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Utilization of Existing Water Sources for Irrigation Purposes-Case Study of Kheware Village

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Abstract - *Water in essential for mankind. We have been fulfilling our water needs through Surface water sources. In the recent past, we have been extracting Groundwater at a humongous rates, and not replenishing it. This is reducing the balance in the Nature and is a source for many problems. Kheware, is home to numerous farmers. Due to unavailability of required quantity of water, they cannot take more than one crop per year. The village is also a home to one Percolation tank. The water from this percolation tank is kept unused and at the same time the fields are dry. Therefore the study involves details of the new Water Management system installed at Kheware. This study includes the complete water scenario of the village including the surface sources as well as the well or bore-wells and the rainfall received in the area.*

***Key Words*: Groundwater Hydrology, Percolation Tank Management, Rainwater Harvesting, Rural Water Management, Shaft for Irrigation, Water Scenario Study.**

1. INTRODUCTION

Water Usage refers to the use of water for various purposes including domestic and commercial use. It includes use of water for Direct as well as indirect purposes. Use of water for activities like bathing, drinking, cooking, cleaning, etc. are considered as Direct use, whereas, use of water as a raw material in paper industry, in production of steel for automobiles, or as a coolant for cooling towers, are considered as indirect use of water.

All countries depend on Rainwater as one of their major sources, but apart from this other sources are also used The World Health Organization (WHO) states that an individual requires around 25 litres of water daily for meeting their basic hygiene and food needs. The rest is used for non-potable purposes like mopping and cleaning. This indicates that for most of the non-potable uses, a quality lower than drinking water is required. Thus, for economic efficiency and environmental sustainability, water must be treated and supplied according to usage. Talking about the National Scenario, India is facing one of its major and most serious crisis. After two consecutive years of weak monsoons, 330 million people are affected by severe drought. With nearly 50% of India grappling with drought like conditions, the situation has been particularly grim this year in western and southern states that received below average rainfall. According to the Composite Water Management Index (CWMI) report released by Niti Aayog in 2018, 21 major cities (Delhi, Bengaluru, Chennai, Hyderabad and others) are racing to reach zero groundwater levels by 2020, affecting access for 100 million people. However, 12 % of India's population is already living the 'Day Zero' scenario, thanks to excessive groundwater pumping, an inefficient and wasteful water management system and years of deficient rains. The CWMI report also states that by 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people. [1]

The Union Government recently formed a new Jal Shakti ministry, which aims at tackling water issues with a holistic and integrated perspective on the subject. The ministry has announced an ambitious plan to provide piped water connections to every household in India by 2024

1.1 Need for Current Study

Situated in the Green lap of Nature, the village of Kheware is blessed with fertile land and dedicated cultivators. As a village, they experiment and practice various new organic growing techniques that help in improving the quality of produce as well as to increase their income from the same. Another fact is that they are majorly dependent on Rainwater for their Water needs, they have structures like Farm Ponds (Locally known Saot tLo) in place that are rain-fed. Therefore, they are able to take crops only up to which the Farm Ponds can suffice. If these cultivators are given an assured perennial water supply, they can increase their income by taking up to 2-3 crops per annum. By performing thorough analysis, losses like depletion of Ground water Table can also be checked and recharge of ground water table can be ensured. Hi-tech and latest technology or machines may not always serve as the best solution, what is effective is a thorough study of the need, area and its current condition, future growth prospects of that area, and then curating a solution will be present itself most efficient and effect for the given problem, thus ensuring a tailor-made solution.

This project can serve as a pilot, which can later be implemented in similar villages after some preliminary studies. This will thus pave the way for better management of water in the Agricultural sector.

The use of data meticulously, analysing the on-ground conditions and integrating use of technology for accurate results will ensure a sustainable solution to problems. [1]

1.2 Problem Statement

"To Study the Current Water Scenario of Kheware village in Murbad Taluka, including existing and upcoming systems related to water and to check the sustainability of the same and to digitize the system using Geospatial Techniques."

2. Data

2.1 Geography

Kheware is a village located in Murbad Taluka in Thane District of State Maharashtra. It comes in Konkan Division of Maharashtra. The Languages spoken in the area are Marathi, Hindi, and Gujrathi & Sindhi. The Elevation of the Kheware with respect to mean sea level (MSL) is 18m. The Geographical area of the village is 289.44 Hectares (2.8944*10^6 sq.m). The type of soil present in the village is Brownish Black (Black and sand mixed soil is found in thane district).This soil is Fertile and mainly suitable for cultivation of Rice Crop, Orchids and Vegetables. The general area in And around Kheware Village is a mostly hilly region which shows huge variation in elevation of land. The same is shown in Figure below.

Figure No. 1- Satellite Image of Kheware

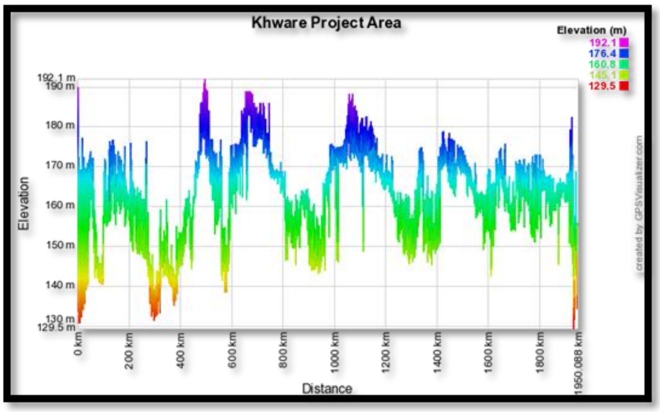


Figure No. 2- Elevation Difference in Kheware

4.2 Climate [2] [4] [5]

Sr.No.	Parameter	Average Value	Maximum Value
1	Temperature	26.7°C (80.1°F)	34.3C (93.8°F) (May)
2	Relative Humidity	68.5 %	89 % (July and August)
3	Wind Speed	1.58 mps	3 mps (July and August)
4	Sunshine Duration	8.63 hrs	10.4 hrs (April)
5	Rainfall	2500mm	3500 mm

Table No. 1- Climate Data

4.3 Hydrology

a) Water Level Scenario

Ground Water Survey Development Agency, Thane periodically monitors 45 Observation wells. Four times a year i.e. in January, March, May (Pre monsoon), October (Post monsoon).

b) Pre monsoon Depth to Water Level (May-2017)

The pre-monsoon depth to water level ranges from 1.00 to 5.00 m bgl. The depth to water level ranging between 2 to 5 m bgl and 5 to 8 m bgl are observed in major part of the district, whereas water level more than 8 m bgl are observed as patches.

c) Post-monsoon Depth to Water Level (Nov- 2017)

The post monsoon water level ranges from 0.30 to 1.00 m bgl. The water levels of 2-3 m bgl are observed in major part of the district. Less than 2 m bgl water level is observed in the eastern part of the district and water level of more than 5 m bgl occurs as isolated patches in the central and northern part of the district.

The hydrography for a certain Rainfall and the data used for the same are as follows:

- Area considered= 2, 00,000 cu. Ft.
- Time of Storm = 20 min
- Runoff Depth = 15 inch (0.38 m)
- Peak Flow = 61.97 Cu. Ft. per Second
- Runoff Volume = 246520 cu. Ft.
- Storm Depth = 1.2 Inches
- Seepage = 0.05 inch/hr (20mm/day)

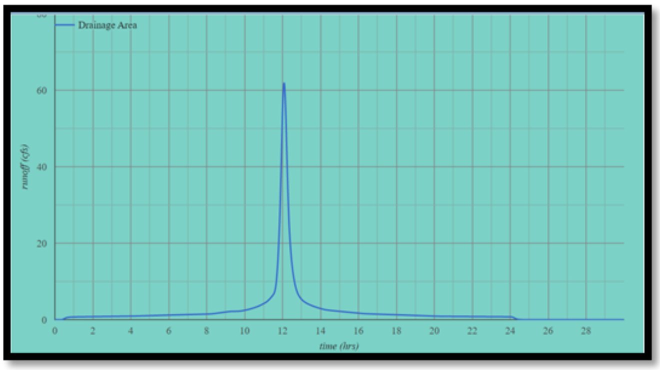


Figure No. 3- Hydrograph

4.4 Depth to Water Level

a) Pre monsoon (May 2017) 1 to 6.00 m.bgl
b) Post monsoon (Nov.2017) 0.30 to 1.00 m.bgl

4.5 Water level trend

a. Pre monsoon (2017) 1.00-5.00 m
b. Post monsoon (2017) 0.30-1.00 m

5. Water Problems

It can be observed that the village of Kheware has more than average rainfall during the monsoons, which should allow multiple crops to be taken easily throughout the year. However, it is equally true that the cultivators are able to take only one crop per annum. This problem arises solely as the village does not have proper means to collect the abundant rain that they receive every year. All of the rain is simply allowed to flow, converted into surface runoff, and ultimately meets the nearest river and ultimately the ocean.

If proper systems are designed to catch the rainwater in monsoons itself and store it, either in surface storage facilities or recharged into the groundwater, the cultivators will be able to use this very rainfall all throughout the year, thus allowing them to take multiple crops per year according to the respective seasons. This will not only help increase their income, but will definitely help in the betterment and progress of the entire village.

5.1 Surface Water [6]

The main source of water in the Village of Kheware is the percolation tank located in the Village of a capacity of approximately 400 ML in Monsoons. Due to Evaporation and percolation losses, the capacity of this tank goes down to up to 150 ML in the driest months of summer

Figure No. 4- On-Site Image of Percolation Tank

Figure No. 5- Satellite Image of Percolation Tank

5.2 Groundwater [6]

The various sources of Groundwater in Kheware Village consist of the Dug Wells and the borewell situated in the Village. A total of 21 Dug wells are situated in the village. The Average depths of these range from 9m to up to 12m. These provide considerable amount of water for period after monsoon but are mostly dry, and thus incapable of providing water in the summers starting almost from March until Monsoon arrives in the month of June.

Another source of Groundwater in the Kheware Village are the 16 Borewell situated in the village. Out of these 16 only 4 Borewell yield water throughout the year sufficiently.

The water level in both the Dug wells and Borewell is seen at a depth of 1m from the ground surface after the monsoon season. But these levels go down up to 10m in the Dug wells and up to 100m in the borewell of this region.

The drop in the groundwater level signifies that the amount of extraction of the groundwater is way more than the rate of recharge into the groundwater.

To make the groundwater sources sustainable, groundwater recharge measures need to be carried out. If recharge of groundwater takes place in sufficient quantities, the existing sources of groundwater will yield sufficient and good quality of water all year long.

5.3 Rainwater

The total potential of surface runoff that can be collected from the entire village is calculated below: [3] [7] [8]

Assumptions made:

Total area of the village 2.8944 X 10^6 sq. m

Total amount of Rainfall – 3.19m

Collection Potential – 0.2 (for Surface Runoff in Rocky Material Catchment from Table No. 2, Rain water Harvesting and Conservation Manual, CPWD)

No. of Rainy Days Considered – 91

Approximate Area (Sq. m)	Total Rainfall (m)	Run Off Coefficient	Collection Potential	
2894400	3.19	0.2	1846628	cu.m per annum

No. Of Rainy Days	91	
Collection Potential	20293	cu. m per Day in Mosoon

Table No.2- Potential of Rain Water Harvesting

Conclusion:

It can be concluded that, if the entire area of the village is considered, water up to 2.0293X10^7 lts per day in monsoon which come up to 1.85 X 10^9 lts per annum (1850 X 10^6lts per annum)

5.4 Demand of Village [10] [13] [17]

Total population of Village	1200	Nos
lpcd of water to be provided	70	lpcd
Required Water Demand	0.084	Ml
Peak daily water demand	0.1176	Ml
	0.12	Ml
Annual Demand	43.92	Ml

Table No.3- Water Demand Calculation

Therefore, it can be concluded that the total water demand of the village is 0.12 Ml, which is equal to 0.12 X 10^6 l per day. Which comes up to 43.92 X 10^6 Lts per annum

5.4 Pattern of Usage [9] [11] [12] [16]

The total breakup of Pattern of Usage in semi-arid Regions is considered as follows:

Sr.No	Usage of Water	Water used Per Day (lpcd)
1	Bathing	27
2	Flushing	6
3	Washing Clothes	12
4	Drinking	6
5	Cooking	6
6	Washing of Utensils	2
7	Cleaning the House	2
8	Domestication of Livestock	7
9	Any Other Use	2
10	Total	70

Table No.4- Water Usage in Rural Areas

5.5 Land usage of village [14] [15]

In general terms, Land Use refers to the method in which the given land in any area is utilized.

In the village of Kheware two crops are prominently grown. In the Monsoons, Rice in cultivated and in winters i.e. the Rabi Season, Okra (Lady's Fingers) is cultivated in a total are. The Okra crop grown organically which is of the best quality, is exported in bulk quantities

6. Upcoming Water Supply Systems in Kheware

The people of Kheware Village are ever-evolving. They are ready to adapt to each and every situation as and when the need arises. It has been observed that the village lacks a proper system of water supply for their Irrigation (Agricultural) needs, thus the villager have come together in order to bring about a revolution in their village. If this problem is solved, the farmers of the village are going to be able to take multiple crop within one year. This alone can easily help them to multiply their income twice or even three times.

Currently, the upcoming projects in the Village are:

1. Rainwater-fed Perennial Irrigation System
2. Shaft

6.1 Rainwater-fed Perennial Irrigation System

a) Installation of 20 new Farm Ponds in the village. These Farm Ponds are purely Rain-fed

b) Gravity System of Distribution adopted in the pipeline to provide water from Percolation tank into 8 strategically placed HDPE Tanks, using 110 mm HDPE Pipeline

c) Solar pump is used in the pumping System to extract water from the Percolation Tank is used in the pumping System to extract water from the Percolation Tank

Figure No. 6- On-Site Image of Existing Farm Pond

Figure No. 7- Satellite Image of Existing Farm Pond

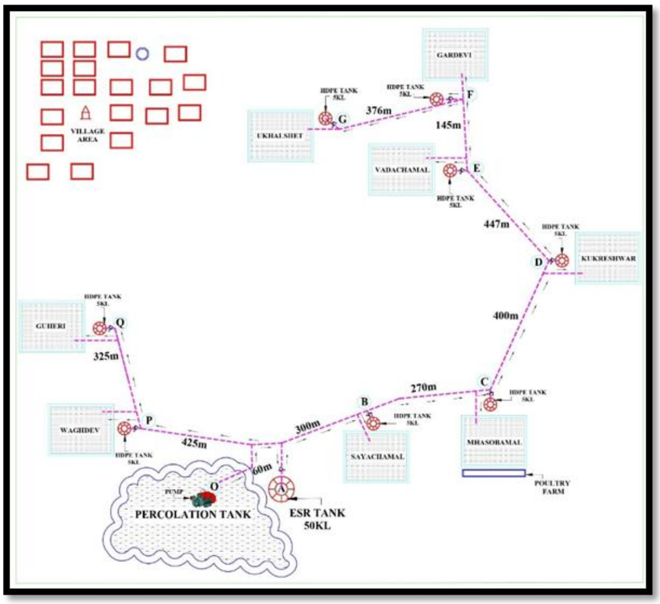


Figure No. 8- Schematic of Proposed Scheme

6.2 Shaft

Shafts serve the following purposes:

1. In the low-lying areas of the influence zone of the tank, a shaft can be implemented to stop unnecessary draining of the water as it will affect the pressure in other areas. The shaft will basically disconnect the hydraulic grade line (HGL), and a new HGL can be established as per the requirement of the residual pressure to be maintained in the low-lying area.

2. Shafts can avoid multiple tapings at the head works of WSS (Water Supply System) as well as to the existing storage tanks.

3. When land for an elevated service reservoir is not available, a temporary shaft can be created, and water can be provided intermittently.

4. Shafts can be constructed at the end of the distribution system, to take the load during the peak of water supply. The head available in the shaft will be useful to satisfy the peak demand of the tail-end consumers of the influence area. Appropriate volume can also be provided in such shafts to serve the peak hour demand.

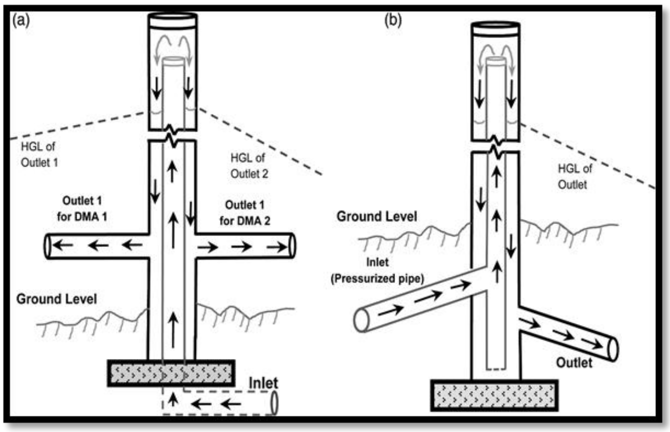
5. In the distribution system, the shaft takes out the additional head from the upstream side and helps in achieving equal water distribution on the downstream side by operating the appropriate threads of the valves on the multi-outlets.

6. Shafts can also be used on the transmission line, where the inlet is the rising (pumping) main and the shaft works as a separator between the upstream high-pressure line and

downstream low-level line. The water cushion will help in dampening the water hammer effects.

7. A shaft will help in achieving auto control on system flow variations, which is very useful as the schemes are expected to function for more than 30 years with increasing demand.

8. As shafts have smaller diameters than the conventional storage tanks, the effect of any reduction in the downstream demand will significantly increase the head in the shaft, which helps in maintaining the overall system pressure for a longer duration with the same flow.



a) Shaft for Distribution b) Shaft for Transmission Mains

Figure No. 9- Schematic of Shaft

The shaft that is installed in the Village of Kheware, works as a replacement to an expensive Elevated Service Reservoir (ESR). As the percolation tank is located at a relative elevation from the entire village, the water in the pipelines can run entirely on gravity. Therefore, construction of an ESR would have caused the system to be overly uneconomical considering the topography of the area, construction and maintenance of any ESR. The only requirement here is to regulate the pressure in order to provide required pressure in the distribution system. The Shaft provides required head to the distribution system and is the least-cost and the most efficient solution for the given project. Here the Shaft will provide the distribution system with a head of 1.5m. This head provides the water in the pipe with enough momentum in order to overcome the minor elevations that the pipeline will have to pass through without any extra pumping requirement. This shaft is being constructed using technical expertise from IIT Bombay.

Figure No. 10- On-Site image of Shaft

7. Sustainability Analysis

Considering the HDPE Tanks are refilled 15 times for all Non monsoon days, the total amount of water extracted from the percolation tank = 120 X 106 lts

This Quantity is less than the total volume of water available in the percolation tank (in the driest Month) as 120 X 106 < 150 X 106 lts

Total volume of water from Farm Ponds = 100 X 106 lts

As the amount of rain received (1850 X 106 lts per annum) is much greater than the volume of Farm Ponds, these Farm Ponds will be completely filled with fresh Rainwater every year.

The Total amount of stored water available = 220 X 106 lts

Therefore, the total land that could be irrigated by using the total storage of water = 352 acres

8. Conclusion

After completion of the Sustainability Analysis of the New Systems in Kheware Village, the following conclusions are derived:

- The system is proved to be exceedingly sustainable.

- If Roof Top Rainwater Harvesting system is installed, the village will not have to depend on Public Water Supply.
- The irrigation system designed and installed is capable to irrigate more than 160 acres of land by using modern water-efficient techniques.
- Only by adopting Drip/Sprinkler system of Irrigation, up to 352 acres of land can be irrigated using water from the HDPE Tanks and Farm Ponds.
- By utilizing the water made available from this system, the farmers can grow up to 4 crops every year, thus increasing their income considerably.
- Materials of Construction is chosen ensuring the sustainability of the system for a long functional life.

9. Results

- Water from the Percolation tank, can fill all 8 HDPE Tank, up to 15 times a day when filled for all 200 non-monsoon days.
- Water holding capacity of the Percolation tank is much greater than the total water requirement needed.
- Farmers can grow up to 4 crops in year by using the new Irrigation system installed.
- The rainfall received in the area is high enough to fill all the Farm Ponds up to the brim and excess rainfall can be utilized for use of Domestic purposes.
- The groundwater analysis of Kheware shows that the water is safe for consumption.
- The water analysis of the Percolation Tank shows that the water is safe for Irrigation purposes.

10. Discussion

- After commissioning of the new Water Supply System, farmers can grow multiple crops in a year thus increase their income considerably.
- After thorough analysis of the soil conditions and the climate pattern, the farmers can practise Crop Rotation, thus ensuring that the soil doesn't lose its nutritional value.
- The construction of a Shaft, has proven to be advantageous, as it has multiple benefits and can be constructed at a much lesser cost than any ESR (Elevated Service Reservoir)
- The new Water Supply System installed is proved to be exceeding sustainable and effective
- The system is so designed that, in future, it can be adapted to expand and cater to new and increased demand easily.

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