None of the studies attempted to understand the water use and environmental degradation. However, during the field visits it was learnt that villagers / farmers were least bothered about the environmental degradation and extraction of groundwater beyond limit. Non Government Organizations, those related to rural development, could play an important role in attitudinal changes, as are very much desired.

Water conservation efforts have met with success in Saurashtra and Kutch – particularly in Saurashtra. The construction of check dams has most certainly increased the water availability for agriculture and for domestic use. The storage of water in a check dam depends on the quality of construction, topological conditions,

geo-hydrological conditions and rainfall. These structures would gain from proper maintenance and the beneficiaries need to be skilled in this respect.

Water conservation efforts seem to be concentrated in Saurashtra and Kutch under the watershed management programme. The movement of water conservation has not picked up in other districts. Considering the geo-hydrological factors the check dams are most suitable for Saurashtra. The impression is formed that there is an absence of alternative suitable water conservation structures in other districts. The alternative water harvesting structure namely, Bandhara[1], Khet-Talavadi[2], deepening of ponds etc. may play an important role in conservation of water and reducing the degradation of soil.

Notwithstanding the wastage of water, continuous efforts are needed to augment water resources in Gujarat. The investment requirements for development of water resources and water conservation are quite substantial. Government financial support and support by Non Government Organizations are very much required in solving/easing the water crisis. The effectiveness of water conservation structure, however, depends heavily on rainfall and management. These structures seem to be short-term solutions for averting water crisis. Long-term solution would be judicious use of ground and surface water as also efforts at water conservation and water harvesting.

One of the studies[20] has applied Linear Programming Model for overcoming the water crisis. The study used available data from Mahi Right Bank Canal (MRBC) of Matar division. The study recommended the `blending' of ground water and surface water in such a way that salinity content of blended water is reduced to "tolerable limit". According to this study (by blending of surface water and ground water in this way) the blended water serves three purposes: (1) it can be used for cultivation. (2) Ground water having high level of salinity can be brought to the use; and (3) additional surface water can be used for drinking water. The study suggested monitoring of water blending process by establishing a network of blending stations. Such blended water may help in curtailing the extraction of ground water. Can we think of such a network for blending of Ground Water and surface water when Narmada water flows through water scarce areas of the State? This perhaps requires sizable investment from Government, support from NGOs and cooperation from community in the management of water resources.

Issues relating to the ownership of water resources require rigorous debate.. If the water is common property, what about the ownership of the wells? What role can be effectively played by Government, NGOs, and Community for water resources development and management?

Investment decisions in water management calls for integrated water policy at state level. The policy may spell out the size and sphere of investment decision in a phased

[1] A masonry water conservation structure that is popular in coastal area. It conserves rainwater and prevents the mixing of rainwater and seawater.
[2] A small water conservation structure constructed by digging a pit near the farm or in the farm in order to preserve rainwater.

manner for water sector. It may also provide for periodically examination of water charges for different stakeholders, pollution control measures etc.

Providing safe drinking water should be on top of the agenda while discussing various aspects of water sector. Drinking water has assumed crisis situation in fluorosis-affected areas. It may increasingly assume an insurmountable character in coastal areas due to salinity ingress and in tribal areas due to topological conditions constraining water retention measures.

References

Sarah Ahmed "Sustainable Ground Water Use: A study of two villages of Padra Taluka".

Rama J Shah "Impact of Ground Water Irrigation of Agriculture Economy – A Case Study of Sabarkantha District".

Premji M Patel "Area of Water Scarcity and Watershed – A Study in Sabarkantha District".

H.T. Patel "Impact of Ground Water Irrigation of Agricultural Economy in Banaskantha District".

D.M. Rohit "Inter Linkage between Ground Water Irrigation and Rural Electricity Supply – A Study of Five villages of Umreth Taluka".

Manoj H Joshi "Impact of Ground Water on Socio-Economic aspect of Mahuva Taluka of Saurashtra".

Jayshree Soni "Water Scarcity and Gender Dimension – Human Aspects of Water Management: A Trend Report".

V.J. Bhammar "Impact of Bandhara Scheme on Agricultural Development – With Reference to Nikol-Bandhara Scheme".

Mahesh V Joshi "Water Crisis and Water Conservation in Saurashtra".

Rajesh R Modi "Impact of Ground Water Irrigation on Agricultural Economy – A Case Study of Thurkha Group of Villages of Botad Taluka, Bhavnagar District".

Ashwin J Raval "Impact of Water Conservation and Groundwater Recharge: A Case Study of Jam Khambhalia Taluka – Jamnagar District".

A.D. Gohil "Impact of Water Conservation – A Ground Water Recharge Activitiy in Saurashtra Region".

13. R.C. Popat "Analytical Study of the Problem of Drinking Water and Water Conservation through People's Participation in Rajkot City".

Dilip H Parikh "Rapid Utilization and Problems of Water".

Ms. Swati Dave & Ms. Ila Shah "Drinking Water Management Distribution in Shilaj Village".

J.K. Tandel "A Study of Ground Water Irrigation in Coastal Areas of Navsari District"

Vinod K Shah "Problems of Drinking Water: A Case Study of Fluoride affected Households in Rural Areas of Mehsana District".

R.R. Bhatnagar "Impact of Excessive Fluoride content in Drinking Water on animals".

J.G. Parmar "Wastage of water in Agricultural Sector: A Case Study of Bardoli Taluka of Surat District"

Paresh A Raval "Conjunctive Use of Ground Water and Surface Water – A Case Study".

Annexes

APPENDIX 1

List of papers submitted by the participants

Sr. No.	Author	Title of the research proposal
1	Mahesh V. Joshi, Prof. Economics, Saurashtra University, Rajkot	Water crisis and water conservation in Saurastra
2	V J Bhammar, Sri Parekh Science, Arts and Commerce College, Mahuva, Dist. Bhavnagar	Impact of Bandhara Scheme on agricultural development
3	B M. Jani, Prof. Economics, Saurashtra University, Rajkot	Techno economic analysis of groundwater resources in Rajkot districts
4	Rohit J Desai, Lecturer in Economics, Arts and Commerce College, Khedbrakma, Dist. Sabarkantha	Estimates of groundwater in Sabarkantha district
5	Ashok B. Trivedi, Smt. H B. Sanghvi, Mahila Arts & Commerce College	Impact of watershed development on agriculture development
6	Premji M Patel, Sardar Patel Institute of Economic and Social Research, Thaltej Rd., Ahmedabad	Scarce area of water and water- shed – A Study
7	M G Sheikh & D R. Vajani, Sri K R Desai Arts and Com.College, Zalod, Dt. Dahod	Impact of over extraction of groundwater on village economy
8	Rajesh R Modi, Lecturer in Economics, Smt. V P Kapdia Mahila Arts College, High Court Road, Bhavnagar	Impact of groundwater irrigation on agriculture economy – A Case Study
9	K R Ram, Lecturer in Economics, Adivasi Arts and Commerce College, Santrampur, Dist. Panchmahal	Impact of over extraction of groundwater on rural economy
10	A D Gohil, Chotunagar Society, Raiya Road, Rajkot	Impact of water conservation and groundwater activity in Saurastra region
11	Ms. Swati Dave and Ms. Ila Shah, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Drinking water management distribution in Shilaj Village
12	Dilip H Parikh, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Rapid urbanization and problems of water
13	R.R.Bhatnagar, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Impact of excessive fluoride in groundwater on human beings and animals
14	Jayashree Soni, Centre for Social Studies, South Gujarat University Campus, Udhna-Magdalla Road, Surat	Water Scarcity and gender dimension
15	D.M. Rohit, Lecturer Adivasi Arts and Commerce College, Santrampur, dist. Panchmahals	Interlinkage between groundwater irrigation and rural electricity supply
16	Ms. Misha V Vyas and Bhavesh N Desai, Deptt. Of economics, Bhavnagar University, Bhavnagar	Impact of groundwater irrigation on agricultural economy with special reference to Mehsana dist.
17	Tushar R. Hathi, Somnath Society, Rajkot	Participatory role in water conservation and groundwater recharge-Issues and impact
18	H.T.Patel, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Impact of groundwater irrigation on agriculture economy
19	Paresh A. Raval, Deptt. Of Civil Engineering , Govt. Polytechnic, Ahmedabad	Conjuctive use of surface and groundwater
20	Rema J. Shah, Head, Deptt. Of economics, Mahila Arts and Commerce College, Dhansura	Impact of groundwater irrigation on agriculture economy – A Case Study
21	Manoj H. Joshi, Parekh Arts and Commerce College, Mahuva Taluka, Dist. Bhavnagar	Impact of groundwater on socio economic aspects of Mahuva Taluka
22	Vinod K Shah, Sardar Patel Institute of Economic and Social	Problem of drinking water – A case

	Research, Thaltej Road, Ahmedabad	study of fluoride affected households in Mehsana district
23	Ashwin J Raval, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Impact of water conservation and groundwater recharge – A Case Study
24	J.G. Parmar, Arts and Commerce Bardoli, Dist. Surat	Wastage of water in agricultural sector – a case study
25	J.K.Tandel, Arts and Commerce College, Bardoli, Dist. Surat	A study of groundwater irrigation in coastal areas of Navsari district
26	P.J.Vaghela, Shivam Society, Talod, Dist. Sabarkantha	Extraction of groundwater and its impact on rural economy in Talod district
27	M.S.Patel, Shivam Society, Talod, Dist. Sabarkantha	Impact of extraction of groundwater on selected villages of Sabarkantha and Gandhinagar districts
28	Jayashree Soni, Centre for Social Studies, South Gujarat University Campus, Surat	Human aspects of water management – A trend report
29	Munian Alag, Sardar Patel Institute of Economic and Social research, Thaltej Road, Ahmedabad	Regional aspects of groundwater use in Sardar Sarovar System – Alternative Patterns and irrigation
30	R. C. Popat, Sandipani Institute of Economic Research, Rajkot	Water conservation through roof water harvesting in Rajkot dist.

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