Summer Field-stay Report (TD 609)

Ikharichapada, Mokhada (Thane, Maharashtra)

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Introduction

This report is the outcome of 10-week field stay which is part of the curriculum of Masters Degree in Technology and Development at CTARA, IIT Bombay. The village chosen for the field stay was Ikharichapada in Aase gram panchayat of Mokhada block in Thane district of Maharashtra. The field stay was facilitated by NGO AROEHAN, which is based in Mokhada and works for the tribal community of Mokhada block. The NGO works in almost all sectors such as Drinking water security, Health, Education and Agriculture and Livelihoods.

Objectives

- To experience the rural setup
- To conduct PRA activities for detailed study of the village
- To study various interventions carried out by institutions (Government / Private / NGO)

Context

Motivation

The motivation for the 10-week field stay was to achieve academic goals along with an opportunity to get exposure of the village life, learn various sub systems in the village and their inter-relations

Study site

Ikharichapada is situated in the northern parts of Mokhada block. The area is hilly and is covered by forests. The region has two major rivers, Waal and Wagh. The region receives very high rainfall during monsoon season i.e. June to September. The area is rich in biodiversity and is habitat for some of the old species of forest trees and shrubs. All the people in the village belong to Warli community which comes under Scheduled Tribes. People are dependent on forest produce and subsistence farming for their livelihood.

Host organization

NGO, AROEHAN (Activities Related to Organization of Education, Health and Nutrition) is a field work project of Nirmala Niketan College of Social Work, Mumbai in 2006 by Mrs. Anjali Kanitkar, a professor in the same college. The current project coordinator is Mrs.

Shraddha Shringarpure, who has passed out as Master in Social Work from Nirmala Niketan College of Social Work in 2008.

AROEHAN was initiated to work on the issue of malnutrition, but now is working in different areas such as drinking water security, agriculture, education, health, livelihoods etc. Currently there are around 20 volunteers in AROEHAN who come from the tribal villages near Mokhada. AROEHAN has a very good reach and almost covers all of Mokhada block and has done some really good work.

The report has been divided into two main parts:

- **Village dynamics component** – This part will focus on the socio-economic profile of the village

- **Directed Research component** – This part will focus on some interventions done by the NGO as well as government in order to solve some critical issues like drinking water and livelihoods in the region. This component will cover the following:

    - Analysis of water harvesting structures built by AROEHAN
    - Analysis of water harvesting structures built through NREGA
    - Analysis of Rain water harvesting tank scheme of GSDA

Chapter 1 - Village Dynamics Component

Objectives

- To experience the rural setup
- To understand the socio-economic and political dynamics of the village

Methodologies

Quantitative Research Methods

Quantitative Research Method depends primarily on the collection of quantitative data. It is systematic empirical investigation of quantitative properties and phenomena and their relationships. Various methods used for quantitative research are structured questionnaire, surveys, visits to government institutions and other secondary data collection.

Primary data collection through Questionnaire Survey

Primary data collection can be divided into two, household level and village level.

Village level questionnaire survey covered following areas:

- Population, no. of households
- Electrification status – is electrified?, since when?, % of houses electrified etc
- Transportation facilities – state transport, private transport, shared vehicles
- Educational infrastructure – anganwadi, primary school, secondary school, higher-secondary school, college, Z.P. (Zilla Parishad) school, tribal residential school
- Health infrastructure – primary health centre, health sub centre, Z.P. hospital, Rural hospital, private clinics
- Water availability – all water sources, number of thirsty days, minimum distance to water source during dry seasons, interventions / schemes by NGO / government
- Agriculture – rain-fed / irrigated, major crops grown, cash crops if any
- Market facilities – nearest market, rates of wheat, rice if sold in market

Household level questionnaire survey covered following areas:

- APL / BPL – which card?
- Name of the caste –

- Caste category –
- No. of people in household – age, sex, literacy, employment
- Land holdings – forest land / own land / landless
- Other sources of livelihood – private jobs / labour / labour outside village / NREGS (National Rural Employment Guarantee Scheme)
- Transport – frequently visited places, distance travelled per month, mode of transport – preferred
- Energy – Sources of energy (firewood, kerosene, electricity, LPG), Energy consumption per month – per source of energy
- Energy for agriculture – raab (firewood and cow dung required), cattle power, human power, no. of days spent in fields
- Agricultural productivity – quantity per acre for all crops grown
- Housing – kacchha / pakka; brick making – no. of bricks made this year, water requirement for bricks
- Water requirement – litres per capita per day (drinking, washing clothes, bathing, cooking), water requirement for cattle (per animal per day)

Secondary data collection –

Secondary data was collected from following government institutions and host NGO, AROEHAN:

- Panchayat Samiti, Mokhada
- Tehsildar Office, Mokhada
- Senior Engineers' office, Mokhada
- Gram Panchayat, Aase
- Anganwadi, Ikharichapada
- Primary Health Centre, Aase

Qualitative Research Methods

Qualitative research methods rely on the collection of qualitative data. In this, effort is made to gather an in-depth understanding of human behavior and the reasons governing such behavior. The methods used are surveys, interviews, focus group discussions, PRA etc.

PRA

Participatory Rural Appraisal (PRA) is a qualitative method used to get in depth knowledge of problems, resources, perceptions and potential. The participatory methods involve the community and allow them to think with their own perception on a taken set of topics which come out from the discussion with community in an informal and healthy environment.

Timeline:

The timeline is the time versus graph based on the history of the community that helps identify trends, events, problems, and achievements in its life.

Trendline:

Trend lines are helpful to understand the resident's perception of significant changes in the communities over time

Seasonality:

This activity attempts to establish regular cycles or patterns of activities and occurrences within a community over 12 months

Social Map:

The social map is normally a picture of the habitation area and shows the houses, places of social importance and the village boundary. It is used to show basic social and institutional infrastructure as well.

Resource Map:

A resource map depicts the natural resources (Water source, Vegetation, Forest etc) available in the area. The resource map normally covers the entire village area including the surrounding areas of village.

Chapati Diagram:

This is a simple method to know the presence and people's attachment towards government as well as other institutions in the village like schools, health centres, NGOs, markets etc.

Village profile

About Mokhada –

Mokhada is a tribal dominated block in Thane district. It is situated in the north-eastern corner of the district. Its eastern boundary touches Nashik district and northern boundary touches Gujarat state. Jawhar and Shahapur blocks of Thane district lie to the west and south respectively.

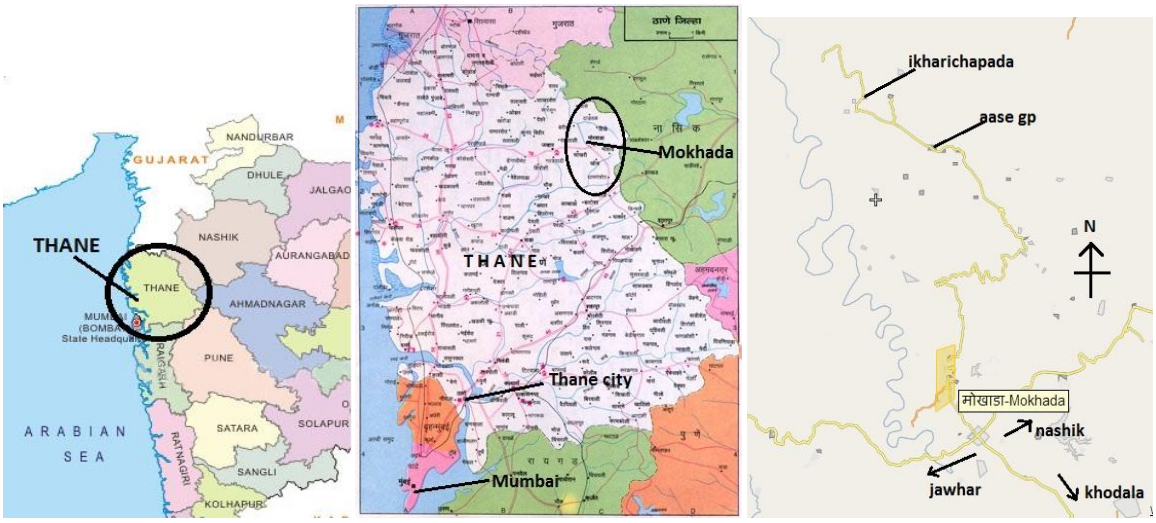


Figure 1-1: Ikharichapada location

The village Ikharichapada lies in the Aase Gram Panchayat which is situated in the northern part of Mokhada block.

Table 1: Latitude - Longitude of Ikharichapada

Ikharichapada	Latitude	Longitude	Elevation
	20.0277°	73.3116°	400 above m.s.l.

Geography

The area is hilly, with undulating slopes. The elevation from mean sea level ranges between 100 - 400 m. The area is covered with forests. Two major rivers Waal and Wagh flow

through the region. The rivers are flooded during monsoon season, but significantly dry up during dry months.

The area receives very heavy rainfall, i.e. between 2500 and 3500 mm per annum. The rainfall trend for last 10 years is as follows:

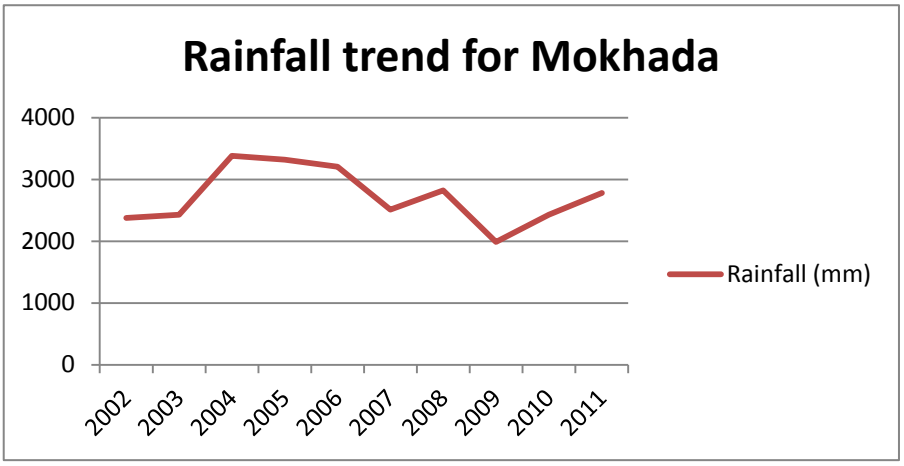


Figure 1-2: Rainfall trend (Source - Central Water Commission office, Mokhada)

Hydrogeology

Geologically, the region is a part of Deccan Basalt Province which is formed from solidification of molten lava around 65 million years ago. It is made of several successive flows of basalt (igneous rock) of variable thickness and lateral extent, commonly known as Deccan Traps. The hydrogeological properties like hydraulic conductivity and specific yield are very low for basalt rock, which makes it a poor groundwater store.

Thus, due to the basalt formations and the hilly terrain, the rain water runs off quickly and very less amount of the rainfall is infiltrated to recharge the groundwater storage. Hence, the yields of the wells in the region are low and the wells generally start drying up from February. April and May are the driest months when people have to travel long distances to fetch water.

Demographics

Timeline / Trendline

According to the villagers the village Ikharichapada came into existence some 80 years ago when two families separated from the village Dapti which is 2-3 km away from Ikharichapada. Since then the village has grown, but not too rapidly.

It got electrified in 1965 and had its first brick house (*pakka house*) in 1989. First mobile phone in the village came in 2006 while 1st motorbike came recently in 2011. Following is the timeline / trendline prepared along with the villagers as a part of PRA exercise:

Table 2: Timeline / Trendline

Year	Event
1930	Two houses existed, Migrated from near by village
1965	Electrified
1970	Kachha road was laid
1972	Drought
1985	Number of houses became around 15; Change in Housing. First kaul type house.
1989	First Brick House
1990	2nd Brick House
1991	Work on Mothi Vihir
1993	Prathmik Shala.(8 June 1993)
1998-99	Piped Water Scheme, 3 connections in village but did not function.
2006	Ist Mobile
2007	ST Bus started, earlier had to travel up to Aase (5 kms), Jalswarajya Well
2008	First fan

2010	First Cycle, First T.V., Aroehan Work
2011	First Motorbike, Dish T.V., Solar Lamp, Pukka road to village
2012	28 houses, 206 population

All the people in the village are tribals of Warli community. The village is homogeneous and there is no social stratification observed within the village. As all the people have low incomes and are very poor there is no class distinction also. Following is the social map for the village sketched out along with the villagers as a part of PRA:

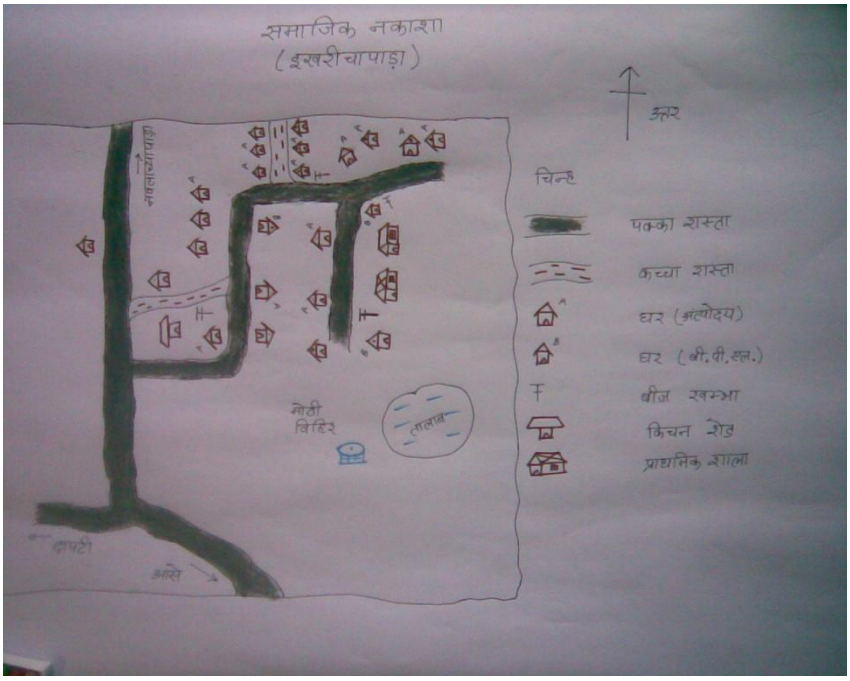


Figure 1-3: Social map of Ikhraichapada

The population data as per the government data (as on 1/4/2003) and as per the questionnaire survey done during the field-stay are as follows:

Table 3: Population Data - Ikharichapada

	As per government data (2003)	As per questionnaire survey
Total no. of households	39	28
Total population	108	206

Total no. of cattle	300	113

Resource Map

The resource map which was sketched by the villagers themselves, gives detailed information about the geographical location of the village, its neighbouring villages, surrounding hills and forests, farms of the villagers, important water sources and also about interventions done by the NGO for solving drinking water problem.

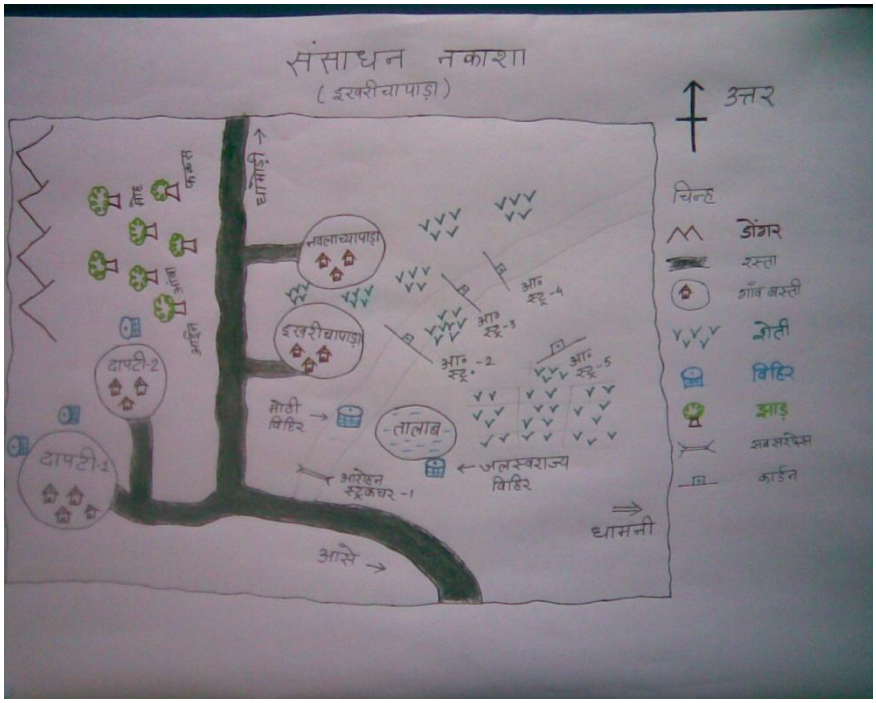


Figure 1-4: Resource Map - Ikharichapada

Major occupations and earnings

The people mainly depend on subsistence farming. i.e. they grow crops only for their own consumption. They don't sell the produce. There is no irrigation in the village, only rain-fed agriculture. Total area under agriculture is 66 acres. Main crops grown in the village and in the surrounding regions are paddy, nachani (nagli) and varai.

Following is the seasonality diagram jotted down by the villagers themselves as a part of PRA exercise. It tells about the main activities of the villagers. E.g. the well gets dry in the months of April and May during which people have to depend on tanker for drinking water. Regarding occupation, they are involved in agricultural activities till November after which

they have to depend on labour work or MGNREGA work till the next agricultural season starts:

Table 4: Seasonality - Ikharichapada

Months / Particulars		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Source For Fetching Water	Well (Drinking)												
	Tanker (Drinking)												
	Pond (Washing etc)		Brick Making				Washing Clothes etc						
Occupation	Agriculture				Raab Preparation		Sowing, weeding, harvesting etc.						
	Other work/ No Work	Work as Labour/ MNREGA Migration											
Catttle		Open grazing					Stall Fed						
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Major source of livelihood is labour-work. People long for NREGA works undertaken in the village. Other than NREGA works, people find agricultural labour jobs in nearby villages for around 6-7 days per year @ 150-200 Rs / day or other labour jobs outside Mokhada block for 14-15 days per year @ 250-300 Rs / day. People travel to places like Bhivandi, Kalyan, Ghodbandar etc for work, which are more than 100 km away from Mokhada. The types of labour jobs they get are sand extraction, construction labour, agricultural labour etc.

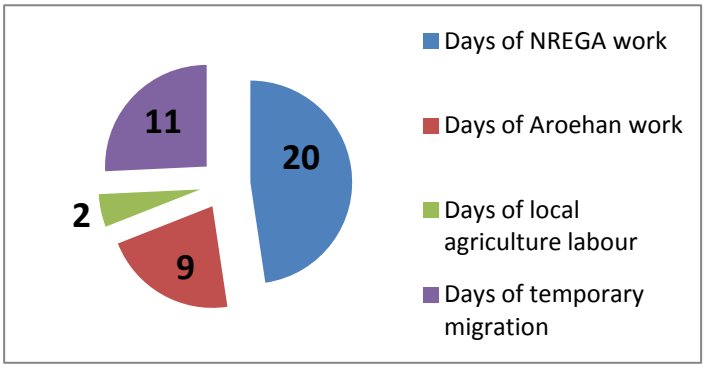


Figure 1-5: Total no. of labour days per year per household

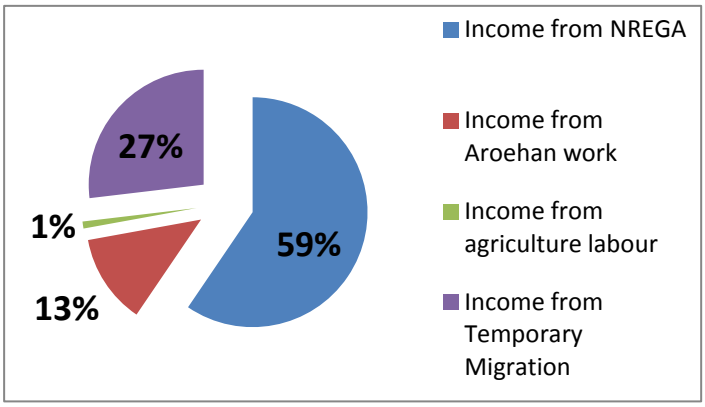


Figure 1-6: Division of yearly income of a household

As shown in the diagram 1 and 2, chief employer for the people in Ikharichapada is NREGA. But there was only one NREGA work in the hamlet in the year 2011-2012. In the year 2012, there was a work initiated by AROEHAN to clean and desilt the pond. People got 7 days of work for this activity.

Agriculture & Land holdings

The land holdings in the hamlet are very small. There are only six households having more than 3 acres of land. 6 households are landless. Others have lands in forest area, which is actually illegal, but they are cultivating these lands for many years.

Most of the land holdings are on slopes as the terrain is hilly. Paddy cannot be cultivated on slopy lands. Hence, they grow nachani (nagli) or varai on such slopes.

The land holding pattern is as shown in the following graphs:

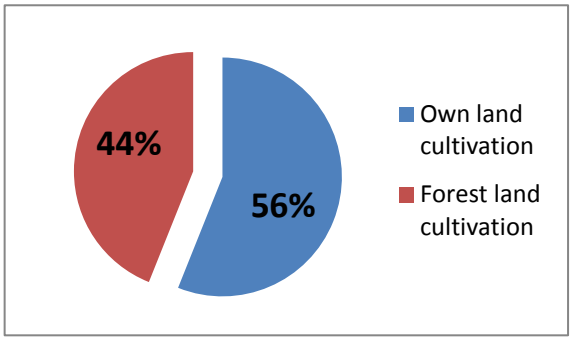


Figure 1-7: Agriculture - Own land V. Forest land

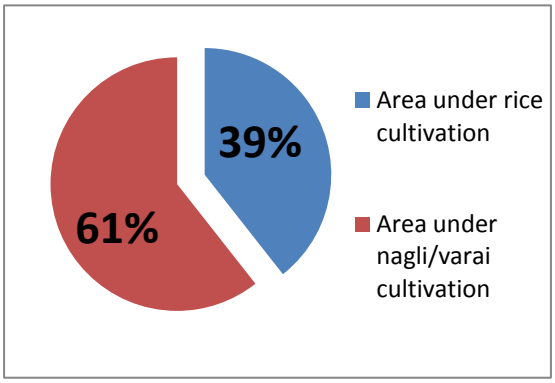


Figure 1-8: Agriculture - Rice V. Nagli/Varai

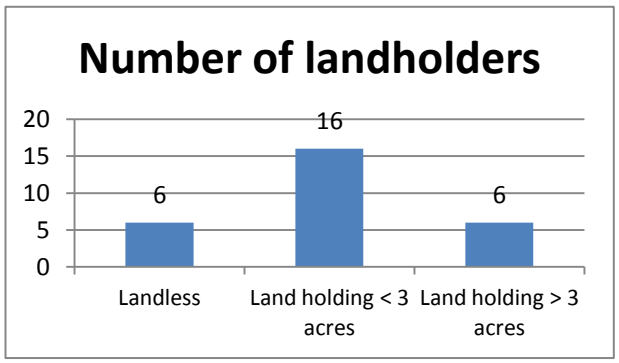


Figure 1-9: Agriculture - Land holding

It is clear from the graph 2 that most of the land holdings in the village are on slopes, where paddy cultivation is impossible. Hence paddy cultivation is only 39% and nachani / varai cultivation is 61%.

Also, 44% of the households cultivate forest lands, which is illegal.

The agricultural productivity is also too low i.e. around 5 quintals per acre. No mechanization is used in agriculture. Fertilizers are organic i.e. cattle dung. Farmers in the region do raab cultivation, where a piece of land is sterilized by burning it with cattle dung, plant waste,

firewood and soil. This kills all the pests according to the local people and also makes the land more productive. Then the crop is planted on this land. Once the crop grows for 10-15 days, it is transplanted to bigger land.

Water scenario in the hamlet

The primary source of drinking water for the village is groundwater. Nearest groundwater source is the mothi well which is in the village itself. There is one more well in the village which is recently built (in 2007). But people don't prefer to use water of this well due to bad quality.

Following are all the sources of water for the village.

Table 5: Water scenario - Ikharichapada

Name of the source	Type of the source	Active / Inactive	Dimensions	Distance from the hamlet	Dries in
Mothi well	Open dug well	Active	11.7m x 6.2m	50m	March
Jalswarajya well	Open dug well	Inactive	5.2m x 3.5m	50m	-
Pond		Active	32m x 35m	50m	March
Waal River		Active	-	5km	-

As mentioned in the table, all the wells dry up around March, after which there is acute scarcity of water. People have to depend on tanker for water supply for the rest of the dry season, but tanker supply is never sufficient.

Even though the region receives high rainfall, most of the rain water runs off due to the hard rock terrain and hill slopes, and hence very less water gets infiltrated in the ground. Thus the groundwater storage is very less, which finishes early.

To solve the drinking water problem of Ikharichapada, watershed intervention was done by AROEHAN in 2010 with the help of technical consultancy Natural Solutions as a part of which 4 sub-surface bunds and four cordons were constructed around the mothi well. The intervention had a positive impact on the yield of the well. In 2011, the well did not dry till the end of the summer season and in 2012, it dried in May 1st week.

According to the villagers, the drinking water stress has been relieved due to AROEHAN intervention. Efficacy of the structures built and their cost-benefit ratio however needs to be analyzed. This study is done in the Directed Research component of the field-stay.

Energy scenario

Electricity

The hamlet got electrified long time back in 60's. But still not all houses are electrified. To add further, only 2 houses are having meter, i.e. legal electricity connection. Most of the houses are having illegal connections.

Major electric appliances used are CFL bulbs and mobile chargers. Only two houses have TV sets and only four houses have fans. Load-shedding is common, and even goes to 14 hours per day sometimes. Electricity cuts due to heavy rains and bad weather is routine. Only one house uses solar lamp.

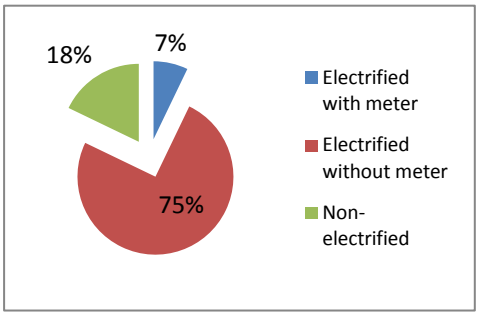


Figure 1-10: Electrification - Ikharichapada

The MSEB (Maharashtra State Electricity Board) or MSEDC (Maharashtra State Electricity Distribution Company) staffs never come to the village as it is quite remote. Hence meter reading does not happen regularly. The result is stacking of electricity bills. The houses with meter complained that they received their 1st electricity bill after one year of starting the connection. And hence the bill amount was huge for them (around 2000). These people never

have such a huge amount with them. And hence they are not able to pay, the result being connection-cut. This is how the people switch to illegal connection.

Firewood

Firewood is the major source of energy in the hamlet. Firewood is used as fuel for cooking, in agriculture and in other activities like brick making. Many times cow dung is also used along with firewood.

Around 10 kg of firewood is required per day for cooking, water heating etc for a household of 5 members. In agriculture, for burning one acre of land for raab cultivation, 100 kg of firewood and 30-40 kg of cow dung is used.

Kerosene

Kerosene is available at the Public Distribution System (PDS) shop which is located at Aase. People get only 4 litres of kerosene instead of 16 litres per month at 15 Rs. per litre on their Antyodaya or BPL card. People with no cards have to buy kerosene at 20 Rs. per litre.

Kerosene is major source of lighting in the houses with no electric connection. During electricity cuts and load-shedding which is common, people have to rely on kerosene for lighting. Only one house in the village has switched to solar lamp.

Petrol

Only one house owns a bike. The house is that of a AROEHAN employee who has to travel 20 km to and fro everyday to Mokhada.

LPG

No house possesses LPG cylinder.

Total energy consuming activities can be summarized as:

- Cooking, water heating etc
- Farming
- Brick making
- Transportation
- Lighting, cooling, TV etc
- Drinking, bathing, washing clothes etc.

Following is the energy flow diagram based on above activities:

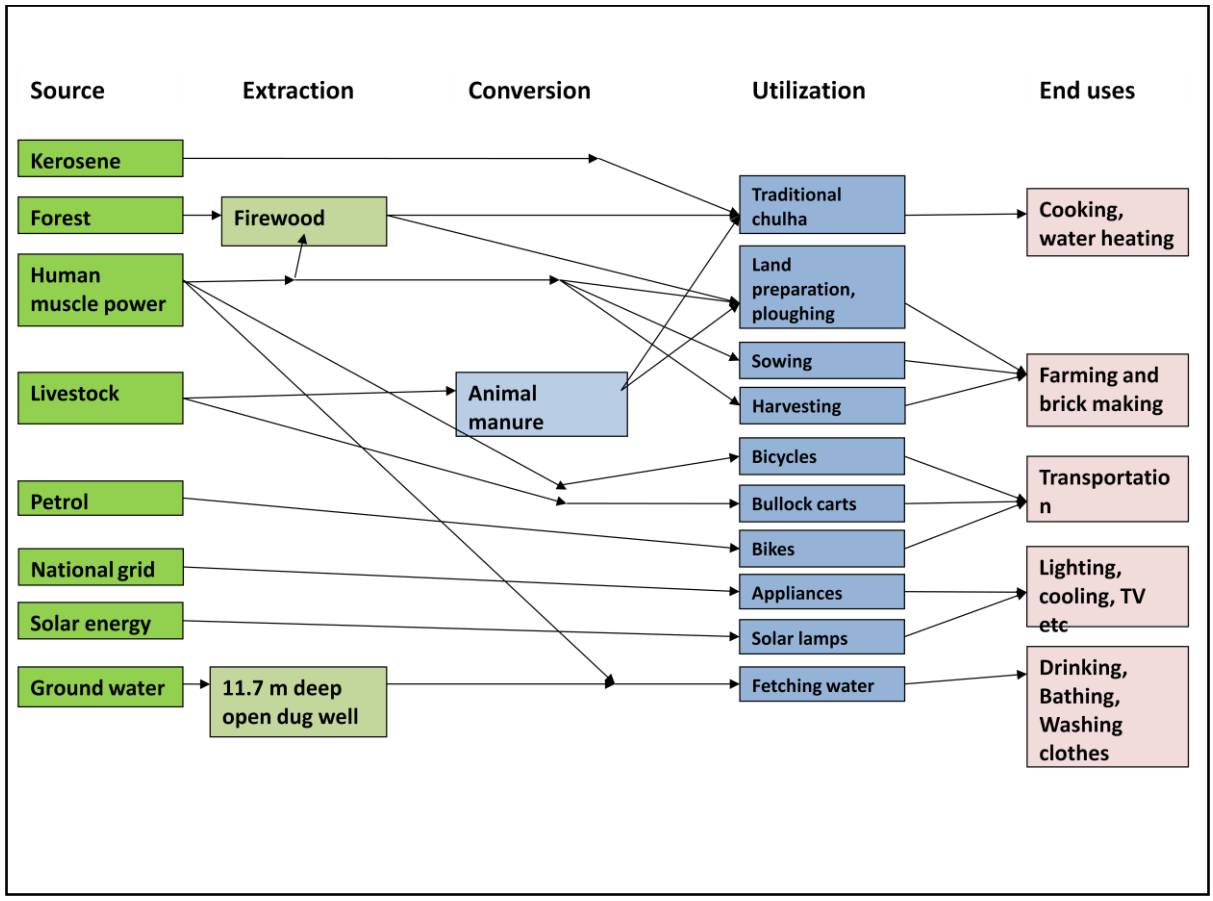


Figure 1-11: Energy Flow Diagram - Ikharichapada

Energy consumption can be divided as follows:

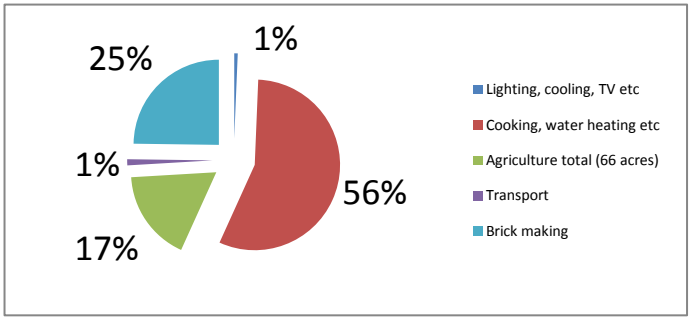


Figure 1-12: Energy Consumption - Ikharichapada

Please refer to annexure to see how the total energy consumed is calculated for each activity.

PDS **–**

Most of the households in the village possess Antyodaya card i.e. they are entitled to get 25 kg rice at 3 Rs. / kg, 10 kg of wheat at 2 Rs. / kg and 4 litres of kerosene at 15 Rs. / litre.

Some of the households possess BPL card i.e. they are entitled to get 25 kg rice at 6 Rs. / kg, 10 kg of wheat at 5 Rs. / kg and 4 litres of kerosene at 15 Rs. / litre.

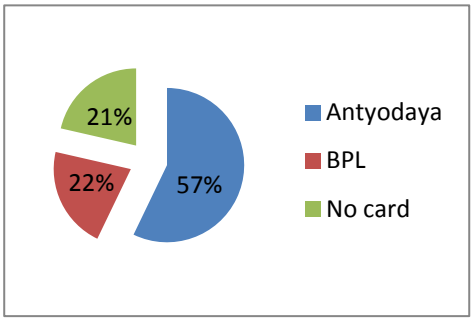


Figure 1-13: PDS cards - Ikharichapada

The ration shop is located in Aase. Few households are members of 'Gharpoch Yojana' of PDS in which they have to pay 300 Rs. for 3 months and in turn they receive all the ration at their doorsteps every month. The scheme is working fine and more and more people are applying for it.

Education –

Village has got anganwadi and a primary school (up to 4th standard). For higher education, students go to residential tribal schools located in Aase (5 km), Chas (15 km) or Mokhada (25 km).

Other institutions –

Following is the *chapati diagram* drawn by the villagers themselves as a part of PRA exercise to show the government or other institutions coming into contact of the village. In the diagram, the big circle in the centre represents the village Ikharichapada and the small circles represent institutions like schools, health centres etc. The position of the circle tells the closeness with respect to distance as well as involvement with the village. It can be seen that the presence of NGO AROEHAN is greater in the village than gram panchayat (Aase). Also, the primary health centre and school are far away from the village.

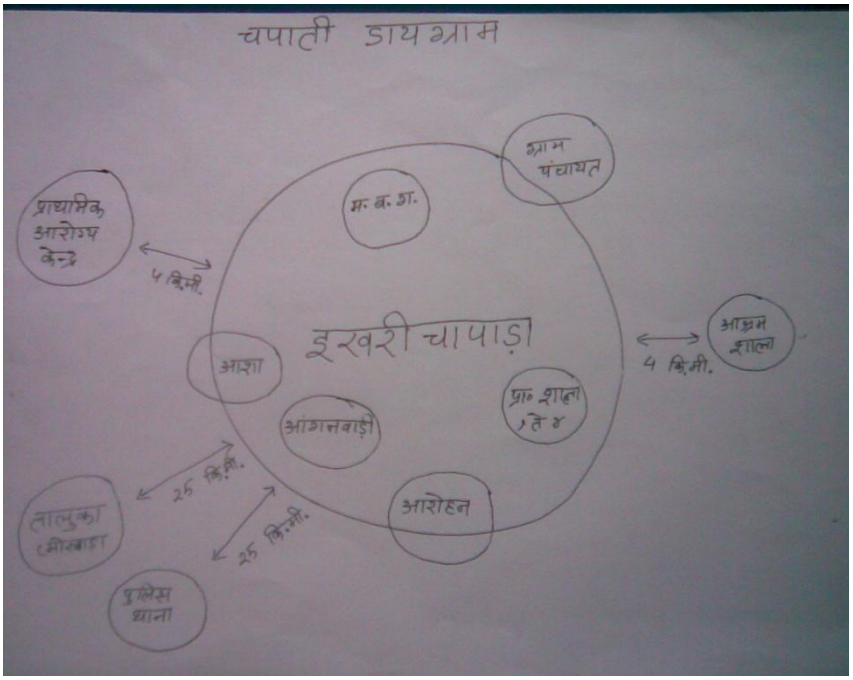


Figure 1-14: Chapati diagram

Following was the more detailed information acquired from secondary data and actual visits:

Table 6: Proximity to institutions - Ikharichapada

Important institution		**Location**	**Distance from hamlet**
Health	Primary Health Centre	Aase	5
	Primary Health Sub centre	Osarvira	8
	Rural Hospital	Mokhada	25
	Z.P. Hospital	Chas	15
School	Anganwadi	Ikharichapada	0
	Primary school	Ikharichapada	0
	Residential tribal school	Aase	4
	Residential tribal school	Chas	15
	Residential tribal school	Mokhada	25

Food security	PDS shop	Aase	8
Rice mill		Dapti 1	2
		Dhamni	4
Market		Mokhada	25
Police Station		Mokhada	25

Chapter 2 - Directed Research Component

The NGO has been doing work in water harvesting in some of the water-scarce parts of Mokhada block. The main objective of the Directed Research component of the field stay was to gain some understanding about the watershed interventions being done by the NGO.

At the same time, need was also felt to look into some water harvesting and conservation works carried out through MGNREGS (Mahatma Gandhi National Rural Employment Guarantee Scheme) in the region and to assess the impact created by assets created through MGNREGA works.

Also, during field stay, it was found that some new structures were being introduced by in the region for tackling the issue of drinking water by GSDA (Groundwater Survey and Development Agency). A preliminary analysis of these structures was also carried out as a part of Directed Research.

Thus, the directed research was broken into three components as follows:

- Analysis of water harvesting structures built by AROEHAN
- Analysis of water harvesting structures built under MGNREGS
- Analysis of Rain water harvesting tank scheme of GSDA

Directed Research – Component I

Introduction

AROEHAN is trying to tackle the issue of drinking water scarcity in Aase gram panchayat since 2010. In collaboration with Natural Solutions, AROEHAN has built water harvesting structures in the region, the first one being built in Ikharichapada in 2010. Natural Solutions is a consultancy led by Dr. Ajit Gokhale and has been doing work in water harvesting in Thane and Raigad districts as well as in Rajasthan.

The structures in Ikharichapada (i.e. Cordons and subsurface bunds) have increased the yield of the well in the village as per the local people. As a result of the success of the structures in Aase, AROEHAN is now going for similar water harvesting structures in other parts of Mokhada block as well.

Objectives

- To understand and analyze the water harvesting structures (i.e. cordons and sub-surface bunds) built by AROEHAN in Aase gram panchayat
- To analyze the impact of the water harvesting structures on the drinking water availability in Ikharichapada

Methodology

Literature survey & Data Collection

Literature on the water harvesting structures, especially underground dykes or sub-surface bunds was studied.

Data regarding water harvesting structures built by AROEHAN in Mokhada was taken from AROEHAN office. Data consisted of village / hamlet details, exact location of the sites, costing etc.

Field visits

Based on the data collected, field visits to almost all the sites were made in order to study the structures.

Analysis

Detailed analysis of sub-surface bunds and cordons in Ikharichapada was done based on the following:

- Impact of the structures on the drinking water availability in Ikharichapada
- Analysis of the structures using conceptual models (future work)

Literature survey, field visits and interviews

Types of structures built by AROEHAN

- Cordons

Cordons are impoundment structures built around small springs in order to make water collection easier for the people. These are small tank-like structures with capacity ranging from 1000 litres to 4000 litres.

Figure 2-1: Ideal sites for cordons

These structures are built across those springs which last till the end of dry season. The springs are nothing but the discharge of groundwater. The discharge is high during monsoon season and few months after that, but decreases significantly during the months of March, April and May. At this time, it becomes difficult for the people to collect water from these discharge points. Most of the times, people dig small mud ponds of dimensions 2ft x 2ft x 1ft (l x b x h) for making collection of water easier.

Figure 2-2: Cordons

Cordons are not water harvesting structures. They don't extend the life of springs, just make collection of water easier at the discharge points of the springs.

Cordons prove to be a solution to this problem of digging temporary ponds and makes water collection through these discharge points easy. These structures are about a meter high, with lengths and breadths ranging from 1 to 2 meters. The thickness of the structures depends on their dimensions and range from 0.75 ft to 1 ft.

Cordons are made of cement concrete and cost around Rs. 5000. They can be useful sources of water for cattle during dry months which may relieve some stress on the drinking water wells, which in turn help in extending the life of wells.

- Subsurface bunds

Sub-surface bunds are barrier-like structures built to obstruct the natural flow of groundwater. The principle of sub-surface bund is simple; a trench is dug across the valley, (or stream) reaching down to bedrock or solid, impervious layer, at a suitable location from the well, and in the trench, an impermeable wall or barrier is constructed and the trench is refilled with the excavated material. A bund constructed this way retains water during wet season which may be used throughout the dry season.

Regions having shallow hard rock are more favourable to sub-surface bunds. The average heights of the sub-surface bunds generally vary in the range of 2-6 m, but in the basaltic region like Mokhada, hard rock can be encountered just 2-3 ft below the surface.

Figure 2-3: Subsurface bunds by AROEHAN

Various materials are used for the construction of impermeable barrier such as clay, concrete, stone masonry, reinforced concrete, bricks, plastic, tarred-felt, sheets of steel, corrugated iron, PVC etc. The choice of the material is dictated by several factors such as local hydrogeologic conditions, availability and cost of the material, ease with which construction is made, need for skilled labour etc. [Reference – H.Onder, M.Yilmaz, 2005, Underground Dams – A tool of Sustainable Development and Management of Groundwater Resources]

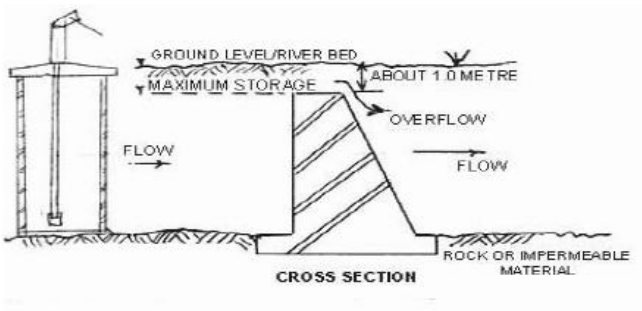


Figure 2-4: Subsurface bund design

Mostly the sub-surface bunds are constructed downstream of a well, so that they can obstruct the flow of groundwater and push it back towards the well, which in turn will increase the yield of the well. But sometimes, very rarely though, sub-surface bunds can be constructed upstream of the well also, as is done in Ikharichapada. The upstream sub-surface bund will slow down the inflow of groundwater to the well and thus will delay the drying of well. Upstream and downstream SSBs are explained in the following diagrams.

It can be seen in the diagram 1 that the downstream SSB acts like an underground dam with its catchment covering the well, thus increasing the local water table and yield of the well.

Similarly, the upstream SSB, delays the quick runoff of the groundwater, thus creating a mound in the water table on the downside of the SSB.

In both the cases, vertical conductivity is assumed to be very less, as is the case in compact basalt.

Downstream sub-surface bunds – before intervention, after intervention

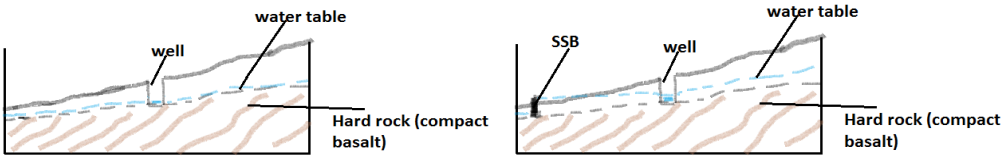


Figure 2-5: Impact of downstream subsurface bund

Upstream sub-surface bunds – before intervention, after intervention

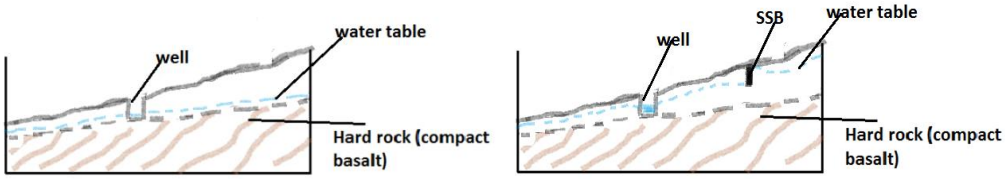


Figure 2-6: Impact of upstream subsurface bund

Along with these structures, AROEHAN has also constructed new wells as well as reconstructed old wells in Aase and neighbouring gram panchayats. Detailed list of all the structures is as follows:

Table 7: Water harvesting structures built by AROEHAN in Mokhada

No	Type of structure	Year	Dimension(meters)	Capacity(cu m)	Location	Total Cost(Rs)	Labour Cost(Rs)	Material Cost(Rs
1	SSB+CORDON	2012	1.80*1.00*0.60	1.08	Brahmanpada	28295	10500	17795
2	SSB+CORDON	2012	2.45*2.10*0.60	3.087	Brahmanpada	21145	9125	12020
3	SSB	2012	12.30*0.30*1.50	N.A	Brahmanpada	23095	10375	12720
4	SSB	2012	8.00*0.30*0.60	N.A	Brahmanpada	15105	6875	8230
5	SSB	2012	16.00*0.30*1.00	N.A	Brahmanpada	53345	25000	28345
6	SSB	2012	21.00*0.30*3.50	N.A	Brahmanpada	94110	40750	53360
7	SSB+CORDON	2012	1.00*1.50*0.50	0.75	Brahmanpada	20580	9500	11080
8	SSB+CORDON	2012	1.50*1.50*0.50	1.125	Brahmanpada			
9	SSB+CORDON	2012	3.14*2.00*2.00*3.50	43.96	Brahmanpada			
10	SSB+CORDON	2012	6.00*7.80*4.50	210.6	Brahmanpada			
11	SSB+CORDON	2012	1.60*1.00*1.25	2	Brahmanpada			
12	SSB+CORDON	2012	3.00*3.50*1.00	10.5	Brahmanpada	44535	20635	23900
13		pending						
14		2012	3.14*2.25*2.25*30	47.69	Brahmanpada			
15		2012	36.00*20.00*1.50	1080	Aase	194020	56500	137520
16	Small Dam	2011	21.00*19.00*1.75	698.25	Aase	467490	150000	317490
17	SSB	2012	27.00*0.30*2.50	N.A.	Aase	98345	37625	60720

Water scenario in Ikharichapada

Mothi well is the primary source of drinking water for Ikharichapada. Before the AROEHAN intervention, the well used to have considerable amount of water till March. (Please refer to Table 5 for detailed information about water sources in Ikharichapada). People from neighbouring hamlets like Dhamni, Dapti 1 and Dapti 2 used to come to this well since February. Due to pressure overload the water used to go down drastically and finally the well used to get dry at the end of March.

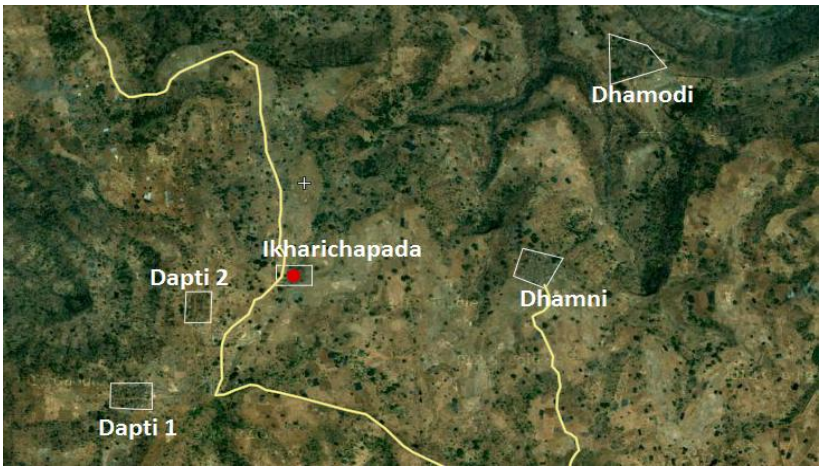


Figure 2-7: Ikharichapada - neighbouring water stressed villages

After March, the hamlet used to become tanker-fed, with tanker of capacity 10,000 litres supplying water after every 2 or 3 days. The people had to travel to the Waal river as the water supplied by tanker was not enough.

Watershed intervention

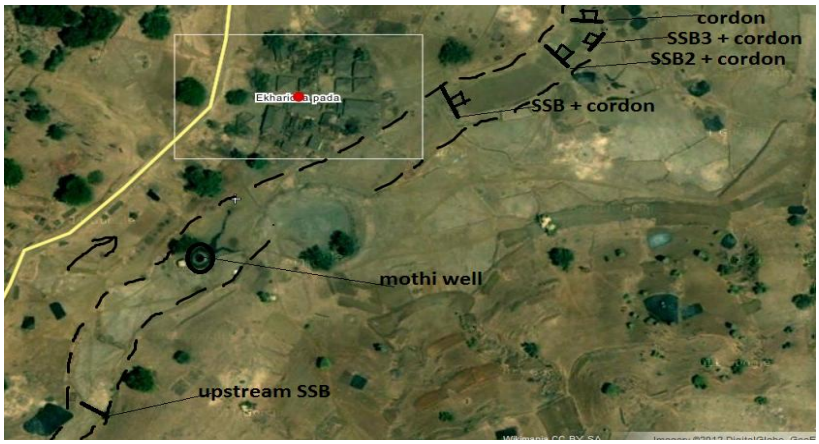


Figure 2-8: Watershed interventions in Ikharichapada

As shown in the diagram, four sub-surface bunds; one being upstream, two downstream of Mothi well and one on another stream; were built along with four cordons.

Understanding the process –

There was a fixed protocol followed by Natural Solutions for assessing the drinking water need and deciding what and how many structures are required in a particular village. The protocol consisted of following important points:

- Preliminary work

  Village / hamlet where water harvesting work needs to be done, is identified by AROEHAN. After identifying the village, it is mapped on the Google Maps or Wikimapia for understanding the local geography. Any obvious water sources such as well, river, bund etc are marked on the map and is carried during the village visit.

- Village visit

  A visit is made to the identified village and an introductory meeting is taken by inviting as many villagers as possible. Questions regarding water related history, their current scenario of water availability are asked. This helps in ice-breaking.

  - Listing of all sources –

  All the sources on which villagers depend for water throughout the year are found out i.e. wells, springs, streams, small mud ponds, bunds, river etc.

  - Visiting all the sources –

  Each source of drinking water mentioned in the list is visited in order to check whether any water harvesting structure can be constructed on it. This survey may take

a few days as the sources are many and may be situated at long distances from the hamlet. But all the sources mentioned in the list are surveyed irrespective of their distance from hamlet.

- Identification of water harvesting structures –

  Depending on the source, following points are noted:

  - Well
    - The stream in which the well is situated is identified.
    - All the farm bunds on the downstream side of the well are surveyed and points where the well discharges are noted, based on the questions asked to the villagers. Thus, suitable location for sub-surface bund is identified.
  - Spring
    - The strength of the spring and the duration till it lasts are noted, based on the questions asked to the villagers.
    - Based on the strength, a decision is made whether a cordon or a small well is required at the location.
  - Stream / river –
    - The strength and the duration of the stream are noted based on the questions asked to the villagers.
    - Decision is made whether a small / large bund can be constructed on it or not.
- Measurements and rough sketches – Measurements are done if any site is found suitable for some kind of water harvesting structure. These measurements are done based on imaginary and intuitive design of the structures.
- Preliminary approval from the villagers – At the end of the survey, all the possible water harvesting structures are communicated to the villagers and a preliminary approval from them is taken. Details about costing and ownership are explained to them.
- Preparation of detailed estimate – Detailed estimate consisting of total material required, total labour required, total cost for each structure is prepared. Based on it, a suitable period for construction is decided and the work is begun with the consent of the local people.

Analysis of water harvesting structures in Ikharichapada –

The analysis was done from following perspectives –

From the perspective of geological and watershed development

A senior researcher in the field of geology, Dr. Himanshu Kulkarni, ACWADAM, was invited to have a look at the sub-surface bunds and cordons in Ikharichapada. Following are some of his key observations after a preliminary geological survey of the region:

- There are predominant north-south fractures in the compact basalt observed in the well. This means that the vertical hydraulic conductivity in the aquifer is high. Hence any attempt to arrest the groundwater downstream will increase its flow in vertical direction instead of pushing it backwards towards the well.

- The upstream sub-surface bund, on the other hand, might be slowing down the runoff rate during the monsoons and thus might be helping in increasing the yield of the well.

- Watershed work needs to be done on the upstream side of the well in the whole aquifer i.e. on the hill tops and plateaus by use of farm bunds, loose boulder bunds across streams etc. This will help in local aquifer recharge and will increase life of the well.

- The local aquifer is tapering towards the downstream side. Hence even if the downstream sub-surface bund pushes the water backwards, there is not much space for storage in the aquifer. Hence the quantity of water harvested will be very low compared to the cost of the structure.

From the perspective of process followed

Some important observations about the whole process of decision making regarding the choice structures to be constructed are as follows:

- Point-based surveys are done (i.e. only water sources are surveyed) instead of aquifer-level survey of the region.
- More dependence on local knowledge for getting information regarding discharge points of the wells, strength of the discharge points and similar crucial information.
- Decisions are intuitive rather than scientific, as no study of geology or the watershed of the region is carried out before deciding the structures.
- More stress is given on the quality of the structures. Hence more high-quality material is used in the structures which may make them costly.

From the perspective of villagers

The water harvesting work in Ikharichapada was done in 2010. According to the local people, there has been a positive impact of the work on the well. Impact analysis was carried out in order to quantify and verify this positive impact.

Some important facts according to the local people:

- The well did not go dry in the summer of 2011.
- The well went dry in the 1st week of May in the summer of 2012.
- There was more load on the well in 2012 compared to 2011, due to more brick making and more people from nearby villages coming for water.

Based on above information, following parameters were chosen for the impact analysis.

- When does the well go dry?
- Number of tanker days
- Change in consumption pattern
- Brick making

Data for above parameters was obtained for the last 3 years from the interviews with the villagers of Ikharichapada as well as neighbouring villages.

Some important data:

- **Population of Ikharichapada – 206**
- **Drinking water consumption per capita per day – 25**
- **No. of cattle – 113**
- **Drinking water consumption per capita per day – 50**
- **Population of Dhamni , Dapti 1 and Dapti 2 – 200 households**
- **Water drawdown from the well per household per day – 30 litres**
- **Water required for making one brick – 2 litres**

Following is the outcome of the analysis:

Table 8: Analysis of impact of watershed intervention - Ikharichapada

Parameter	**Before intervention**	**After intervention (year1)**	**After intervention (year2)**
When does the well do dry?	Last week of March	Never	1st week of May
Number of tanker days	45 to 50 days	0	15
Change in consumption pattern	people from Dhamni, Dapti1 and Dapti2 used to come to the well from 2nd week of March	people from Dhamni, Dapti1 and Dapti2 came to the well from 2nd week of March	people from Dhamni, Dapti1, Dapti2 and Dhamodi came to the well from 2nd week and 3rd week of March respectively
Brick making (number of bricks made)	50000	50000	200000

Based on the parameters, extra water available for the year 2011 and 2012 was calculated as follows:

Table 9: Extra water available due to intervention - Ikharichapada

	No. of days well got extended	**Increased consumption (litres per day)**	**Increased consumption due to brick making (litres)**	**Total extra available water (cum)**
2011	60	206 x 25 + 200 x 30 +	0	1008

		113 x 50		
2012	37	206 x 25 + 280 x 30 + 113 x 50	150000 x 2	1010.4

This shows that the water in the well has increased after the intervention. Then total cost of extra water harvested was calculated as follows:

- **Total cost of structures in Ikharichapada = 1,12,000 Rs.**
- **Total extra water available (or water harvested) = 1009 cum.**
- **Cost per cubic meter increase in water = 111 Rs per cum**

Conclusions:

There has been a positive impact of the water harvesting work done in Ikharichapada. The yield of the well has increased.

The cost of increase in the water available in this case is on the higher side.

It was observed in one subsurface bund built in neighbouring village, that the water has found an alternative path and was bypassing the subsurface bund altogether. This is a complete failure of the subsurface bund. These things can happen in any subsurface bund because water can easily find alternative paths. This raises some fundamental questions about the efficacy of subsurface bunds and needs to be studied.

According to the observations by senior geologist Dr. Himanshu Kulkarni, the increase in the yield should be due to the upstream sub-surface bund. The downstream sub-surface bunds are not effective.

Future work

In order to find out precisely which structure is contributing towards increase in the yield of the well, observation pits should be dug near to both the upstream as well as downstream bunds and should be monitored all the year round. This will tell us the water table and its fluctuations with time at different positions from the well.

If a mathematical or conceptual model simulating the upstream as well as downstream sub-surface bunds is developed it will become possible to verify the efficacy of the structure before constructing it.

Directed Research – Component II

Objective

To understand the working of NREGA water harvesting structures (*vanrai bandhara*)

Methodology

- Secondary data collection
- Field visits
- Interviews with people
- Analysis

Analysis of Vanrai bandhara

Vanrai bandhara is a temporary bund made of plastic bags filled with clay. The bund only lasts for one monsoon season.

Vanrai bandhara are constructed just after the last rains to arrest the runoff and store water for few months into the dry season. The typical height of a *vanrai bandhara* is about 0.8 m to 1.2 m. Length of the bandhara ranges from 6-7 m up to 25 m. The breadth of the bandhara is about 2 m to 2.5 m.

The bags used for the vanrai bandhara are 40cm x 30cm x 15cm (l x b x h). The bags are filled with fine clay. Some room is kept for the clay to expand in the bag. The bags are then arranged at the location in the chain method i.e. bund is constructed from the both the banks in to the centre of the stream. Bags are arranged in layers to give the desired height.

Figure 2-9: Vanrai bandhara - Mokhada

Around 80% of the NREGA works in Mokhada are related to water harvesting and conservation, out of which around 90% are *vanrai bandhara*. *Vanrai bandhara* is a popular structure in this region.

In Gomghar gram panchayat, around 20 km south of Mokhada, 33 vanrai bandhare were constructed in the year 2011-2012. Hence Gomghar gram panchayat was chosen for the analysis of vanrai bandhara.

Table 10: Vanrai bandhara statistics - NREGA Mokhada

No of Vanrai bandharas in Gomghar	Cumulative Water Holding Capacity(litres)	Total Expenditure (Rs.)	Expenditure per Bandhara (Rs.)	Water Holding Capacity per bandhara (litres)
33	102600	600845	18207.42	3109.091

Surveys were conducted in which 7-8 *vanrai bandhara*s on two different streams in near Dongarwadi and Wasind were visited and studied.

Interviews were conducted of the people, who worked on those bandhare.

Following are the google images of the two site visits:

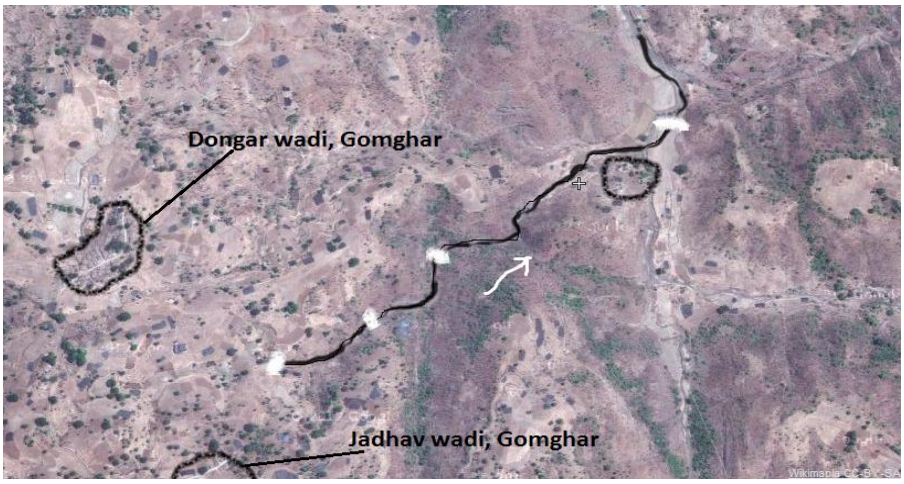


Figure 2-10: Field survey of vanrai bandhara sites -1

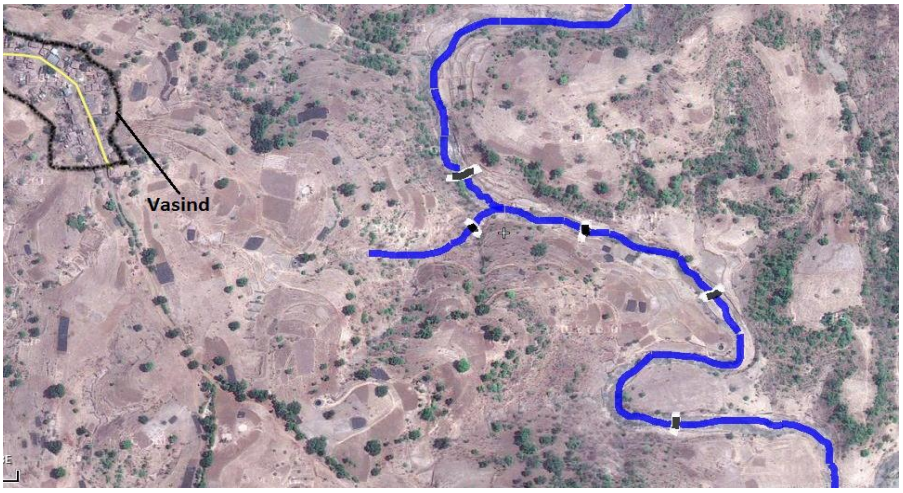


Figure 2-11: Field survey of vanrai bandhara sites -2

Analysis was done from two perspectives:

From the perspective of villagers

- mostly built for employment generation rather than asset creation or water harvesting;
- sites not properly chosen with respect to quantity of water harvested
- moreover, most of the sites are inaccessible even for cattle
- no stress given on timing of construction of *'vanrai bandhare'*, which may defeat the whole purpose
- no sense of ownership of assets being created

From technical perspective

Main parameters on which success of Vanrai bandhara depends were studied and are as follows:

- Location of bandhara (slope of the stream, height of bandhara)
- Evaporation rate
- Seepage rate through plastic bags and clay
- Inflow rate of the stream

Based on above parameters, a system dynamic model was developed to simulate working of vanrai bandhara, which is as follows:

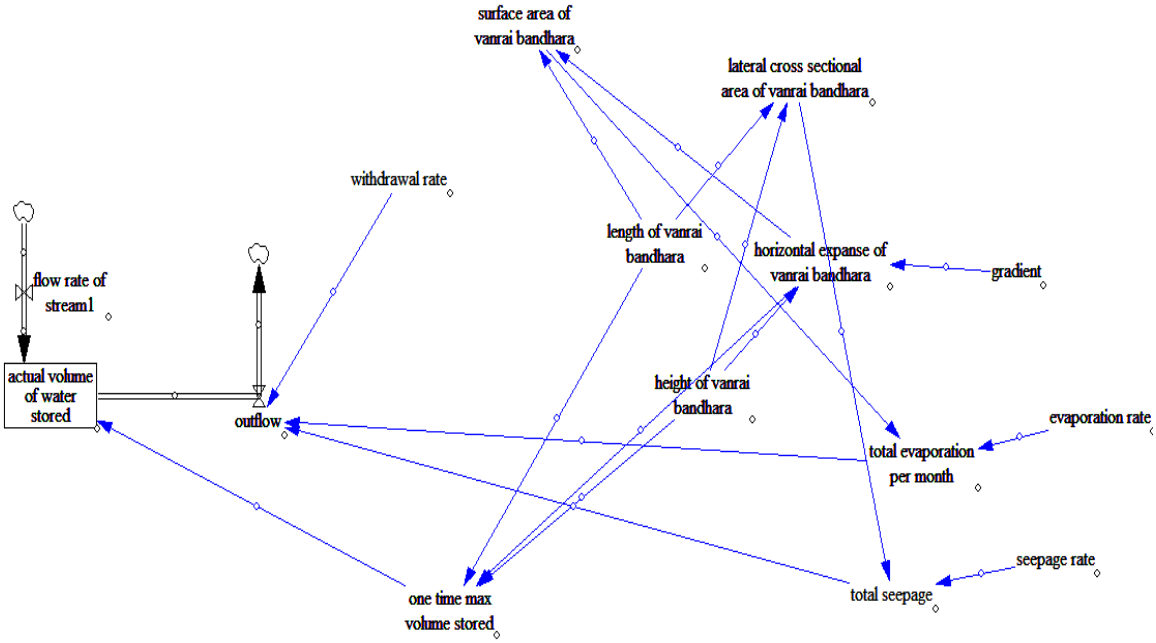


Figure 2-12: System Dynamics analysis of vanrai bandhara

The results of the model were as expected. Any change in the parameters affect the quantity of water harvested as well as the duration of the vanrai bandhara. For e.g. vanrai bandhara constructed on gentle slopes would last for longer time as well as store more water than one constructed on steeper slopes.

Run 1 –

For gradient = 5%

Max water stored = 199.75 cum.

No. of days *vanrai bandhara* holds water = 142

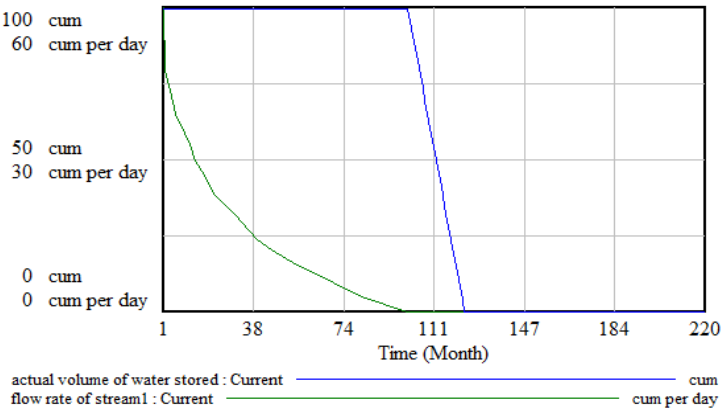


Figure 2-13: System Dynamics - output 1

Run 2 –

For gradient = 10%

Max water stored = 99.49 cum.

No. of days *vanrai bandhara* holds water = 122

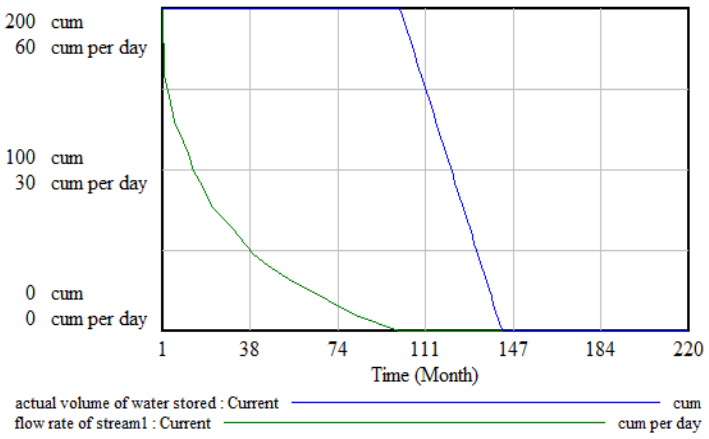


Figure 2-14: System Dynamics - output 2

Conclusions:

- Location of vanrai bandhara is primary factor on which its success depends. The slopes should be as gentle as possible.
- The time at which vanrai bandhara is constructed is also very important. It should be constructed as soon as the last rains are over.

- Some technical approval based on the strength of the stream, time of construction and slope of the stream should be given by Senior Engineer before going ahead with construction.

Directed Research – Component III

Objective

Analysis of Groundwater Survey and Development Agency's Rainwater Harvesting Tanks in Mokhada block

Methodology

- Field visits
- Interviews with –
    - Mr. K.S. Lokhande: Sub-divisional engineer, Rural Water Supply Sub-division, Jawhar
    - Beriste – Osarvira sarpanch
    - People of Beriste, Brahmangaon and construction workers at the site in Beriste
- Analysis

Overview

To combat with the drinking water security problem in Mokhada block, the Groundwater Survey and Development Agency (GSDA) has come up with a solution called RWH tanks (Rain water harvesting tanks). The details of the scheme are as follows:

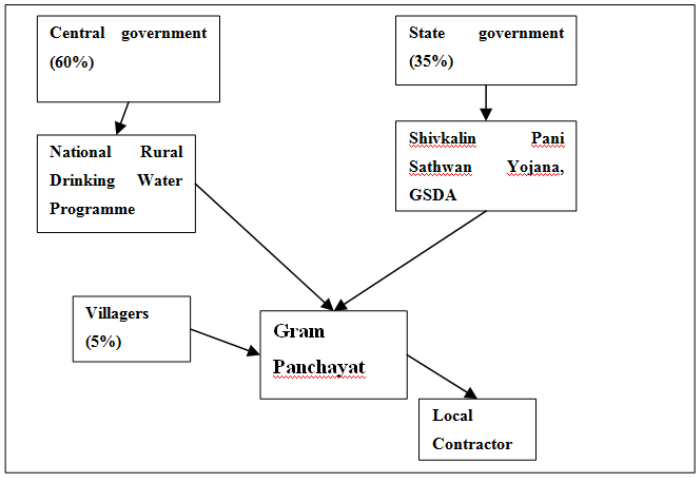
- 3,00,000 litres capacity R.C.C. G.S.R. for collecting and storing rain water during monsoon which will be utilized 6 months later during scarcity period
- Scheme being implemented in 3 blocks of Thane district

Table 11: Water harvesting structures - GSDA

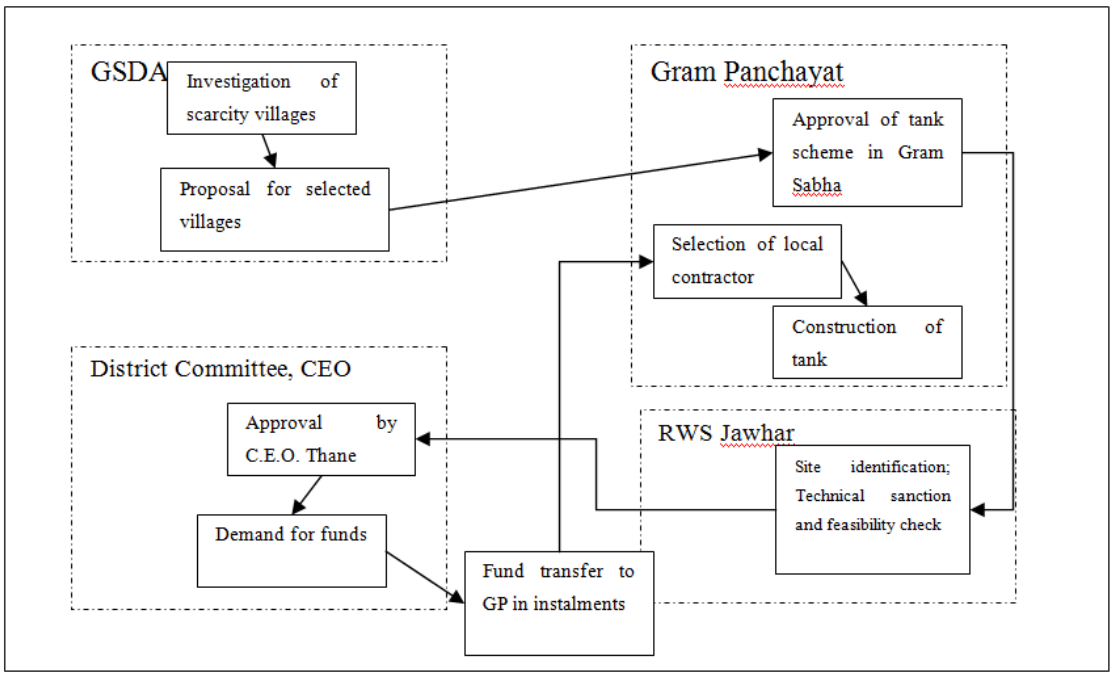
Block	Under construction	Proposed
Jawhar	5	5
Mokhada	8	9
Vikramgad	5	-

- Scheme design – as per Shivkalin Pani Sathwan Yojana of Groundwater Survey and Development Agency (GSDA)
- Scheme implemented through Rural Water Supply sub-division, Jawhar

- Cost of the project – around 18,00,000/- per tank
- Funding
    - Central government – 60%
    - State government – 35%
    - Gram Panchayat – 5%
- Fund flow



- Work flow



- Tank design
    - Capacity – 300000 litres
    - Tank diameter – 15 m
    - Tank height – 2 m

- Material – R.C.C. – M25
- R.C.C. lid designed specially to collect rainwater
- Rainwater to be collected at 4 points on the lid
- Filters connected to collection points
- 4 inner columns for support
- Hand pump to extract water from the tank
- Tank to be closed for six months after monsoon
- Man hole for cleaning

Features of the Shivkalin Pani Sathvan Yojana scheme

- Target villages – tanker-fed, scarcity-declared villages in Mokhada, Jawhar and Vikramgad blocks where all nearby sources go dry in summer and where piped water supply schemes do not fit in Maharashtra government's financial norm of 2330/- per capita
- Water will be stored for six months
    - Protected from sunlight
    - Protected from sewerage and waste water seepages
    - Filtered at collection point
    - TCL to be used for further purification
- Costs
    - One-time cost; no electricity cost
    - very low operation and maintenance cost
    - no / very low tariff
    - Funds handed over to Gram Panchayat after technical sanction by Rural Water Supply sub-division, Jawhar/Mokhada/Vikramgad i.e. Gram Panchayat to execute the project on their own by hiring local contractor

Conclusions

- Mental acceptance – Generally people here do not opt for stored or stale water. Hence people acceptance is the major issue in success of the scheme
- Village identification is a bit unclear. Approval in Gram Sabha is mandatory, but what happens at the ground level needs to be examined

- As Gram Panchayat hires local contractor, chances of bad quality of work increase (as skilled labourers will not be easily available). But presently local contractors are not hired for this scheme. All the works are being contracted to a big contractor from Dahanu.
- Scheme is designed for 300000 litres and 50 days i.e. 20 l.p.c.d. (litres per capita per day) for population of 300
    - If a village has more population, per capita availability will decrease even further.
    - If people from nearby villages also start depending on the tank, per capita availability will further decrease.
    - There will be no control over extraction if not properly managed. Tank may be emptied quite earlier than expected leaving people in scarcity for remaining dry period.
- No water quality tests during six-month period in the design.
- No mechanism for draining the tank for cleaning purpose. As per the design, the tank will be 1 m below ground and 1 m above ground. This makes the outlet more difficult to design.