

# Micro-watershed Analysis of Kurlod-Botoshi

## Status Report



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Mohit Singhal and Mukul Kaushik, BTech students from IIT Roorkee, prepared this report as part of their 2014 summer research internship at the Centre for Technology Alternatives for Rural Areas (CTARA) at IIT Bombay. They received invaluable support from Areohan (NGO based in Mokhada taluka), the villagers of Kurlod and Botoshi, and the Siemen's CSR team.

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# 1. EXECUTIVE SUMMARY

This report presents findings from a water security status assessment of the 13 habitations of Kurlod and Botoshi, two villages located in Mokhada taluka, Thane district. Despite receiving 2000-3000 mm of rainfall annually, this region faces a severe shortage of water for several months in a year.

During the dry months of May-July 2014, the team conducted site surveys and discussions with villagers to determine the severity of drinking water stress at each habitation. Findings include population, details about each well, and number and condition of existing bunds. Using the findings, habitations were categorized by level of drinking water stress.

Based on the analysis of existing structures and the area surrounding each habitation, a number of possible interventions have been discussed for increasing water availability for both drinking and livelihood purposes. The interventions described in this report are intended as a preliminary guide; a thorough investigation is required into the techno-economic feasibility and suitability of any intervention before it is finalized.

This report has been divided into three parts:

- Introduction: current status of water availability in each habitation
- Analysis: categorization of different habitations by level of drinking water stress
- Interventions: possible interventions to increase year-round water availability

***Table -- Summary of drinking water status in all habitations of Kurlod and Botoshi***

Habitation	Pop.	Wells	Water available until...	Stress category
Botoshi (Botoshi)	400	5	October (4), March (1)	High Stress
Kurlod (Kurlod)	400	4	Oct (1), Feb (1), May (1), year round (1)	High Stress
Markatwadi (Botoshi)	150	3	December (2), January (1)	High Stress
Wadpada (Kurlod)	100	2	October (2)	High Stress
Pethechapada (Kurlod)	450	3	Jan (1), year round (2)	Medium Stress
Raipada (Kurlod)	80	1	Year round	Medium Stress but poor water quality
Kirkirewadi (Botoshi)	40	1	Year round	Low Stress but poor water quality
Shedyachapada-Jambhulpada (Kurlod)	150	1	Year round	Low Stress
Bhelpada (Botoshi)	450	1	Year round	Low Stress
Bhojpada (Botoshi)	340	5	October (3), year round (1)	Low Stress
Manipada (Kurlod)	60	2	October (1), year round (1)	Low Stress
Kapshipada (Kurlod)	15	5	Jan (1), April (1), year round (3)	Low Stress

**Table -- Summary of possible interventions \***

Habitation	DW stress	Intervention	Purpose
Botoshi	<b>High Stress</b>	Old Bund Repair	Connectivity+Livelihood
		Old Well Repair	Drinking
Kurlod	<b>High Stress</b>	New Bund	Livelihood
		Watershed treatment	Drinking
Markatwadi	<b>High Stress</b>	New Bund	Drinking+Livelihood
		New Well	Drinking
		Old Well Repair	Drinking
Wadpada	<b>High Stress</b>	New Bund	Drinking+Livelihood
		Watershed treatment	Drinking
Pethechapada	<b>Medium Stress</b>	New Bund	Drinking+Livelihood
Raipada	<b>Medium Stress</b>	Old Well Repair	Drinking
Bhojpada	<b>Low Stress</b>	New Bund	Drinking+Livelihood
		Old Bund Repair	Livelihood
Manipada	<b>Low Stress</b>	Old Bund Repair	Drinking+Livelihood

\* Possible interventions are identified for 8 of the 13 habitations – the remaining are five Low Stress habitations: Kirkirewadi, Shedyachapada, Jambhulpada, Bhelpada, and Kapshipada.

The objectives of this study were: to assess the intensity of the water scarcity in the 13 habitations of Kurlod-Botoshi, to identify and collect basic information on the existing wells and bunds, and to suggest a set of watershed interventions to explore that would help alleviate the drinking water crisis or provide additional water for livelihood.

Next steps from here would be the preparation of technical designs for the interventions, starting perhaps with the interventions for the High Stress habitations. This process would include deriving estimates for the demand for drinking and livelihood uses, sustainable supply rates of existing wells and structures, the volume of additional water that can be stored, cost figures, and so on. These tasks would form the scope of the next project.

## 2. CURRENT WATER SECURITY STATUS

### 2.1 Background on Kurlod - Botoshi

Kurlod and Botoshi are villages in Mokhada taluka, Thane district, Maharashtra. Botoshi village has five habitations, one named after itself: Botoshi, Bhelpada, Bhojpada, Kirkirewadi and Markatwadi. Kurlod has eight habitations: Kurlod, Jambhulpada, Kapshipada, Manipada, Pethechapada, Raipada, Shedyachapada and Wadpada. The overall population of Botoshi and Kurlod are around 1380 and 1354 respectively. A noteworthy point is that generally the habitations are on higher altitude than their water resources. At some places, this elevation difference is as high as 60 meters, while the distance of habitation to water resources is usually about one kilometer. Usually women fetch water in *handis* balanced on their heads, carrying weights as great as 40 kilograms at a time. At most of the habitations, the primary source of water is well water and the secondary is the Pinjal River or streams that drain into it.

This chapter describes the findings from site visits and surveys on the water security status in each of the habitations. The field visits were conducted in the summer months of May-June 2014. The table below summarizes a portion of the findings; additional details about each habitation are included in further in the chapter.

**Table -- Summary of findings**

Habitation	Pop.	Wells	Water available until...
Botoshi (Botoshi)	400	5	October (4), March (1)
Kurlod (Kurlod)	400	4	Oct (1), Feb (1), May (1), year round (1)
Markatwadi (Botoshi)	150	3	December (2), January (1)
Wadpada (Kurlod)	100	2	October (2)
Pethechapada (Kurlod)	450	3	Jan (1), year round (2)
Raipada (Kurlod)	80	1	Year round
Kirkirewadi (Botoshi)	40	1	Year round
Shedyachapada- Jambhulpada (Kurlod)	150	1	Year round
Bhelpada (Botoshi)	450	1	Year round
Bhojpada (Botoshi)	340	5	October (3), year round (1)
Manipada (Kurlod)	60	2	October (1), year round (1)
Kapshipada (Kurlod)	15	5	Jan (1), April (1), year round (3)

## 2.2 Water sources and seasonal availability in each habitation

### 2.2.1 Botoshi (habitation), Botoshi village

The Botoshi habitation has about 68 households and a population of 400. The primary sources of water are the five wells around the habitation, most at almost 300 meters away from habitation. Out of five wells, four dry very early and one retains water up to March.

The secondary source of water is the Pinjal river which is about 300 meters from the habitation. The villagers dig pits of depth varying from one to three meters along the side of the river and collect water from the pit. There's a bund as well along the stream but it's broken. Besides poor water availability, a major issue at the Botoshi habitation is accessibility; the habitation is almost one kilometer from the closest road and a river needs to be crossed to reach it. Healthcare is also severe issue – the nearest health center is in Khodala which is 20 km away.

Even if it is hundreds of meters away, water is available so villagers have not demanded water tankers yet. According to villagers in the Botoshi habitation the government has not come up with any water scheme till now.

#### Data Tables for Botoshi (habitation), Botoshi village

Habitation	Elevation (m)	No. of Households	Population
Botoshi	182	68	400

Wells	Well 1/Botoshi	Well 2/Botoshi	Well 3/Botoshi	Well 4/Botoshi	Well 5/Botoshi
Elevation(m)	171	174	174	170	181
*Elevation difference(m)	-11	-8	-8	-12	-1
Diameter (m)	3	6	2.5	4.5	3
**Depth (m)	3.8	1.5	2.5	3	6
Water available upto	October	October	October	October	March
No. Of Dry months	7	7	7	7	3
Distance from habitation (m)	300	400	350	400	300

\*'Elevation difference' in the table refers to the elevation difference between well and respective habitation. \*\*'Depth' in the table refers to the depth of well up to water surface.

River pits	River pit 1/Botoshi	River pit 2/Botoshi	River pit 3/Botoshi
Elevation(m)	171	171	172
Elevation difference(m)	-11	-11	-10
Diameter (m)	1	0.4	0.6
Distance from habitation (m)	300	350	350
Elevation(m)	171	171	172

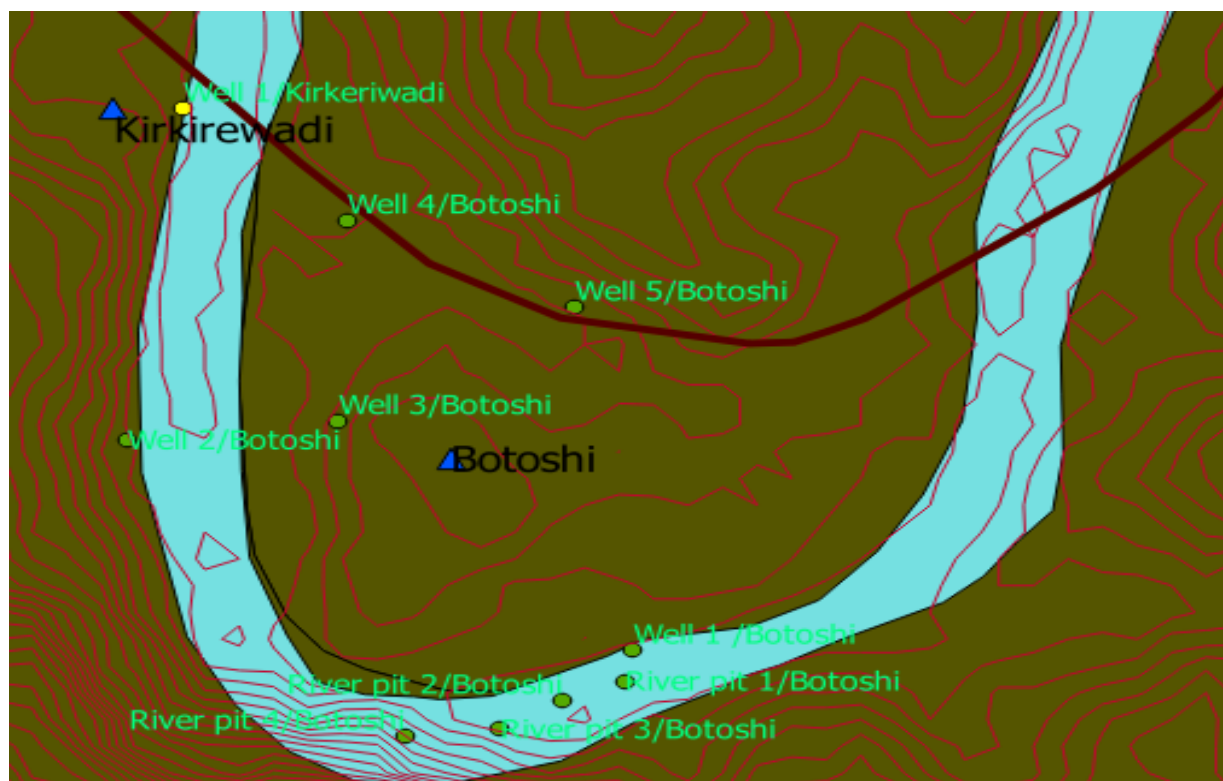


Figure 1 Location of wells in Botoshi (habitation)



### 2.2.2 Markatwadi, Botoshi village

Markatwadi is another habitation of Botoshi village. There are 25 households here and the population is around 150. The primary source of water here is well water. There are three wells here that retain water up to the month of December only. After that people go use the river as secondary water source. Primary and secondary sources of water are 300 and 350 meters from the habitation respectively. As long as water remains in the wells i.e. up to December, people use it for drinking purpose and the river for other uses. After that, they are totally dependent on the river. There is a primary school in the Markatwadi habitation, but healthcare and connectivity are major problems here again. This habitation gets totally cut off during monsoons.

There hasn't been any bund constructed in this region yet. According to the villagers, the government has not implemented any scheme till now.

#### Data tables for Markatwadi, Botoshi village

Habitation's name	Elevation (m)	No. of households	Population
Markatwadi	196	25	150

Source	Well 1/Markatwadi	Well 2/Markatwadi	Well 3/Markatwadi
Elevation(m)	199	166	164
Elevation difference(m)	3	-30	-32
Diameter (m)	3.5	4	3
Depth (m)	3	3	1
Water available upto	December	January	December
No. Of Dry months	5	4	5
Distance from habitation (m)	200	350	450

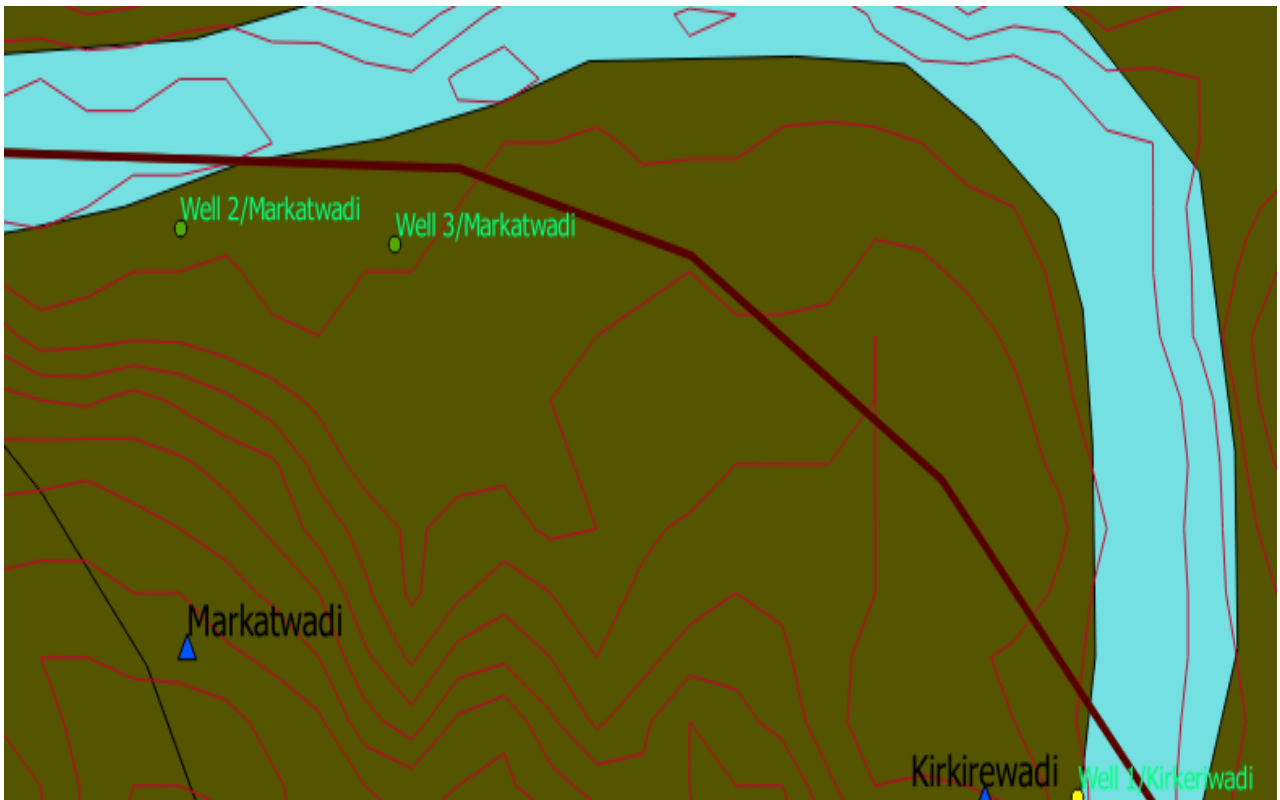


Figure 2 Location of wells in Markatwadi

### 2.2.3 Kirkirewadi, Botoshi village

You can reach Kirkirewadi habitation through Botoshi habitation after crossing the Pinjal river by foot. There are only eight households here and the population is merely 40. The primary source of water is the one well here, which retains water for the whole year but in April-May, the water in this well isn't drinkable. During this time people go for river water as a secondary water source. Primary and secondary sources of water are around 100 and 150 meters from the habitation respectively. There is no school in the habitation - children have to Markatwadi for primary education after crossing another river stream in between. Again, the major problems here are healthcare and connectivity. This region gets totally cut off during monsoons. There hasn't been any bund constructed in this region yet. According to people over there government hasn't implemented any scheme there till now.

#### Data tables for Kirkirewadi, Botoshi habitation

Habitation's name	Elevation (m)	No. of households	Population
Kirkirewadi	172	8	40

Source	Well1/Kirkeriwadi
Elevation(m)	166
Elevation difference(m)	-6
Diameter (m)	3
Depth (m)	5
Water available upto	Always
No. Of Dry months	0
Quality (visiblity )	Poor
Distance from habitation	30



Figure 3 Well in Kirkirewadi (June 2014)

## 2.2.4 Bhelpada, Botoshi village

Bhelpada has 50 houses and a population of 450. There is one well, which is at a distance of almost 200 meters and which meets the needs of villagers up to the month of June. After June, it does not remain suitable for drinking purposes. The river is used for other daily uses and after June villagers become entirely dependent on the river which is almost 500 meters from the habitation. Again, the healthcare issue is severe here: the nearest health center is in Khodala which is at a distance of 20 kilometers. The electricity is in about 35% of homes. As a pakka road passes through this habitation, there is no issue of connectivity here. There is primary school in the habitation.

### Data tables for Bhelpada, Botoshi village

Habitation's name	Elevation (m)	No. of households	Population
Bhelpada	197	50	450

Source	Well 1/Bhelpada
Elevation(m)	180
Elevation difference(m)	-17
Diameter (m)	7
Depth (m)	8
Water available upto	Always
No. Of Dry months	0
Quality (visiblity )	Good
Distance from habitation (m)	350
Source	Well 1/Bhelpada
Elevation(m)	180
Elevation difference(m)	-17

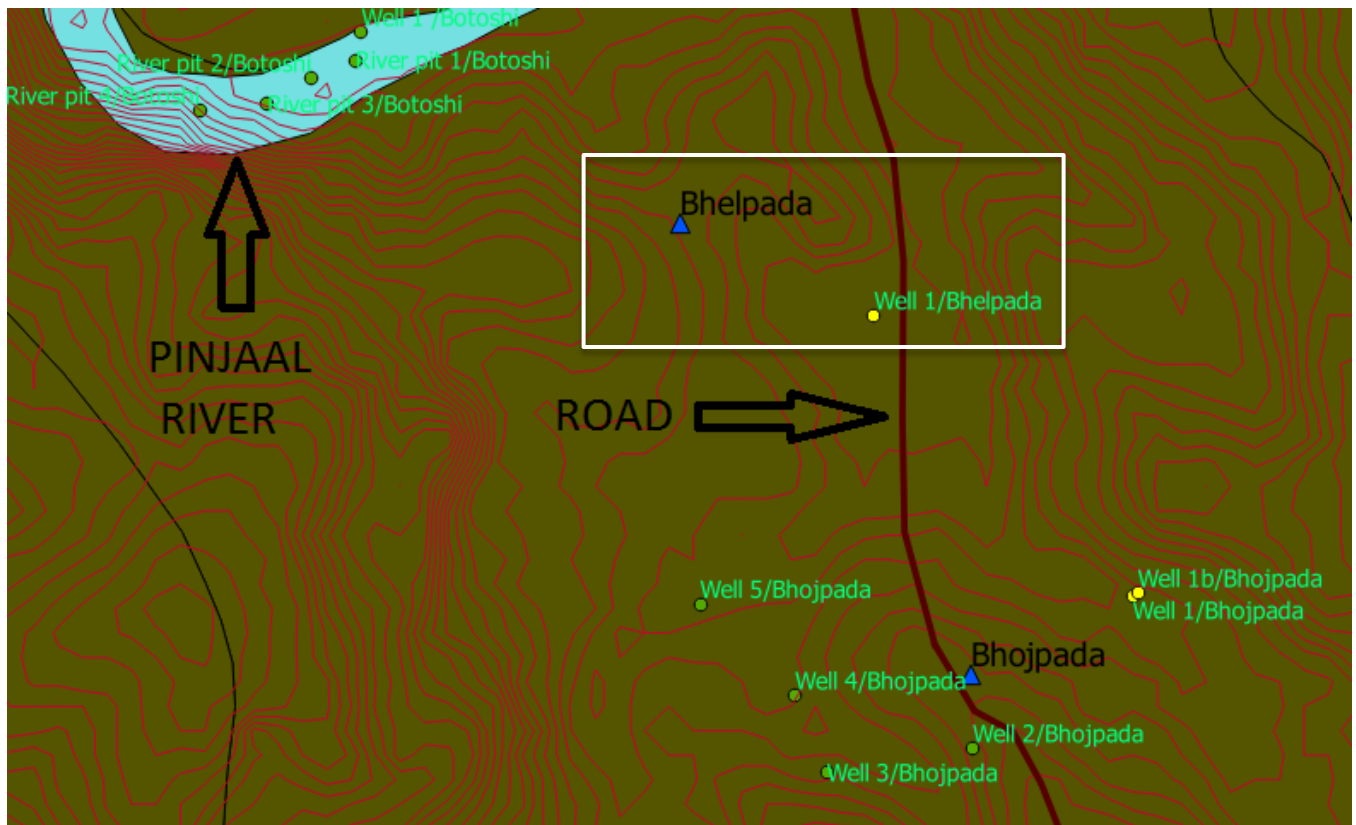


Figure 4 Location of well in Bhelpada

### 2.2.5 Bhojpada, Botoshi village

Bhojpada is connected to the road network by a pakka road; it lies on two sides of that road. There are 65 houses in the habitation and the population is 340. There are five wells in Bhojpada. In two of them, water remains for the whole year and in the rest, up to October only. In those two wells, people use the water of only one well as it is transparent and seems of better quality. This well could possibly be used for supplying water to Botoshi by some means.

In Bhojpada, there are two bunds, one of them is highly silted and possibly leaks. The second bund is able to retain water for few months only. There is a primary school in the habitation but access to health care is a problem.

#### Data tables for Bhojpada, Botoshi village

Habitation's name	Elevation (m)	No. of households	Population
Bhojpada	215	65	340

Source	Well 1/ Bhojpada	Well 1b/ Bhojpada	Well 2/ Bhojpada	Well 3/ Bhojpada	Well 4/ Bhojpada	Well 5/ Bhojpada
Elevation(m)	202	204	216	209	201	195
Elevation difference(m)	-13	-11	1	-6	-14	-20
Diameter (m)	6.5	4.5	3	4	5	6
Depth (m)	5	3.5	2	3	2.5	7
Water available upto	Always	Always	October	October	October	Not sure
No. Of Dry months	0	0	7	7	7	0
Quality	Good					Poor
Distance from habitation (m)	350	350	100	150	250	500

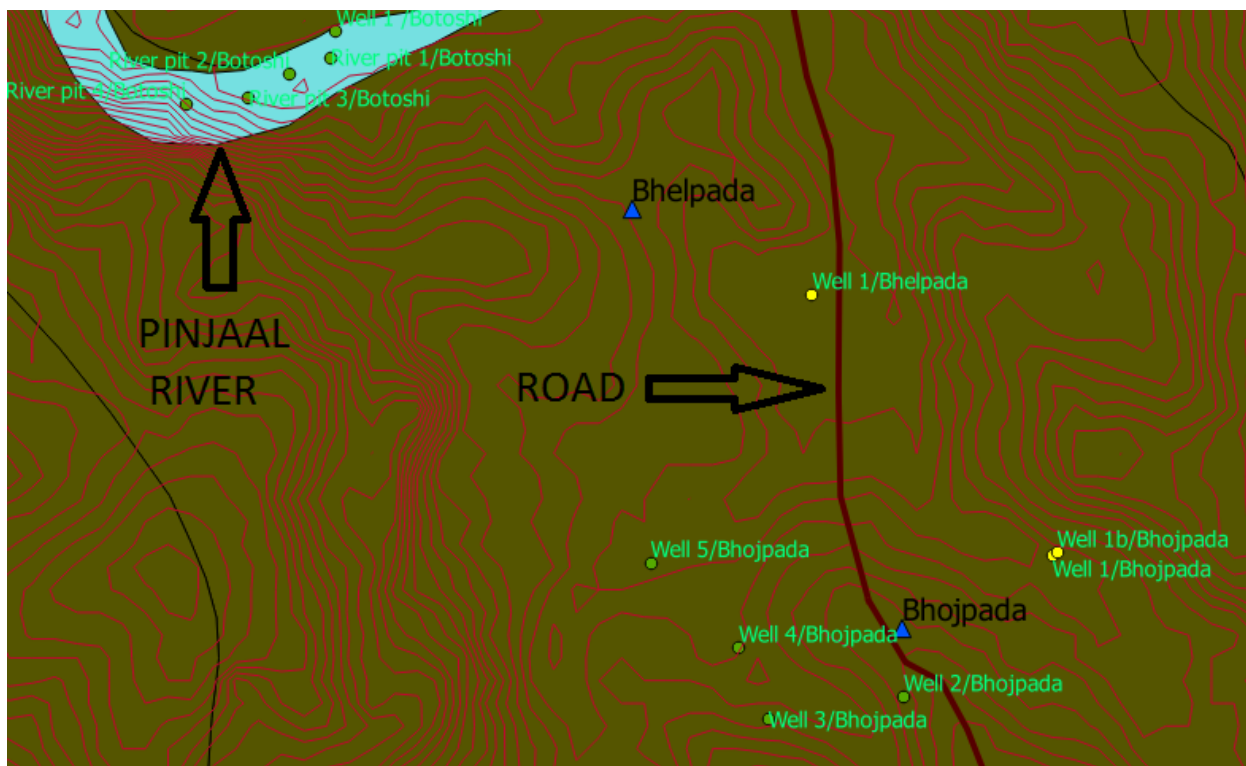


Figure 5 Location of wells in Bhojpada

### 2.2.6 Wadpada, Kurlod village

There are 22 households in Wadpada and the population is around 100. Here, people have formed two separate groups of households, possibly because of their agricultural land. One of them is located at an elevation of 191 meters and another is at 174 meters. Like Botoshi, the primary source of water here is from wells and the secondary source is Pinjal River. There are two wells that retain water up to October, and after this they use the river water. The river is at a distance of about a kilometer from the hamlet. According to the people, they need a bund on the nearby stream. The water requirement for a particular family having five members is about ten to twelve *haandis* a day or 70-80 liters a day.

Another major issue is accessibility. There is no pakka road to this habitation. There is no electricity and no school as well. For primary education, children have to go Manipada and for further study, an aashram in Adoshi. According to the villagers, the government has not implemented a water-related scheme there.

#### Data tables for Wadpada, Kurlod village

Habitation's name	Elevation (m)	No. of households	Population
Wadpada	182	22	100

Source	Well 1/Wadpada	Well 2/Wadpada
Elevation(m)	191	174
Elevation difference(m)	9	-8
Diameter (m)	3.2	6
Depth (m)	2.7	8
Water available upto	October	October
No. Of Dry months	7	7
Quality		
Distance from habitation (m)	200	400



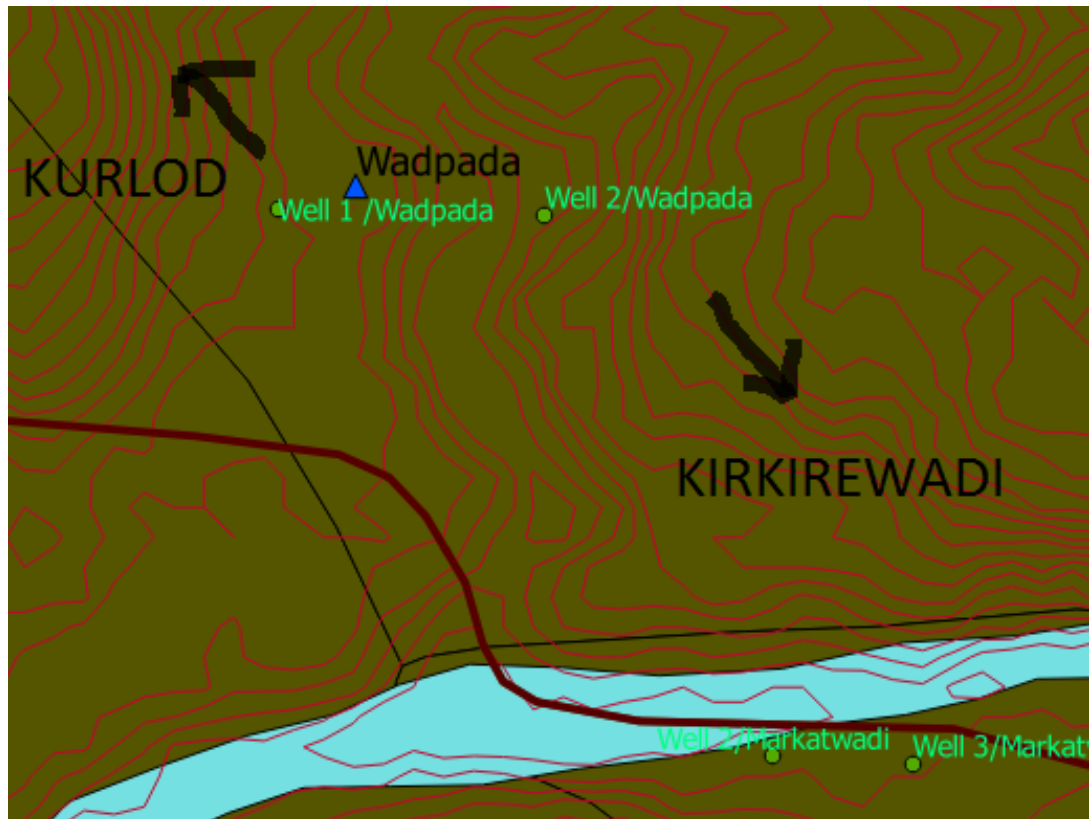


Figure 6 Location of wells in Wadpada

### 2.2.7 Manipada (Manichapada), Kurlod village

Manipada has only 17 households and a population of 60. There are two wells here: one dries in October and other one retains water for whole year. The habitation has a partially constructed bund with a length of 70 meters which can be a major source of water for nearby people.

There is a primary school here and for further education they go to the ashramshala in Adoshi. There is no electricity but the main problem, according to the villagers, is health care. There is no health center in the habitation. However, a healthcare camp is organized for four months i.e. June to September.

#### Data tables for Manipada

Habitation's name	Elevation (m)	No. of households	Population
Manipada	170	17	60

Source	Well 1/Manipada	Well 2/Manipada
Elevation(m)	177	162
Elevation difference(m)	7	-8
Diameter (m)	3.2	6
Depth (m)	3.2	5.8
Water available upto	October	Always
No. Of Dry months	7	0
Quality		Poor
Distance from habitation (m)	300	200

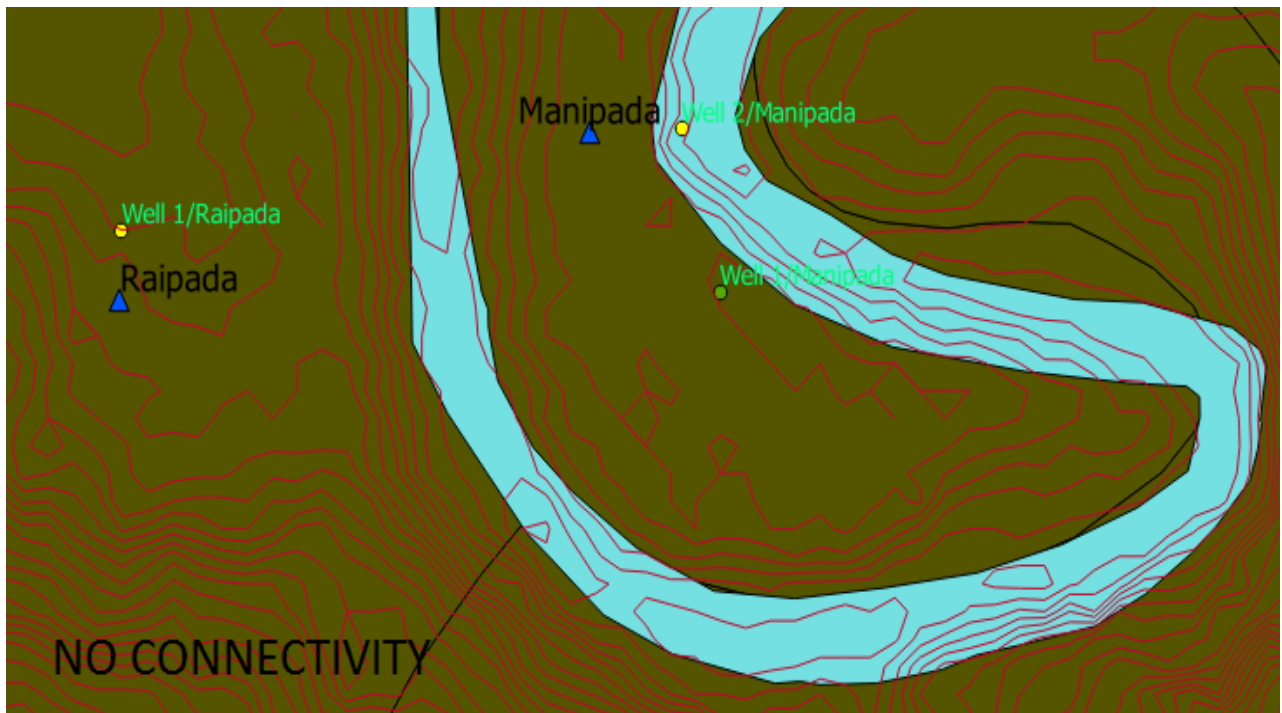


Figure 7 Location of wells in Manipada and Raipada



Figure 8 Incomplete bund at Manipada (Kurlod)

### 2.2.8 Raipada, Kurlod Village

There are 22 households in this habitation and the population is around 80. There is one well in the habitation which villagers say lasts through the year but whose water is unfit for drinking. Villagers still use the water for drinking, however. There was an additional well that had been washed away by the river flow last year. Villagers in Raipada say that that well had better quality of water and had water available for the whole year. In the same stream, there is a bund in which the water is available up to February. There is electricity and a primary school here, and for further education children go to the ashram shala in Adoshi.

#### **Data tables for Raipada**

[see Figure 7 for map showing the well in Raipada]

Habitation's name	Elevation (m)	No. of households	Population
Raipada	183	22	80

Source	Well 1/Raipada
Elevation(m)	177
Elevation difference(m)	-6
Diameter (m)	5.8
Depth (m)	7
Water available upto	Always
No. Of Dry months	0
Quality	Poor
Distance from habitation (m)	150

### 2.2.9 Shedyachapada, Kurlod village

This hamlet has 26 households and a population of 150. There are two wells that retain water for whole year and in which the water appears clear. The one with the poorer water quality is used by both Shedyachapada and Jambhulpada since both habitations are very close to each other. People use the well water for drinking purposes and the river for washing purpose.

There is electricity in this habitation but no school. The children have to go Jambhulpada for primary education and for further education up to senior secondary they go to Adoshi. According to the villagers surveyed, the main problem in this hamlet is health care.

#### Data tables for Shedyachapada, Kurlod village

Habitation's name	Elevation (m)	No. of households	Population
Shedyachapada	161	26	150

Source	Well 1/Shedyachapada
Elevation(m)	145
Elevation difference(m)	-16
Diameter (m)	3.6
Depth (m)	4
Water available upto	Always
No. Of Dry months	0
Quality	Poor
Distance from habitation (m)	200

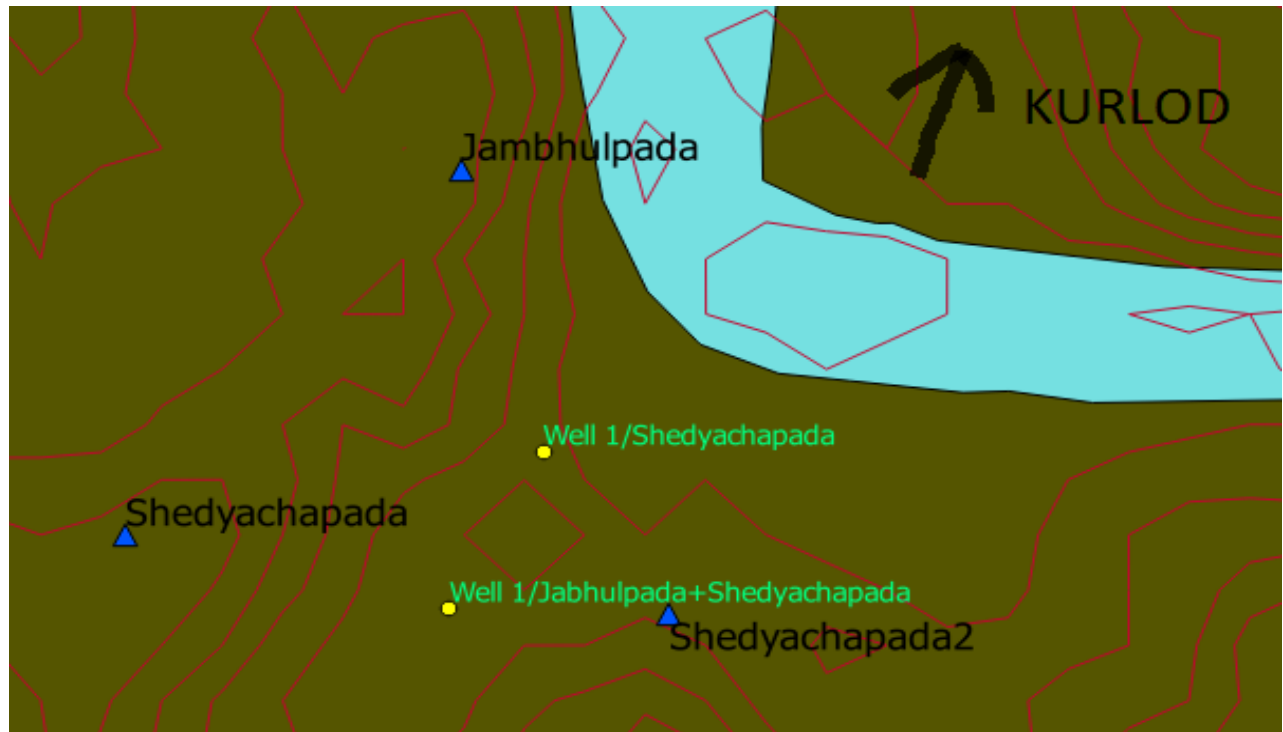


Figure 9 Location of wells in Shedyachapada

### 2.2.10 Jambhulpada

There are 21 households in this hamlet and the population is around 90. The primary source of water is the well in the previous hamlet discussed, Shedyachapada, which is common for both. As with other habitations, villagers at Jambhulpada use river water for other purposes. There is electricity with 600-700 metered connections. There is a primary school and for further education they go Adoshi.

#### **Data Tables for Jambhulpada:**

Habitation's name	Elevation (m)	No. of households	Population
Jambhulpada	153	21	90

Source	Well 1/Jambhulpada+Shedyachapada
Elevation(m)	148
Elevation difference(m)	-5
Diameter (m)	3.1
Depth (m)	2.8
Water available upto	Always
No. Of Dry months	0
Quality	Good
Distance from habitation (m)	300/300

### 2.2.11 Kurlod (habitation), Kurlod village

This is the largest habitation in Kurlod village. It has 88 households and a population of 400. Many of the households have cattle, and the total cattle population in the habitation is 150. There are four wells here. One of them remains filled for twelve months but people don't use it because there is a mortuary nearby. Two other dry very early and the fourth one dries in May. As a secondary source, they use river water in the same fashion as people do in Botoshi i.e. they dig beside river stream and form pits. These pits have clear water. Also, a bund is there but because of a lot of siltation, its capacity has decreased drastically. There is a primary school; for further education they go Adoshi.

Data tables for Kurlod (habitation), Kurlod village

Habitation's name	Elevation (m)	No. of households	Population
Kurlod	175	88	400

Source	Well 1/Kurlod	Well 2/Kurlod	Well 3/Kurlod	Well 4/Kurlod
Elevation(m)	145	172	185	153
Elevation difference(m)	-30	-3	10	-22
Diameter (m)	6	2.4	2.7	4.9
Depth (m)	6	2.8	4	6
Water available upto	Always	October	February	May
No. Of Dry months	0	8	3	1
Distance from habitation (m)	150	250	200	600



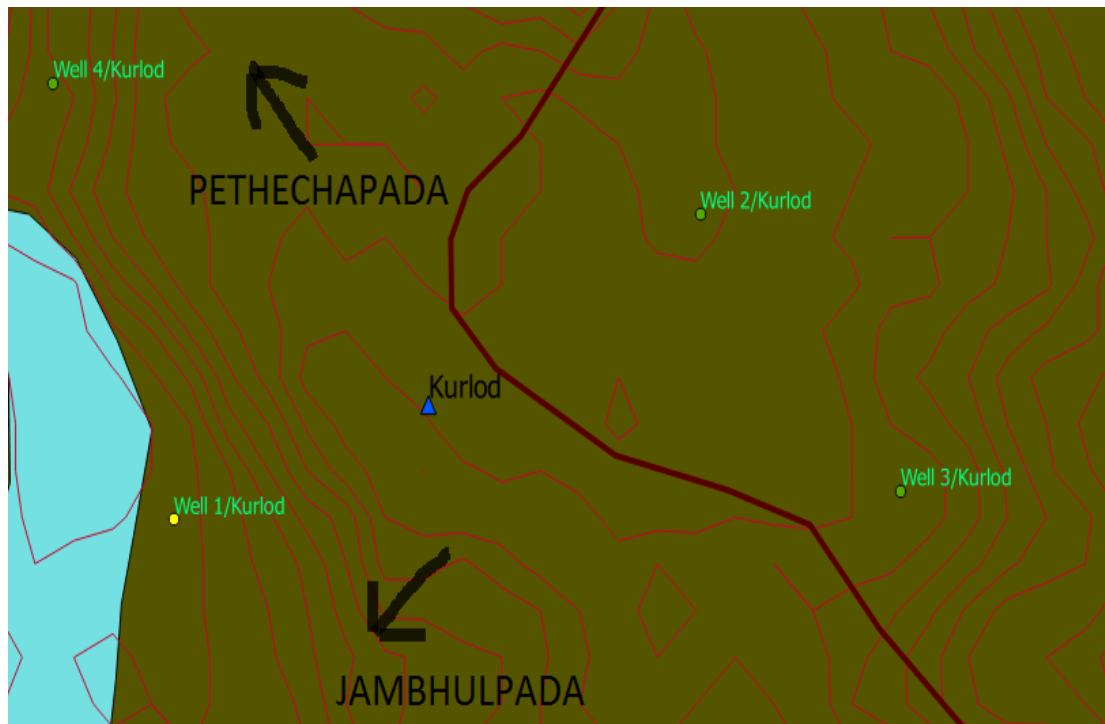


Figure 10 Location of wells in Kurlod habitation



Figure 11 Siltation in bund in Kurlod habitation

### 2.2.12 Pethechapada, Kurlod village

Pethechapada is the first habitation you find when you go Kurlod by road. There are 65 households and the population is around 450. There is electricity with 25 metered connections. There are three wells, out of which one is not used due to poor quality water, one dries in February and the third is in the stream and never dries. People also use a river pit close to stream-well. Sometimes they share a well with Kurlod as well. In this habitation, a health camp is organized every year from June to September.

#### Data Tables in Pethechapada, Kurlod village

Habitation's name	Elevation (m)	No. of households	Population
Pethechapada	152	65	450

Source	Well 1/Pethechapada	Well 2/Pethachapada	Well 3/Pethachapada	River pit 1/Pethachapada
Elevation(m)	147	162	160	147
Elevation difference(m)	-5	10	8	-5
Diameter (m)	7.1	7	5.8	1
Depth (m)	5.1	6	5.8	0.5
Water available upto	Always	Always	Jan-Feb	(unknown)
No. Of Dry months	0	0	4	(unknown)
Quality	good	poor	(unknown)	(unknown)

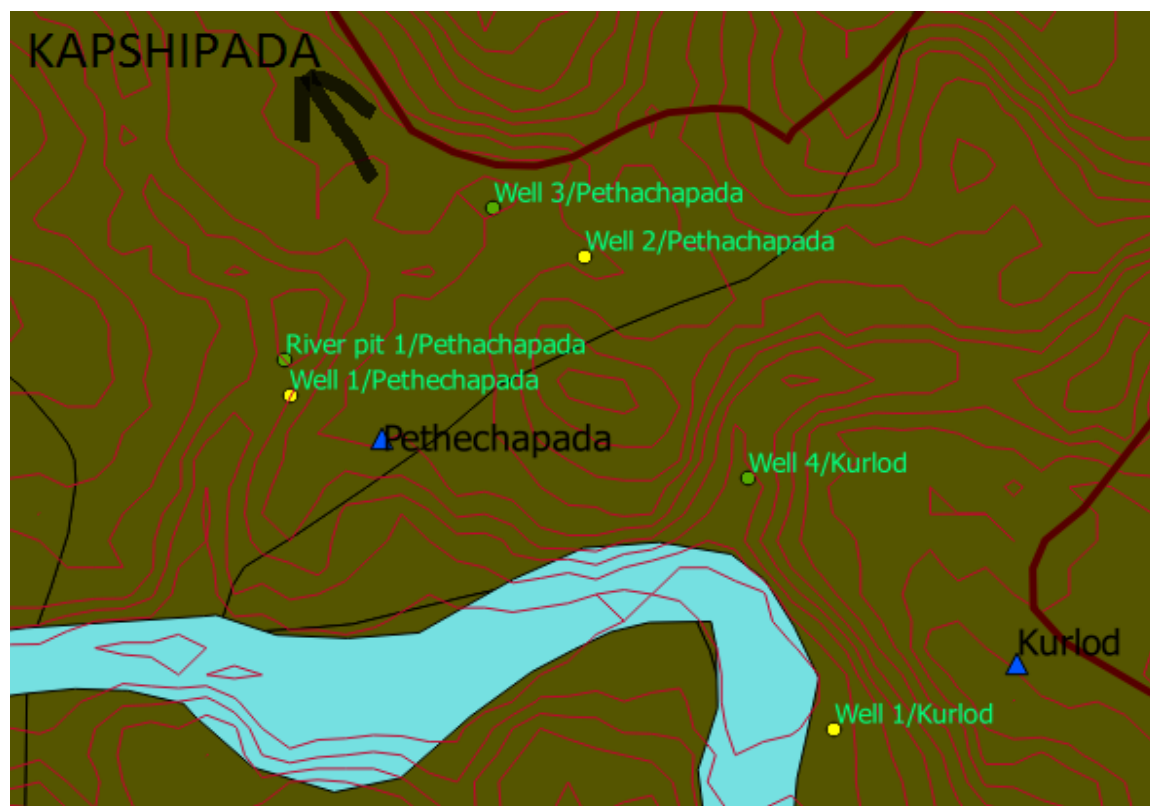


Figure 12 Location of wells in Pethachapada

### 2.2.13 Kapshipada, Kurlod village

Kapshipada is the smallest habitation of the Kurlod village with only four households. Each of the households owns their own private well. In total, there are five wells. Two retain water up to January or February and rest retain water for the full year. The villagers have started fishing in them as well. There is no electricity or school in the village. For primary education children go to Pethechapada and for further studies they go to Adoshi.

#### Data tables for Kapshipada, Kurlod village

Habitation's name	Elevation (m)	No. of households	Population
Kapshipada	178	4	15

Source	Well 1/Kapshipada	Well 2/Kapshipada	Well 3/Kapshipada	Well 4/Kapshipada	Well 5/Kapshipada
Elevation(m)	170	175	168	172	171
Elevation difference(m)	-8	-3	-10	-6	-7
Diameter (m)	5.5	6	3	5	5.7
Depth (m)	4.5	8.5	3	3.5	5.8
Water available upto	April	Always	Jan-Feb	Always	Always
No. Of Dry months	2	0	4	0	0
Quality				Poor	Poor
Distance from habitation (m)	200	150	150	200	150

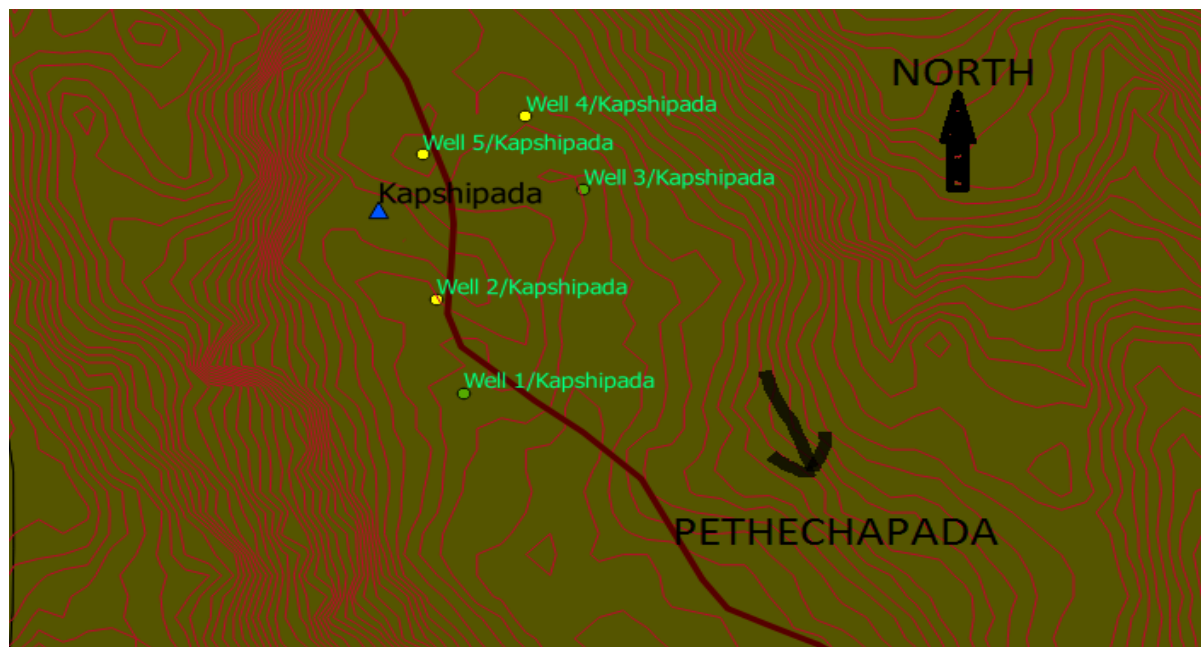


Figure 13 Locations of wells in Kapshipada



Figure 14 Hamlet meeting

### 3. DRINKING WATER STRESS ANALYSIS

From our observations, villagers in Botoshi and Kurlod use wells for drinking purposes until they run dry, and at that point they turn to river water or stored water of much poorer quality. For livelihood water purposes, villages will generally use the water stored in bunds or the river water directly. Based on our surveys and site visits at each habitation, we have categorized the intensity of drinking water stress in each habitation and offered possible solutions or interventions to address the same. In habitations where the drinking water stress levels are low, the interventions mentioned would focus on increasing the water for livelihoods.

The table below shows the habitations categorized based on the level of water stress. We have used the following standard:

- A habitation where there exists no single well that lasts for whole year is listed as 'High Stress'.
- A habitation where there is a well which lasts for whole year but either has a water quality issue or is not used by the villagers is listed as 'Medium Stress'
- All others habitation are categorized as 'Low Stress'

**Table – Stress levels of drinking water availability and road connectivity**

Habitation	Water Issue	Connectivity Issue
Botoshi	High Stress	Medium Stress
Markatwadi	High Stress	High Stress
Wadpada	High Stress	High Stress
Kurlod	High Stress	Low Stress
Pethechapada	Medium Stress	Low Stress
Raipada	Medium Stress and quality needs to be checked.	High Stress
Kirkirewadi	Low Stress but quality needs to be checked.	High Stress
Shedyachapada-Jambhulpada	Low Stress but quality needs to be checked.	High Stress
Bhelpada	Low Stress	Low Stress
Bhojpada	Low Stress	Low Stress
Manipada	Low Stress	High Stress
Kapshipada	Low Stress	Low Stress

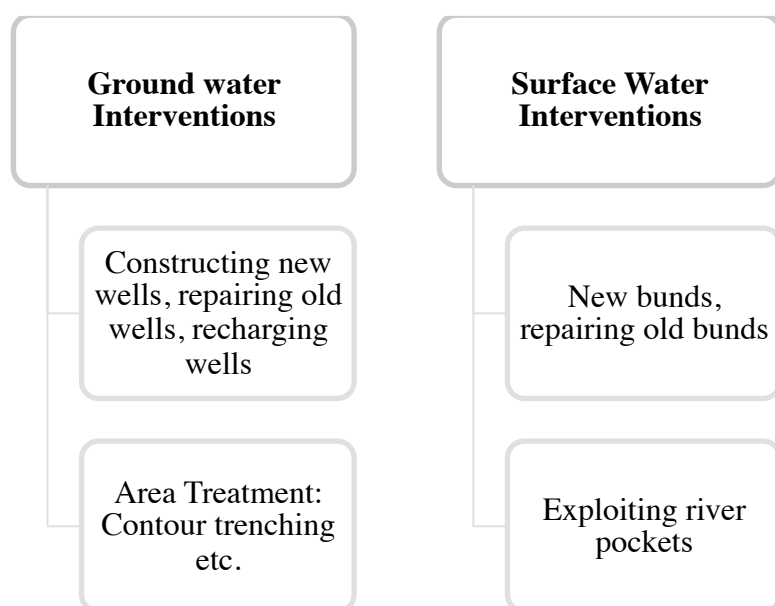
## 4. POSSIBLE WATERSHED INTERVENTIONS

The previous section presents the findings of the surveys and site visits and categorizes the 13 habitations in Kurlod and Botoshi based on the degree of drinking water stress. In this section we suggest a set of interventions to explore for the region based on the water resources and existing structures in the habitations.

The interventions in this section have been identified after a preliminary site visit and the analysis of GIS maps around each habitation. This section is intended to be used only as a guide to the next stage of the project; a detailed techno-economic feasibility study of an intervention must be conducted before it is selected for implementation. Factors such as the design feasibility, storage capacity, and cost of the intervention, as well as the estimated water demand at each habitation, would be part of such an investigation.

### 4.1 General Notes

The flow chart below outlines the possible types of watershed interventions in Kurlod-Botoshi.



For drinking water purposes, our aim would be strengthening wells in particular. In habitations where there is a well near the stream, there may be a possibility to recharge the well by constructing a bund just downstream. If location permits, such wells can also be recharged by watershed treatment (e.g.



contour trenching, plantation) along the upstream side of the stream feeding this well. There are some locations, such as Raipada, where wells need to be repaired as well.

For livelihood purposes, we would aim to increase the storage of surface water. Many bunds in Kurlod and Botoshi villages are not functional: some are broken, highly silted or leaking. Old bunds could be repaired, while at some locations new bunds could also be constructed. Some habitations, namely Botoshi, Kurlod, Wadpada and Manipada, are close to river pockets (see figure below). These pockets can also be exploited for livelihood purposes or, if the water stored here is treated, can be used for drinking water.

The next part looks at possible interventions in detail and the approximate locations where they could be implemented. A note about images: most of the intervention descriptions have an accompanying GIS image of the region which marks the key drainage lines, including major and minor streams. The darkest color (black) indicates the lowest elevation points and generally represents the Pinjal river, whereas the blues are likely to be smaller streams draining into the Pinjal river.

The table below summarizes the interventions described in the rest of the chapter:

***Table – Summary of possible interventions***

Habitation	DW stress	Intervention	Purpose
Botoshi	<b>High Stress</b>	Old Bund Repair	Connectivity+Livelihood
		Old Well Repair	Drinking
Kurlod	<b>High Stress</b>	New Bund	Livelihood
		Watershed treatment	Drinking
Markatwadi	<b>High Stress</b>	New Bund	Drinking+Livelihood
		New Well	Drinking
		Old Well Repair	Drinking
Wadpada	<b>High Stress</b>	New Bund	Drinking+Livelihood
		Watershed treatment	Drinking
Pethechapada	<b>Medium Stress</b>	New Bund	Drinking+Livelihood
Raipada	<b>Medium Stress</b>	Old Well Repair	Drinking
Bhojpada	<b>Low Stress</b>	New Bund	Drinking+Livelihood
		Old Bund Repair	Livelihood
Manipada	<b>Low Stress</b>	Old Bund Repair	Drinking+Livelihood



## 4.2 Kurlod habitation (High Stress)

Kurlod is categorized as High Stress. It has four wells, three of which run dry during the year and a bund that is highly silted. The fourth well, which has water through the year, is not used because there is a mortuary nearby. The following interventions are suggested:

### Well strengthening by repairing bund:

Figures below show the bund (“bund1”) that is highly silted and leaking. It lies on a stream, just downstream of a well (“well4”). If this bund would function properly, well4 would get better recharged. This well is used by both by Kurlod and Pethechapada and right now retains water up to the month of May, but the villagers surveyed believe it cannot sustainably supply to both habitations due to the low quantity of water available each day. Repairing the bund could solve both drinking and livelihood water issues in Kurlod and Pethechayapada.



Figure 5 Location of bund-1 in Kurlod habitation

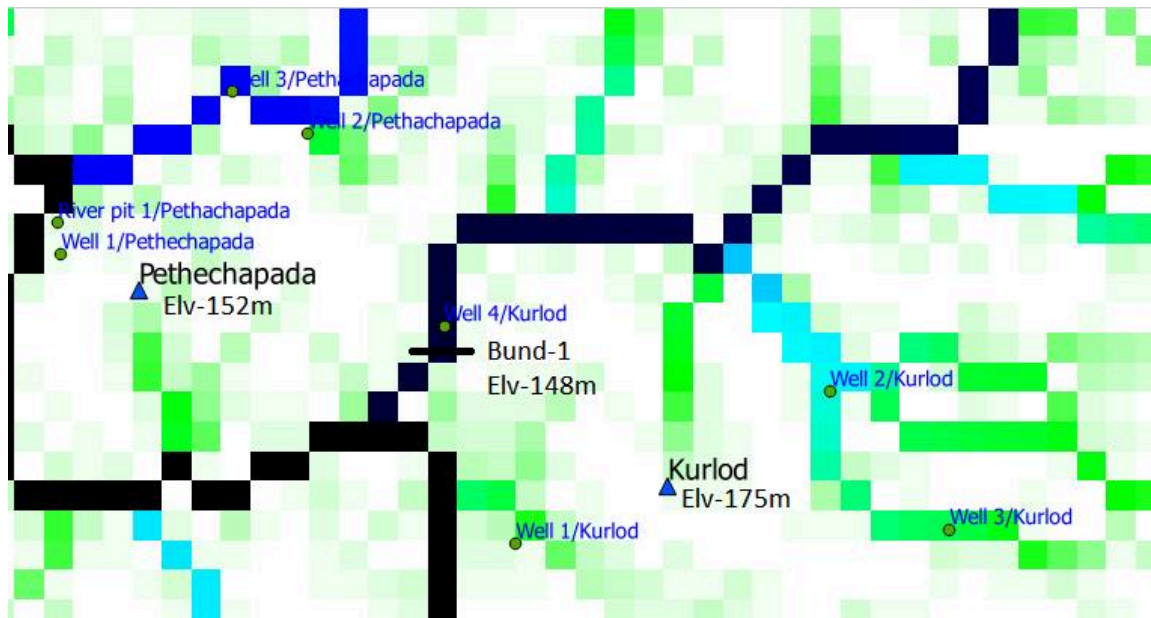


Figure 6 GIS image showing location of bund-1 in Kurlod

#### Well strengthening by Area Treatment:

In Kurlod, to recharge 'well2' and 'well3' as shown in figures below, contour trenching can be done on the hills just beside them. It will help in recharging groundwater and hence recharge these wells.



Figure 17 Possible location for contour trenching in Kurlod

### New Bund Construction for Livelihood purpose

In Kurlod, near 'well-2', there's a stream having very high natural embankments with around 13 meters depth. This site may be fit for a new bund. The figure below shows the location where the bund could be constructed. The increased water storage from this bund would provide water for livelihood by allowing farmer to irrigate winter crops as well.



Figure 18 Possible location of a new bund in Kurlod



### 4.3 Markatwadi (High Stress)

Markatwadi is listed as a high stress habitation. It has three wells, all of which dry by December-January. Villagers are then forced to turn to the river for drinking water. Possible interventions for Markatwadi would be repairing the well and constructing a new bund to increase the well recharge. The following interventions are suggested for exploration:

#### Old Wells Repair and bund construction:

In Markatwadi, one well ('well3') needs to be cleaned and dug more. Currently its depth is merely a meter or two. There is another well ('well2') near it, which is incompletely constructed.



Figure 19 Wells for repairing in Markatwadi

There is a stream passing beside these wells; if a bund is constructed on this stream, this bund may recharge both wells.

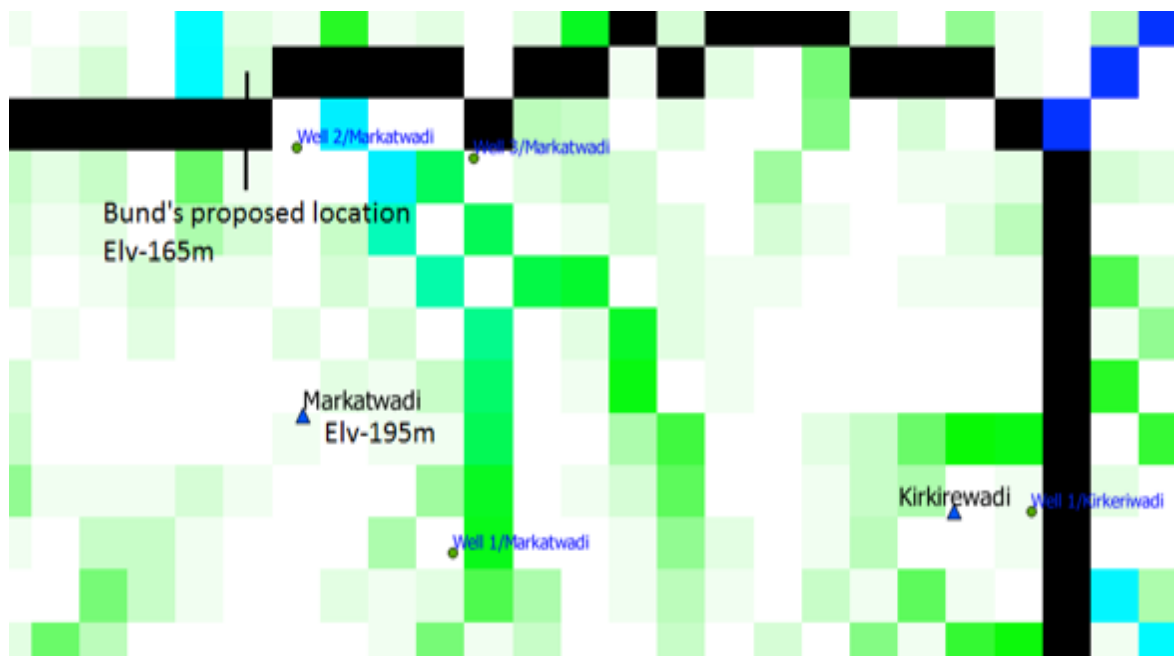


Figure 7 GIS image of bund location in Markatwadi



Figure 21 Location of a possible new bund in Markatwadi

#### 4.4 Wadpada (High Stress)

Wadpada is also a high stress village. It has two wells, both of which dry in October forcing the villagers to use the river water for drinking purposes for seven months in a year. The following interventions are suggested:

##### Well Strengthening by Constructing Bund and Area Treatment (Contour Trenching):

In Wadpada, near 'well-2', there are two streams coming together and forming one single stream as shown in the figure. On the hills just above well, contour trenching can be done which will recharge this well. Also, if a bund is constructed here, it could create a reservoir along the stream, which would recharge the well for drinking purposes and store water for livelihood purposes. So, a bund here may serve to supply water for both drinking and livelihood purposes.

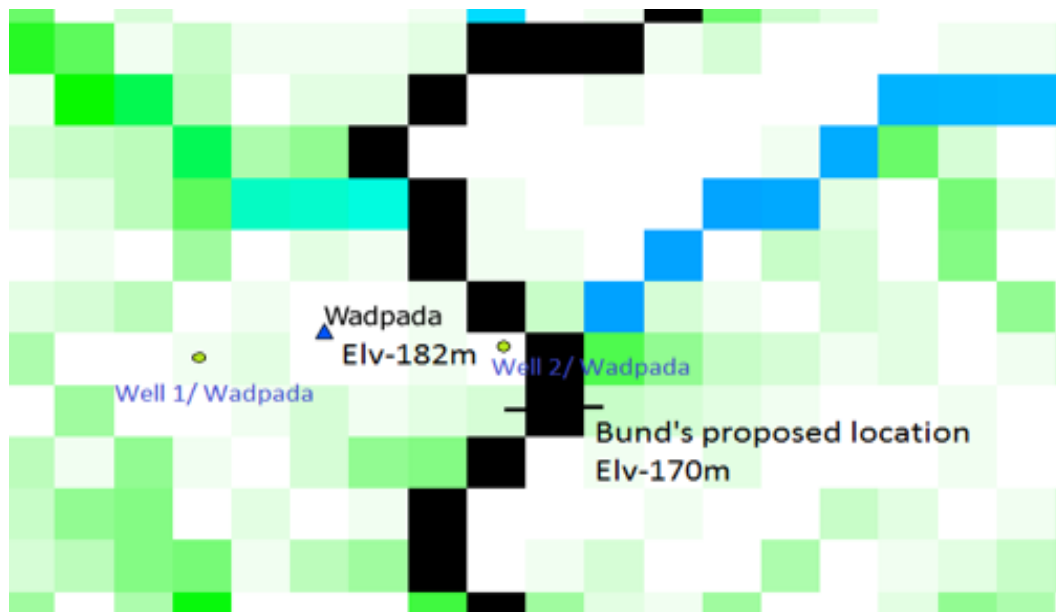


Figure 22 GIS image showing location of possible bund in Wadpada





Figure 8 Location of possible bund in Wadpada

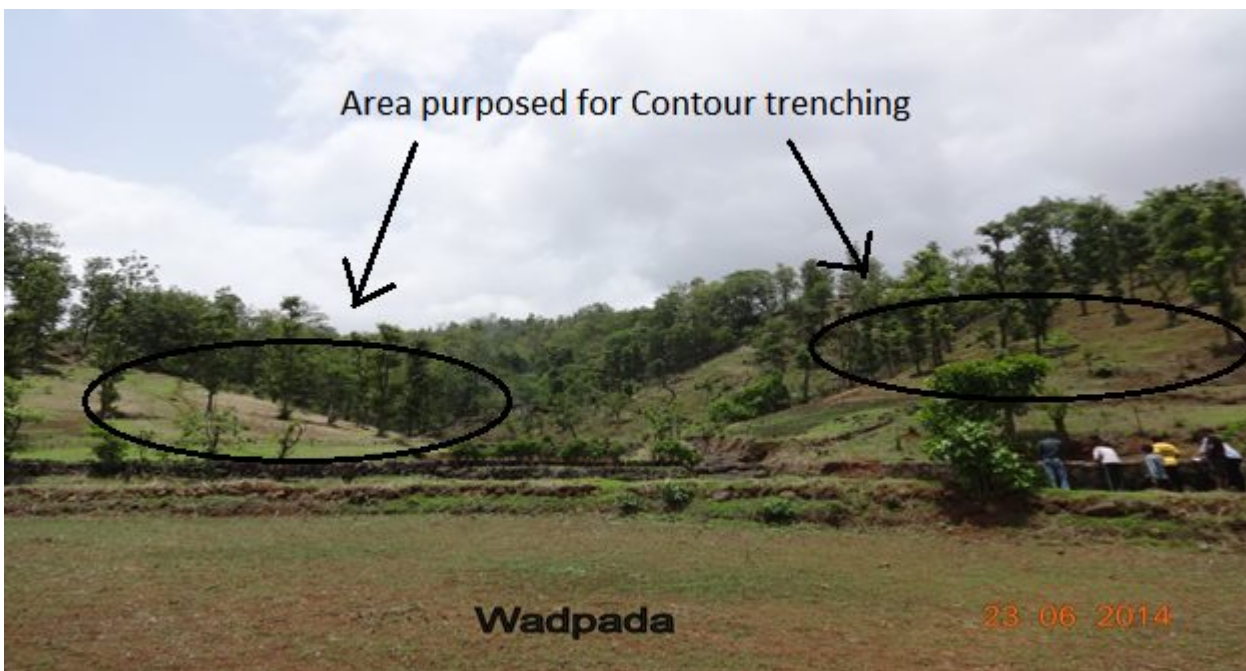


Figure 24 Possible location for contour trenching in Wadpada

## 4.5 Botoshi (High Stress)

Botoshi (habitation) also faces severe water stress. It has five wells, but four run dry by as early as October and the fifth dries in March. There is a bund constructed along the river but it is broken. The following interventions are suggested:

### Old Well Repair:

In Botoshi, the boundary of 'well-5' broke from one side and fell into the well, which is hindering a spring to feed it properly. This well needs to be cleaned and repaired so that the water can come from that spring into the well.

### Old Bund Repair to Solve Livelihood Water and Connectivity Issue:

The bund that connects the pakka road to the habitation is broken, so in the monsoon season the habitation gets cut off, and the storage of water is limited. If the bund functions properly, it may serve the need for both connectivity and livelihood water.

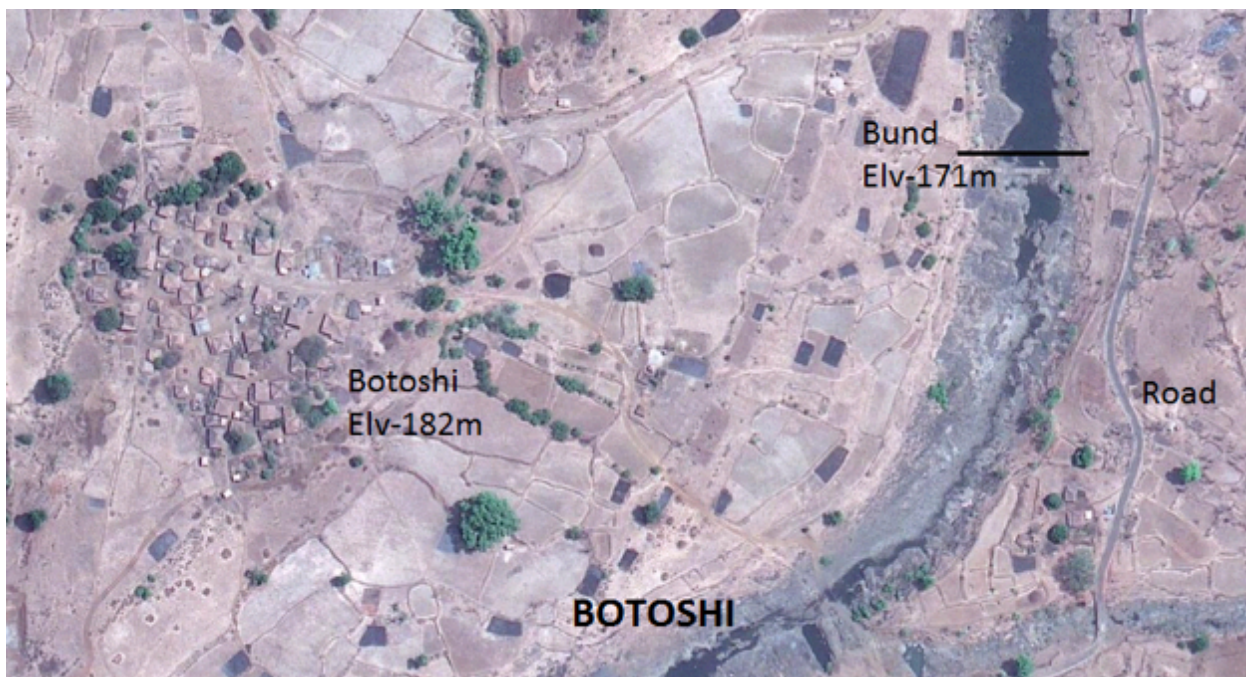


Figure 25 Google Earth image showing location of broken bund in Botoshi



## 4.6 Pethechyapada (Medium Stress)

Pethechyapada is listed as a medium stress habitation. It has three wells and a river pit. Two of the wells have water through the year but one of those has a water quality issue. The following intervention is possible for Pethechyapada:

### Well Strengthening by Constructing Bund

In Pethechyapada, a bund can be constructed at the location shown in the figure. It can be seen that the embankments of the bund are well defined. A bund constructed here would increase drinking water availability by helping recharging 'well-1' and also allow water to be stored for livelihood purposes.



Figure 26 Possible location of a new bund in Pethechyapada

#### 4.7 Raipada (Medium Stress)

Raipada is categorized as a medium stress habitation because it currently has one well that supplies water year round but the villagers complain that the water has a quality problem. There was an additional well in the habitation that supplied clean water through the year but this well was washed away during the last monsoon.

##### Old Well Repair:

To ensure that Raipada has a safe drinking water source, the well that was flushed away could be repaired.



Figure 9 Well for repairing in Raipada



#### 4.8 Manipada (Low Stress)

Manipada is not listed as a high water stress habitation but there is scope to increase water availability in the area for livelihood purposes. The following interventions are suggested:

##### Old Bund Repair to Strengthen Well:

Manipada has an existing bund, which is completely broken as shown in the figure below. If it is repaired, it would help recharge well-2 and also provide water for livelihood purposes.

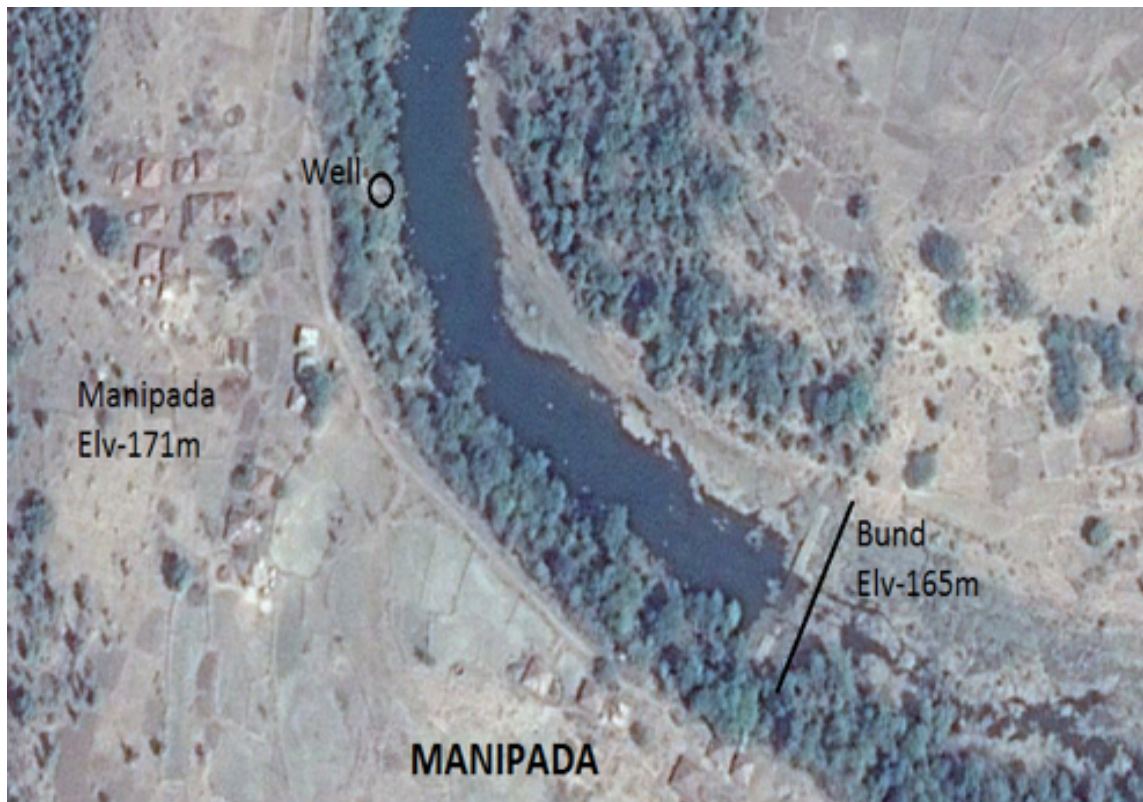


Figure 28 Location of well to be repaired in Manipada

## 4.9 Bhojpada (Low Stress)

Bhojpada is categorized as a low stress habitation. The habitation has five wells and two bunds. Water remains in only two of the five wells through the year – the rest run dry in October. One bund retains water for a few months, while the other appears ineffective due to possible leaks and siltation.

One of the two primary wells used by the villagers (well-1 in the figure below), is about 350 meters away and sometimes gets cut off by a stream during the monsoons. The following interventions are suggested for further exploration in order to increase availability of both drinking water and water for livelihood.

Well Strengthening and improving accessibility by constructing a bund:

In Bhojpada, the way to well-1 gets cut off by a stream during the monsoon season. A bund constructed on the stream would help recharge the well and provide a means to reach it. A possible location for the bund can be seen in figures below:

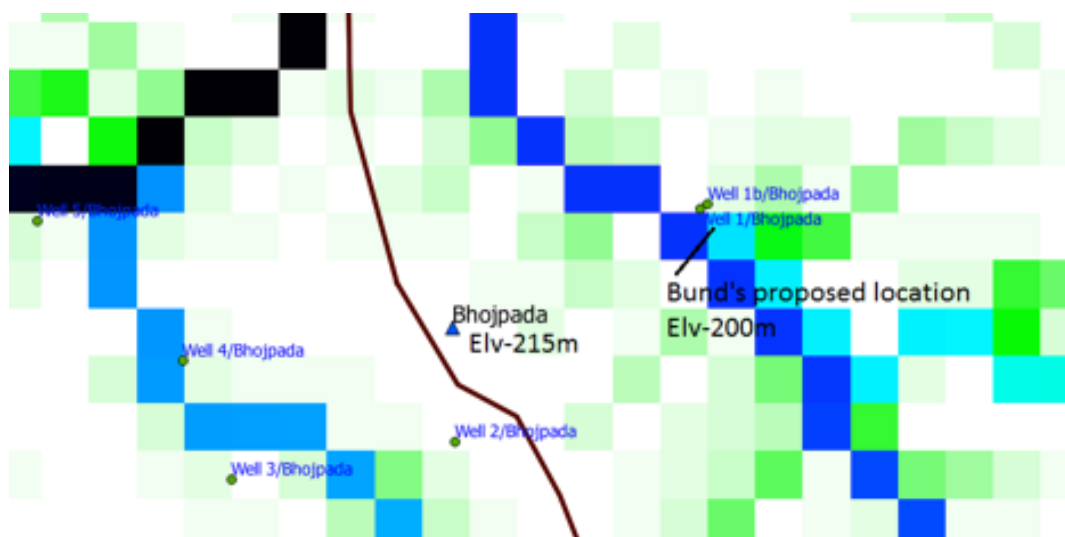


Figure 10 GIS image showing possible location of a new bund



Figure 30 Possible location of new bund in Bhojpada

#### Repairing Old Bund for Livelihood Purpose

Bund-2 in Bhojpada, at an elevation of 204 m, appeared to have leaks and siltation. If it is repaired and desilted, the water stored in the bund could be used for livelihood purposes



Figure 11 Location of bund for repair in Bhojpada

## 5. ACTION ITEMS

This report presents an overview of the water security status in the 13 habitations of Kurlod and Botoshi, and offers a set of possible interventions to explore further. For the next stage of this project, a subset of the interventions described in the report could be studied and designed in greater detail. Since drinking water is a priority, the first intervention for consideration could be in a habitation categorized as High Stress. The exact location, design, and techno-economic feasibility would be worked out along with estimates of the storage capacity of the intervention and the requirements and concerns of the villagers of that habitation.

The following list of action items is proposed for the team from CTARA:

- Visit the four High Stress habitations (Botoshi, Kurlod, Markatwadi, Wadpada) to collect the following information:
  - o At location of possible intervention:
    - Measurements of stream embankment height and distance from each other in the exact location(s) where a new bund is proposed
    - Observations about soil and rock properties of the stream bed and of the embankment
    - Measurements of upstream width to calculate storage capacity
    - Estimate of the catchment size of the bund with GIS
    - Distance from intervention location to the well being targeted for recharge
  - o Through discussions in the habitations:
    - Approximate drinking water demand of the habitation and usage patterns of the well that would be recharged by the bund
    - Approximate water demand for livelihood purposes
    - Cropping patterns, and cultivatable land around the habitation
    - Locally available building materials and local building practices
- Design a set of bunds for the High Stress habitations with the objective of increasing recharge in the wells in the area and providing additional water storage capacity for irrigation uses
- Estimate the cost of the bund(s) based on design and the parameters above
- Compare designs and costs to determine which interventions can be implemented
- Test the water in Pethechapada and Raipada, where villagers have complained of poor water quality, and submit findings to the villagers, Aroehan and Siemens CSR.

## 6. APPENDIX

### 6.1 Habitation coordinates and elevations:

Habitation	Longnitude(deg)	Latitude(deg)	Elevation(m)
Botoshi	19.7977	73.3342	182
Kirkirewadi	19.80134	73.33149	172
Markatwadi	19.80199	73.32671	196
Bhelpada	19.79355	73.33929	197
Bhojpada	19.78842	73.3426	215
Wadpada	19.8091	73.3228	182
Manipada	19.80149	73.31854	170
Raipada	19.7998	73.3133	183
Shedyachapada	19.8075	73.3065	161
Shedyachapada2	19.8071	73.309	147
Jambhulpada	19.80934	73.30804	153
Kurlod	19.8115	73.3117	175
Pethechapada	19.81384	73.30537	152
Kapshipada	19.82567	73.29859	178

### 6.2 Intervention table in different habitation:

Intervention	Habitation	Purpose
New Bund	Bhojpada	Drinking+Livelihood
New Bund	Wadpada	Drinking+Livelihood
New Bund	Markatwadi	Drinking+Livelihood
New Bund	Pethechapada	Drinking+Livelihood
New Bund	Kurlod	Livelihood
Old Bund Repair	Manipada	Drinking+Livelihood
Old Bund Repair	Bhojpada	Livelihood
Old Bund Repair	Botoshi	Connectivity+Livelihood
New Well	Markatwadi	Drinking
Old Well Repair	Markatwadi	Drinking
Old Well Repair	Botoshi	Drinking
Old Well Repair	Raipada	Drinking
Watershed treatment	Kurlod	Drinking
Watershed treatment	Wadpada	Drinking



### 6.3 Well water availability in all habitations:

Habitation	Pop.	Existing Wells	Well water available until...	Drinking water Stress category
Botoshi (Botoshi)	400	5	October (4), March (1)	High Stress
Kurlod (Kurlod)	400	4	Oct (1), Feb (1), May (1), year round (1)	High Stress
Markatwadi (Botoshi)	150	3	December (2), January (1)	High Stress
Wadpada (Kurlod)	100	2	October (2)	High Stress
Pethechapada (Kurlod)	450	3	Jan (1), year round (2)	Medium Stress
Raipada (Kurlod)	80	1	Year round	Medium Stress but poor water quality
Kirkirewadi (Botoshi)	40	1	Year round	Low Stress but poor water quality
Shedyachapada-Jambhulpada (Kurlod)	150	1	Year round	Low Stress
Bhelpada (Botoshi)	450	1	Year round	Low Stress
Bhojpada (Botoshi)	340	5	October (3), year round (1)	Low Stress
Manipada (Kurlod)	60	2	October (1), year round (1)	Low Stress
Kapshipada (Kurlod)	15	5	Jan (1), April (1), year round (3)	Low Stress

### 6.4 Bund's for repairing in different locations:

Bunds	Habitation	Longnitude (deg)	Latitude (deg)	Elevation (m)	Length (m)	water upto	Status
<b>Bund 1 /Manipada</b>	Manipada	19.8	73.3213	165	70	-	Broken
<b>Bund 1 /Raipada</b>	Raipada	19.80328	73.31196	163	26	Feb-March	Functional
<b>Bund 1 /Kurlod</b>	Kurlod	19.81289	73.3088	148	19.2		
<b>Bund1 /Botoshi</b>	Botoshi	19.79829	73.338611	170			
<b>Bund1 /Bhojpada</b>	Bhojpada	19.78956	73.3433	195	18.5	November	Siltation, leakage likely
<b>Bund2 /Bhojpada</b>	Bhojpada	19.787	73.3387	204	27		Siltation likely



## 6.5 Interventions sorted by Stress Level:

Habitation	DW stress	Intervention	Purpose
Botoshi	<b>High Stress</b>	Old Bund Repair	Connectivity+Livelihood
		Old Well Repair	Drinking
Kurlod	<b>High Stress</b>	New Bund	Livelihood
		Watershed treatment	Drinking
Markatwadi	<b>High Stress</b>	New Bund	Drinking+Livelihood
		New Well	Drinking
		Old Well Repair	Drinking
Wadpada	<b>High Stress</b>	New Bund	Drinking+Livelihood
		Watershed treatment	Drinking
Pethechapada	<b>Medium Stress</b>	New Bund	Drinking+Livelihood
Raipada	<b>Medium Stress</b>	Old Well Repair	Drinking
Bhojpada	<b>Low Stress</b>	New Bund	Drinking+Livelihood
		Old Bund Repair	Livelihood
Manipada	<b>Low Stress</b>	Old Bund Repair	Drinking+Livelihood