CHAPTER - V

RAINWATER HARVESTING POTENTIAL IN THE STUDY REGION

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SUMMARY

REFRENCES

5.1 INTRODUTION:

In the previous chapters attempt has been made to analyse the present water harvesting practices in the study region. Then impact of rainwater harvesting, particularly of percolation tank on ground water recharge and cropping pattern are also analysed by taking a case study. Rainwater harvesting potential both in rural and urban areas is attempted in the present chapter.

5.2 THE POTENTIAL

Conceptually the total amount of water that is received in the form of rainfall over an area is called the rainwater endowment of that area. Out of this, the amount that can be effectively harvested is called the water harvesting potential.

The theoretical potential of rainwater harvesting for meeting the need is enormous. Rain captured from 1.2 percent of India's land could provide India's population of 1000 million with as much as 100 liters of water per person per day (Agrawal, 1999). There is no village in India, which could not meet its drinking water needs through rainwater harvesting (CSE, 2003).

In study region, people from 34 villages, are affected every year by water quality and availability. The Phaltan tahsil presently uses only a small part of its water endowment and there is still huge potential for it to meet its water need through developing water harvesting system.

5.3 THE PRIORITY ZONES FOR WATER HARVESTING

In the study region rainfall is concentrated during four months of monsoons. Further its temporal variability adds to the seriousness of the problems. The water supply schemes in study region in most of the villages depend on the Nira right bank canal, Maharashtra Jeevan

Pradhikaran & groundwater storages made available through dug wells & tube wells. For Phaltan city water supply scheme entirely depends on Nira canal. Barring a few examples in most of the schemes the reservoirs are meant for irrigation, drinking and domestic water. These measures basically depend on the discharge harvesting rather than direct rainwater harvesting. The discharge harvesting can not become a feasible solution particularly in the southern part of tahsil where the streams are seasonal. In the region dependence on ground water is also seems to be risky as a result of depleting water level. Considering these problems an attempt has been made to form the priority zones for development of the rainwater harvesting potentiality.

For deleting the priority zones the annual average rainfall, surface water resources, scarcity of drinking water, facility of irrigation are considered as major parameters. Accordingly following three priority zones have been emerged (Table. 5.1 & Fig. 5.1)

i) First Priority Zone:-

It comprises the revenue circles of Taradgaon, Adarki, and Girvi which are 10 to 30 km. away from Nira River and Nira right bank canal. This zone suffers from inadequate water even for drinking purpose in summer season. About 34 villages are usually supplied water by tanker. Although well irrigation seems to be developed recently and few areas have been covered under well & tank irrigation, the undulating topography and scanty rainfall conditions have adversely affected the avability of natural water resources. This zone has 3842 hectors of cultivated area (40.2% of the region) recording 437.66 mm annual average rainfall and supporting 36.36 percent (18558) population of the region. This certainly indicates the crucial need to develop water resources in this part adopting suitable measures.

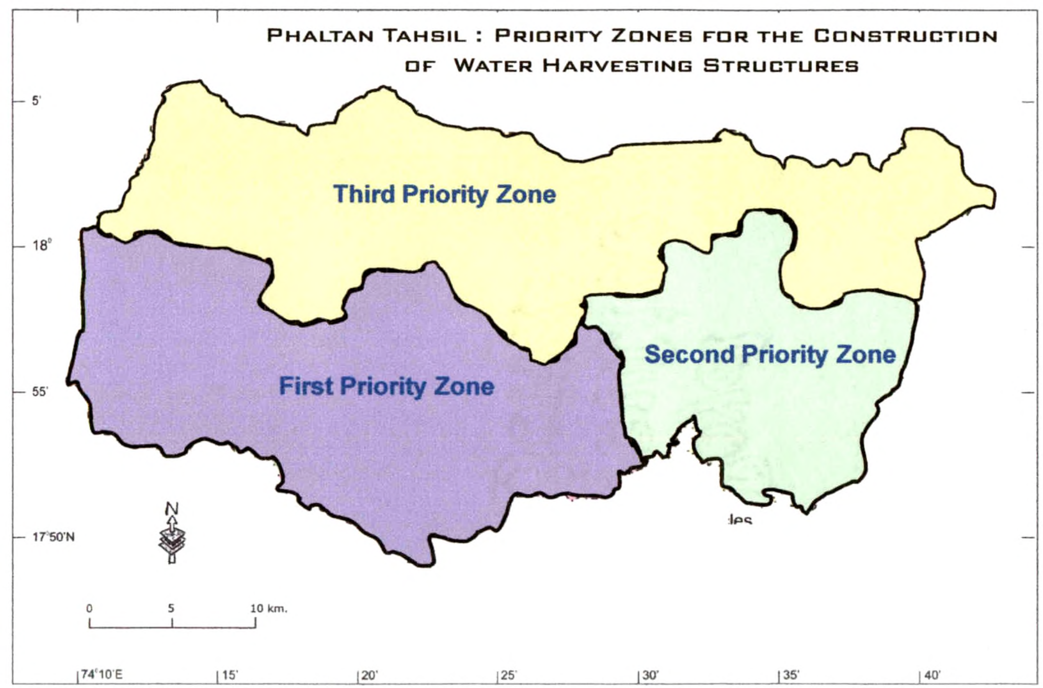

PHALTAN TAHSIL : PRIORITY ZONES FOR THE CONSTRUCTION
OF WATER HARVESTING STRUCTURES
Third Priority Zone
Second Priority Zone
First Priority Zone
N
0
5
10 km.
5'
18°
55'
17°50'N
74°10'E
15'
20'
25'
30'
35'
40'

Fig. 5.1

Table 5.1

PHALTAN TAHSIL: WATER HARVESTING PRIORITY ZONES

Water Harvesting Priority Zone	Number of villages covered	Name of the circles covered	Average annual rainfall (in mm)	% to total geograpical area of the region	% of area irrigated to region total	Sources of water resources	Number of villages supplied drinking water by tankers every year in summer season.	% of the area covered to the region	% of population to region total
First Priority Zone	53	Taradgaon, Adarki & Girvi	437.66	40.20	10	Wells, Bore wells and Tanks	34	48	36.36
Second Priority Zone	17	Barad	497.60	16.48	25	Wells & Tanks	04	12	15.32
Third Priority Zones	47	Hole, Phaltan & Assu	561	43.32	65	Canal	00	40	48.32
Total	117	-	-	100	100	-	38	100	100

Source: Compiled & Processed by Researcher.

ii) Second Priority Zone :-

This zone constitutes the part of Barad circle with 33088 population (15.32%) and 8502.03 hect. of cultivated land (16.48) with 497.60mm annual average rainfall. This circle falls in the zone of moderate requirements of water. This is facilitated partly by canal and partly by well irrigation. Well irrigation is dominant (60.58%) followed by canal irrigation (32.77%), However, most of the land area (40.00%) is still waiting for sufficient drinking and irrigation water.

In the above two zones, the attention will have to be paid on the development of water harvesting system in two ways. **Firstly**, by adopting modern methods of rooftop rainwater harvesting and collect rainwater through houses, buildings surface catchments and store water in various types of tanks. Some portion of rainwater harvested can be injected in to the bore wells to recharge groundwater table.

Secondly, through the development of surface water harvesting system, the natural sites should be utilized to store the rainfall runoff water. Thus a chain of small percolating tanks will be fruitful at the foothill zones of the Sitabai Donger, Varugad and Mograla Ghat region. Check dams, Contour bunds; Farm Ponds would be well utilized for harvesting the rainwater. This will help to increase the water table leading to substantial development in drinking, domestic and irrigation water. This system will help to shift farmers from traditional crops to commercial crops as it is observed in the case of command area of Dhaval percolation tank. (Chapter IV).

iii) Third Priority Zone:-

This part of the region comprises the areas of Taradgaon, Hole, Phaltan and Assu Circles with 15859.46 hect. of cultivated area (43.32%)

104360 Population (48.32%) having 561 mm of average annual rainfall. This zone is facilited by Nira Right Bank Canal which has minimized the priority of this zone. Phaltan, the only urban center in this region falls in this zone. Despite an extensive land under canal irrigation, this zone also needs to adopt water harvesting & rooftop rainwater harvesting because about 50 percent of the population of the tahsil reside in this zone. Increasing population both in urban and rural area needs additional water for domestic and irrigation purpose.

5.4 THE ANNUAL RAINWATER HARVESTING POTENTIAL

5.4.1 SURFACE RAINWATER HARVESTING POTENTIAL IN FIRST AND SECOND PRIORITY ZONES

Following are some of the measures to tap the rainwater harvesting potential:

i) CHECK DAMS (Cement & Vanrai bandhara)

This is the most prevalent form of traditional water harvesting system. It facilitates water for domestic and irrigation purpose also. It also helps to overcome the seasonal nature of rainfall and create availability of water for agriculture. Taking into consideration the importance of this method, it is proposed for the Banganga river basin.

The first and second order streams of Banganga basin are considered for the constructing of cascade system of check dams. Out of the 67 hectares of selected area 40% is uncultivated, 50 % is cultivated remaining 10 % is culturable waste land. About 13 villages are situated in this catchment area. Considering the topography; about 10 sites are selected for constructing new check dams (Fig. 5.2). The said sites will enable to collect the drain out excessive water from upper located tank to lower one and so on. Mr. Garg (1987) firstly suggested this method for the small land holders in hilly region. Considerable conservation of water can be achieved by this system. One of the disadvantages of the grouping of tanks however is if a breach occurs in an upper tank it exposes all the tanks in the series below to the risk of similar failures. Repairs or restoration work in such cases is done collectively and not individually.

The command area of all check dams is 300 hectares; rainwater harvesting potential calculated is 10 TCM (each dam 1 TCM capacite).As stated by Agrawal, 2002, after the construction of such check dams many benefits are observed, like rise in the ground water level, increase in duration of water in the wells, change in cropping pattern, reduction in soil erosion and development in the social forestry.

ii) ***CONTOUR BUNDS***

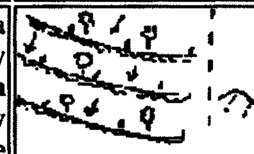
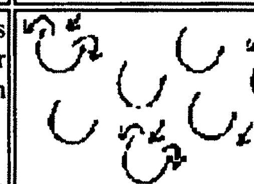
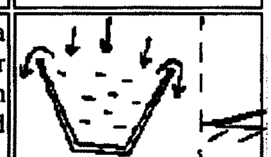
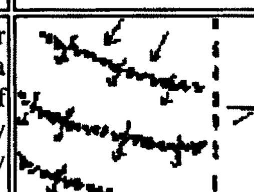
- **Site selection**

Mainly based on the slope of the land, various types of bunds are recommended as below (Table 5.2):

a) Contour bunds for trees

Contour bunds for trees are a simplified form of micro catchments. Construction can be mechanized and the technique is therefore suitable for implementation on a larger scale. The suitable site is suggested for the construction of contour bunds is near the Wathar Nimbalkar and west hill slope land of Thakurki village. These sites are having more than 4 % of slope. Advantage of contour bunds is their suitability to the cultivation of fodder. As in the case of micro-catchment water harvesting techniques, the yield of runoff is high, and when designed correctly, there is no loss of runoff out of the system.

Table 5.2
Plan for surface rainwater harvesting through contour bunds

Types & Slope in %	Classification	Main Uses	Description	Sites Appropriate	Layout
Contour Bunds	micro catchment (short slope catchment) technique	trees & grass	Earth bunds on contour spaced at 5-10 metres apart with furrow upslope and cross-ties	For tree planting on a large scale especially when mechanized **(In Second Priority Zone - Near the Wathar Nimbalkar & Thakurki Villages)**	
Semi Circular Bunds	micro catchment (short slope catchment) technique	rangeland & fodder(also trees)	Semi-circular shaped earth bunds with tips on contour. In a series with bunds in staggered formation	Useful for grass reseeding, fodder or tree planting in degraded rangeland **(Surrounding Area of Dhumalwadi Village Reserve Forest land)**	
Trapezoidal Bunds	external catchments (long slope catchments) technique	crops	Trapezoidal shaped earth bunds capturing runoff from external catchments and overflowing around wingtips	Widely suitable (in a variety of designs) for crop production in arid and semi-arid areas **(Eastern part of Tahsil near Mirde & Javli village barren land)**	
Contour Stone Bunds	external catchment (long slope catchments) technique	crops	Small stone bunds constructed on the contour at spacing of 15-35 meters apart slowing and filtering runoff	Versatile system for crop production in a wide variety of situations. Easily constructed by resource-poor farmers**(first priority Zone - first and second order streams of Adarki an Bibi villages also)**	

Source – Crichley and Reij 1989 and Compiled & Processed by Researcher

b) Semi-circular bunds

Semi-circular bunds are earth embankments in the shape of a semi-circle with the tips of the bunds on the contour. Semi-circular bunds, of varying dimensions, are used mainly for rangeland rehabilitation or fodder production. This technique is also useful for growing trees and shrubs. Adjecent area of Reserve Forest near the Dumalwadi village is best to build the semi-circular bunds. Slope of the region is more than 3 %., and 35 hectare area is covered by Reserve Forest. In some cases after the construction of semi-circular bunds peoples have grown the tree plantation under social forestry scheme of Government forest department.

c) Trapezoidal bunds

Trapezoidal bunds are used to cover larger areas (up to 1 hectare) and to impound larger quantities of runoff which is harvested from an external or "long slope" catchment. The name is derived from the layout of the structure (Table 5.2) which has the form of a trapezoid base bund connected to two side bunds or wing walls which extend upslope at an angle of usually 135°. Crops and trees can be planted within this area. Mostly suitable area is observed in the first priority zone. Eastern part of tahsil, near Mirde and Javli villages located at foot hill zone of Shikhr Shinganapur ghat are best sites for the construction of Trapezoidal bunds.(Table 5.2).

d) Contour stone bunds

Contour stone bunds are used to slow down and filter runoff, thereby increasing infiltration and capturing sediment. The water and sediment harvested lead directly to improved crop performance. This technique is well suited to small scale application on farmer's fields. It the stones are adequate it can be implemented quickly and cheaply. Making bunds - or merely lines - of stones is a traditional practice in parts of Western Ghats region in Maharashtra. Stone bunding techniques for water harvesting is best suited in undulating topography of cultivated land in first and second priority zones (Table 5.2).

iii) NETWORKING OF FARM PONDS

In the Second Priority Zone it is not always feasible to construct check dams to harvest water due to less number of 1^{st} & 2^{nd} order streams and having slope less than 3%. However this part is suitable for farm ponds. A series of ponds located in the upper reaches of the watershed help to retain good soil moisture regimes throughout the watershed. While the stakeholders upstream have easy access through percolation of water and seepage into the valley. Hence It is recommended in such priority zone a series of ponds to be constructed along contour lines and to be connected to one another; (Fig.5.2), will allow easy access to water and a better soil moisture regime.

About 130 ponds are recommended for construction in the villages namely Adarki, Kapshi, Bibi, Wathar Nimbalkar and Wakhari. With each pond having a capacity of 0.175 million liters, in one filling as much as 50 million liters can be harvested (Reddy, 1988). Most of this water percolates down, and in a normal rainfall year these ponds can be expected to overflow at least three times. These ponds also help in harvesting runoff during 'stray rains' in summer. With the first peak of monsoon in June-July, all the ponds overflow. With subsequent rains, the ponds get filled up. With second peak of rains in August-September, when maximum rains are received, the ponds overflow more than once

Fortunately, Govt. of Maharashtra has approved the ponds as effective rainwater harvesting systems and earmarked funds for their regeneration. The government has launched a scheme with the stated aim of 'every village should have a village pond'.

iv) PERCOLATION TANK

Percolation tank is one of the important and oldest sources both for irrigation and drinking purpose. Rainwater harvesting structures are popularly called as 'Tank', which are small water reservoirs with earthen dams (Bansil, 1998). Southern part of tahsil 9 percolation tanks are already constructed nearly 40 years ago. Tank irrigation is also getting importance for all purposes like agricultural, drinking and domestic.

The geomorphologic conditions in Girvi and Adarki revenue circles are favorable for construction of percolation tanks. It is recommended to construct 2 new percolation tanks in second priority zone of study region. In this zone most of the peoples depends on only ground water source for all purposes. However, the ground water level is depleting fastly (GSDA, 1973). The narrow topography of Ghadgewadi village, across the Karanj odha (3^{rd} order Stream of Nira River vally) is suitable location for percolation tank. A site for another percolation tank has been proposed to the western side of the Kapshi and Aljapur village (Fig.5.2). After the construction of these two proposed percolation tanks about 6 million cubic meter of water will be made available. It will help to mitigate the need of water of surrounding five villages.

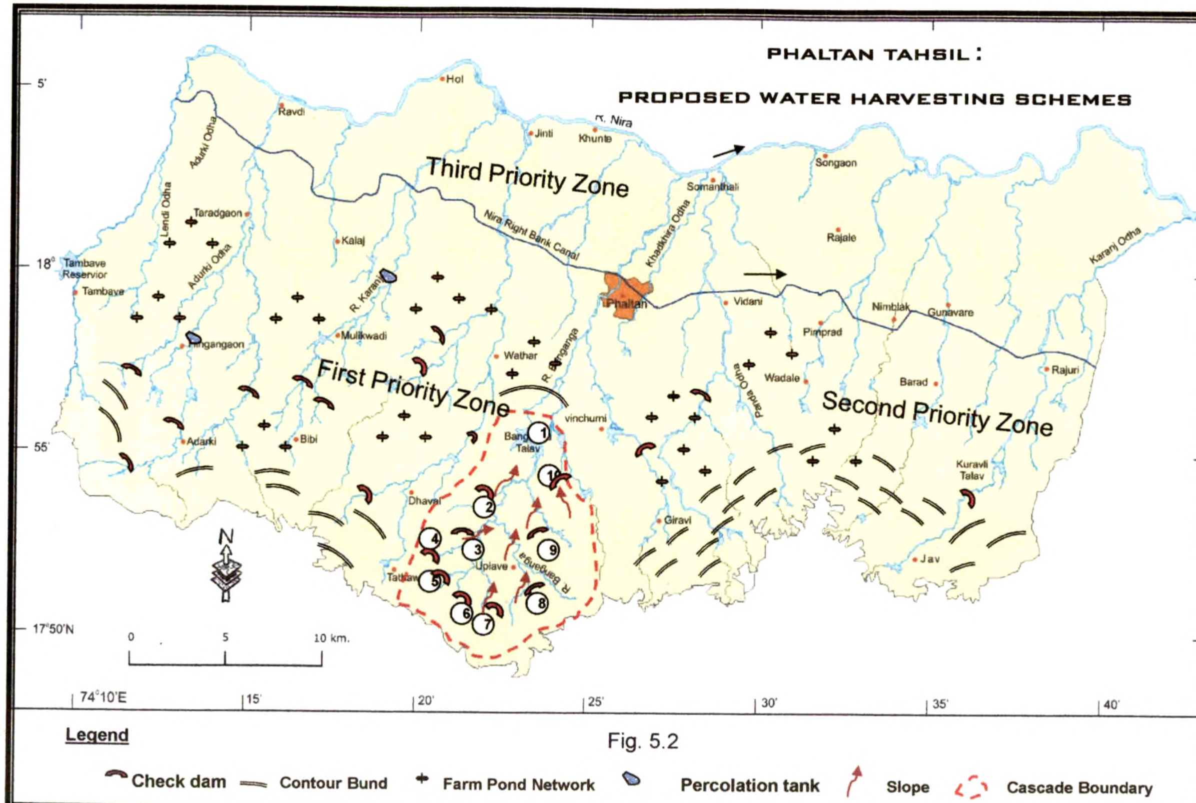

PHALTAN TAHSIL :
PROPOSED WATER HARVESTING SCHEMES
Third Priority Zone
First Priority Zone
Second Priority Zone
Nira Right Bank Canal
R. Nira
R. Karan
R. Banganga
Phaltan
Hol
Ravdi
Jinti
Khunte
Songaon
Somanthali
Rajale
Kalaj
Taradgaon
Tambave Reservior
Tambave
Lendi Odha
Adurki Odha
Khadkhara Odha
Panda Odha
Karanj Odha
Mulikwadi
Wather
Vidani
Pimprad
Wadale
Nimblak
Gunavare
Barad
Rajuri
Kuravli Talav
Jav
Giravi
vinchurni
Bang Talav
Dhaval
Tathav
Uplave
Adarki
Bibi
5'
18°
55'
17°50'N
74°10'E
15'
20'
25'
30'
35'
40'
0
5
10 km.
N
Legend
Check dam
Contour Bund
Farm Pond Network
Percolation tank
Slope
Cascade Boundary

Fig. 5.2

Table 5.3

Surface Water Harvesting Potential in Study Region

SWH Structure Name	**Number of structures**	**Selected zones**	**Catchment area**	**Command area**	**Potential in cu.m**
Check dams (Cascade system)	10	First priority zone	250 (25 hect. Per check dam)	300 hectors	10 million cu.m
Contour bunds	-	First priority zone	400 hect.	-	Based on slope
Networking of Farm ponds	130	First and second priority zone	650 (5 hect. Per farm pond)	260 hectors	22.75 Million liters
Percolation tanks	02	First and second priority zone	230 hect.	300 hectors	06 million cu.m

Source: Compiled & Processed by Researcher.

5.4.2 THE ROOFTOP RAINWATER HARVESTING POTENTIAL IN SELECTED URBAN & RURAL AREAS

In the tahsil both the urban and the rural areas face water scarcity in summer season. Dependence on ground water has increased manifold, but the natural recharge to ground water has not increased in the same rate. As a result the depletion of groundwater level has become a major problem. Hence artificial recharge has become unavoidable. Nature has provided us cheapest source of water through rains. Rooftop rainwater can be harvested to supplement the ground water recharge. The state government of Rajasthan has made compulsory provision for rooftop harvesting. Gujarat and Maharashtra are pioneer states in water harvesting structures.

Collection of water on roofs of houses is done by using galvanized sheet iron shaped into a channel at the edge of the roof. The water collected is stored in a small well adjacent to the building. This approach requires connecting the outlet pipe from rooftop to divert the water to existing tube wells / bore wells or specially designed wells. The urban areas are feasible for rooftop rainwater harvesting to recharge ground water through injected wells. Injected wells are similar to tube wells but with the purpose to recharge the aquifer directly from the surface water.

Rooftop water harvesting can enable households to save water for drinking& domestic purpose up to 4 - 5 months, people can use rooftop harvesting techniques to meet the growing needs of water particularly during water scarcity period. The quantity of rainwater received at roof top is not totally available down the roof due to various losses. The main problems in promoting rooftop water harvesting technology is the cost of construction of water tank, water conduit system and gutter.

i) METHODOLOGY

The number of houses in city becomes the basis of calculation of roof top area. Generally the exact size of individual houses is not available; therefore an average roof size is adopted for calculation of roof area. The estimation of water available from roof top harvesting is worked out by multiplying the roof area with normal rainfall available during monsoon period. Computation of rooftop areas needs to be done properly.

a) Rainwater Harvesting Potential -

Water harvesting potential = Rainfall (mm) x collection efficiency

The collection efficiency accounts for the fact that all the rainwater falling over an area cannot be effectively harvested, because of evaporation, spillage etc. Factors like runoff coefficient (Table 3.1) and the first-flush wastage are taken into account when estimating the collection efficiency.

The following is an illustrative theoretical calculation that highlights the enormous potential for rainwater harvesting. The same procedure can be applied to get the potential for any plot of land or rooftop area, using rainfall data for that area.

Consider a building with a flat terrace area of 200sq.m. The average annual rainfall in Phaltan tahsil is approximately 460 mm.

In simple terms, it means that if the terrace floor is assumed to be impermeable, and all the rain that falls on it is retained without evaporation, then in one year, there will be rainwater on the terrace floor to a height of 460 mm.

Area of the terrace = 200sq.m.(concret)

Annual rainfall = 0.46 m (460 mm)

Volume of rainfall = Area of terrace x Annual rainfall

= 200 sq. m. x 0.46 m

= 92.00 cu. m. (92000 liters)

Assuming that only 60 % (0.6) of the total rainfall is effectively harvested,

Then Annual Rainwater Harvesting Potential (ARHP) =

Area of roof catchments in sq.m. x Rainfall in meters x Runoff coefficient

200 x 0.46 x 0.6

Annual Rainwater Harvesting Potential = 55.2 cu. m (55200 liters)

b) Water availability -

The average daily water requirement per person is 50 liters.(Table 5.5)(average of urban & rural area) (3 lit. drinking + 4 lit. cooking + 13 lit. bathing + 10 lit. flushing + 20 lit. washing clothes).

Based on above calculation for the family of 5 persons annual water availability would be:-

- ***Annual water availability***

$$\frac{55200 \text{ liters}}{365 \text{ days}} = 151.23 \text{ liters per day.}$$

$$= \frac{151.23 \text{ liter}}{5 \text{ members}} = 30.24 \text{ liter per person per day.}$$

Thus about 60.48 % of the daily water demand for 5 member family could be fulfilled.

➢ ***Water availability only in dry season.(210 days or 7 months):*** $\dfrac{\textbf{Water harvesting potential}}{\textbf{Dry days}}$

$$\frac{55200 \text{ liters}}{210 \quad \text{days}} = 262.86 \text{ liter per day.}$$

$$= \frac{262.86 \text{ liters}}{5 \text{ members}} = 52.57 \text{ liters per person per day.}$$

Thus the daily demand per person (50 Liters) could be full filled through the potential created by 200 sq.m. rooftop for 7 months.

The Center for Science and Environment (CSE, New Delhi)and Rainwater Club, Bangalore is making our society aware of rooftop rainwater harvesting potential since last 10 years. The club is promoting this practice to urban and rural areas like Delhi, Mumbai and rural areas of Rajasthan. The CSE has given directives regarding water harvesting suitable for particular region. As such following norms will be suitable for our region.

Table 5.4

Collection of Annual Rainwater harvesting potential in liters based on rainfall variation -

Roof Area (sq. m.)	Annual rainfall in mm			
	800	1000	1200	1400
100	64,000	80,000	96,000	112,000
150	96,000	120,000	144,000	168,000
200	128,000	160,000	192,000	224,000
250	160,000	200,000	240,000	280,000
300	192,000	240,000	288,000	336,000

Note:-1) Assume 80% efficiency

2) Yearly potential to collect water in a 240 sq.m ground

Source: CSE Rainwater Club

Table No. 5.5

Demand of water per person per day

Item	Qty	UOM	Applicable? (Yes/No)
Drinking	3	liters	Yes
Cooking	4	liters	Yes
Bathing	13	liters	Yes
Flushing	10	liters	Yes
Washing clothes	20	liters	Yes
Total:	50	liters	

Total applicable demand per person per day:	50	liters
Number of inmates:	5	persons
Number of days (applicable):	365	days
Total demand:	91250	liters

Source: Compiled & Processed by Researcher based on CSE Rainwater Club

Table No. 5.6

Size of storage tank - based on Demand and water harvesting potential

Size of storage tank (litres)							*43778*
Month	Number of days	Monthly rainfall	Rainfall harvested	Cumulative harvest	Demand	Cumulative demand	4 - 6
	1	(mm) 2	(liters) 3	(liters) 4	(liters) 5	(liters) 6	(liters) 7
July	31	84.00	16212	16212	7750	7750	8462
August	31	77.00	14861	31073	7750	15500	15573
September	30	185.00	35705	66778	7500	23000	**43778**
October	31	27.00	5211	71989	7750	30750	41239
November	30	00	00	71989	7500	38250	33739
December	31	00	00	71989	7750	46000	25989
January	31	00	00	71989	7750	53750	18239
February	28	00	00	71989	7000	60750	11239
March	31	16.00	3088	75057	7750	68500	6557
April	30	00	00	75057	7500	76000	- 943
May	31	76.60	14783.8	89840.8	7750	83750	6090.8
June	30	191.55	36969.15	126809.95	7500	91250	35559.95

Source: Compiled & Processed by Researcher based on CSE Rainwater Club.

Note: 1) Harvest about 193 liters in an area of 240 sq. m. (2400 sq. ft.) for 1 mm of rainfall at 100% efficiency

2) Water demand is 50 liters per person per day, calculated for family of 5 members.

3) Rainfall data for Phaltan station.

ii) ROOFTOP RAINWATER HARVESTING IN URBAN AREA

Growing water scarcity in the urban areas is forcing to search for simple, economical and self-reliant solution. While governments are looking for mega-solution, individual campuses can harvest the free and pure rainwater falling in their premises, thus augmenting their water supply in a self-reliant way. As rainfall in India is concentrated in monsoon season and unevenly distributed, storage is key to spreading resource availability in to the lean season. Hence, capturing rainfall from rooftop run-off for local use in now the key concept.

Phaltan city – Location

The historical city of Phaltan is situated nearly at the northern boundary of Satara district. It is spread over an area of 125500 sq.m. supporting a resident population of 53746. The city experiences the erratic and undependable monsoon rains. About 460 mm of rainfall is received spread over 50-100 rainy days during July to September, but it tends to vary from year to year. The mean maximum temperature during summer is in the range of 35^0 to 45^0 c. and minimum of 15^0 to 20^0 c.

The need of the Rain water Harvesting

i) Increasing demand of water –

Phaltan city water demand is increasing due to natural growth of population immigration from rural to urban, increase in industrialization and rise in standards of living.

The Nagarparishad presently supplies about 60 liters water per capita per day to its citizens. However, for the newly developed suburbs like Bhadkamkar nagar it is up to 40 liters. Rapid and unplanned growth, water losses due to leakage in pipelines, has pushed the city on the brink of a water crisis.

At present Phaltan city needs 3224760 liters of water per day, but it receives only 3208523 liters per day from canal water supply scheme of Nagarparishad. Water demand & supply gap observed that – 16237 liter per day in city (Table 5.7).Whereas the projected demand would be 80,00000 liters per day (80 liter per day per person) catering to the need of a population of approximately one lakhs in 2015.

ii) Water Availability –

At present 70% population of city lives near the Nira right bank canal. This zone receives sufficient water from canal water supply scheme. Table 5.7 shows that ward A, B, C receives per day per person more than 60 liters water. Hence there is no need for adopting the rainwater harvesting technique in these zones presently.

During last decade (1991-2001) city population has increased and residential colonies have expanded to surrounding areas of Phaltan city. About 30 % populations residing between '5 to 6' km peripheries of the city face water shortage. Nagarparishad use to provide water by tankers in summer months. Most of house holders depend on ground water extracted from bore wells but day by day ground water level is depleting very fastly. Keeping in view the increasing pressure of population, this area has been selected for calculating the annual rooftop rainwater harvesting potential.

iv) Current water supply sources of Phaltan city

Nira right bank canal is the main water source for Phaltan city. Canal water is lifted and treated in two plants located near the Somwar

Table 5.7
PHALTAN CITY: DAILY DEMAND AND SUPPLY GAP OF DRINKING AND DOMESTIC WATER (2005)

(Water demand in liters)

Ward	Population	Demand (Per person per day minimum 60 liters)	Supply		Gap		Leakage loss	Ground water	Water availability
			Rainy & Winter season	Summer Season	Rainy & Winter season	Summer Season			
A	9235	554100	555000 (60.10)	544000 (58.90)	+ 900 (+0.10)	- 10100 (-1.1)	3000	40000	Sufficient availability
B	9014	540840	542500 (60.11)	530000 (58.79)	+ 1660 (+0.18)	- 10840 (-1.21)			Sufficient availability
C	8650	519000	515000 (59.53)	500000 (57.80)	- 4000 (-0.47)	- 19000 (-2.2)			Medium availability
D	8471	508260	505000 (59.61)	485000 (57.25)	- 3260 (-0.39)	- 23260 (-2.75)			Medium availability
E	6962	417720	415000 (59.60)	390000 (56.02)	- 2720 (-0.4)	- 27720 (-3.98)			Low availability
F	5625	337500	325000 (57.77)	280000 (49.78)	- 12500 (-2.23)	- 57500 (-10.22)			Very low availability
G	5789	347340	340000 (58.73)	280000 (48.36)	- 7340 (-1.27)	- 67340 (-11.64)			Very low availability
Total	53746	3224760 (60.00)	3197500 (59.49)	3009000 (55.98)	- 27260 (-0.57)	- 215760 (-4.02)	3000	40000	

Source: Data collected from Nagarparishad Phaltan, water supply department & : Compiled & Processed by Researcher.

Note: Figures in bracate shows per day per capita demand and supply gap in liters.

peth, and then stored in two main water containers located at Raviwar peth and Laxmi nagar. Water is then distributed through 13000 connections. The entire network is spread over an area of 5 sq.km.

Ground water contributes less than 10 % of the total supply. Presently 31 dugwells and 39 bore wells are in operation in southern part of Phaltan city.

The projected population for Phaltan city in 2015 would be 1 lakh and by 2025 it would be 1.5 lakh. To mitigate the need of water, roof water harvesting would be one of the best solutions.

- **ROOFTOP RAINWATER HARVESTING POTENTIAL OF SANJIVRAJE NAGAR IN PHALTAN CITY: A CASE STUDY.**

The total area of selected campus of Sanjivraje Nagar is about, 97150 sq.m. The campus is located at southern part of Phaltan city (Fig 5.3). Total population of the campus is 1600 accommodated in 292 dwellings. Besides 13 shopping centers, one cooperative bank, one primary school & one secondary school are locating with in this campus. The sources of water are 7 bore wells and 2 dug wells and canal water supply scheme of Phaltan Nagarparishad. The average annual rainfall is 460 mm. In summer season all bore wells, dug wells go and dry, increase the pressure on canal water supply scheme. In summer period only 3 days in a week drinking water is made available through water tankers and regular water supply scheme.

i) Methodology

A detailed survey has conducted to enquire about the domestic water requirement of resident population and non-residential centers of selected campus. The questionnaire covered various aspects such as day-to-day, occasional and festival water requirements. The available sources

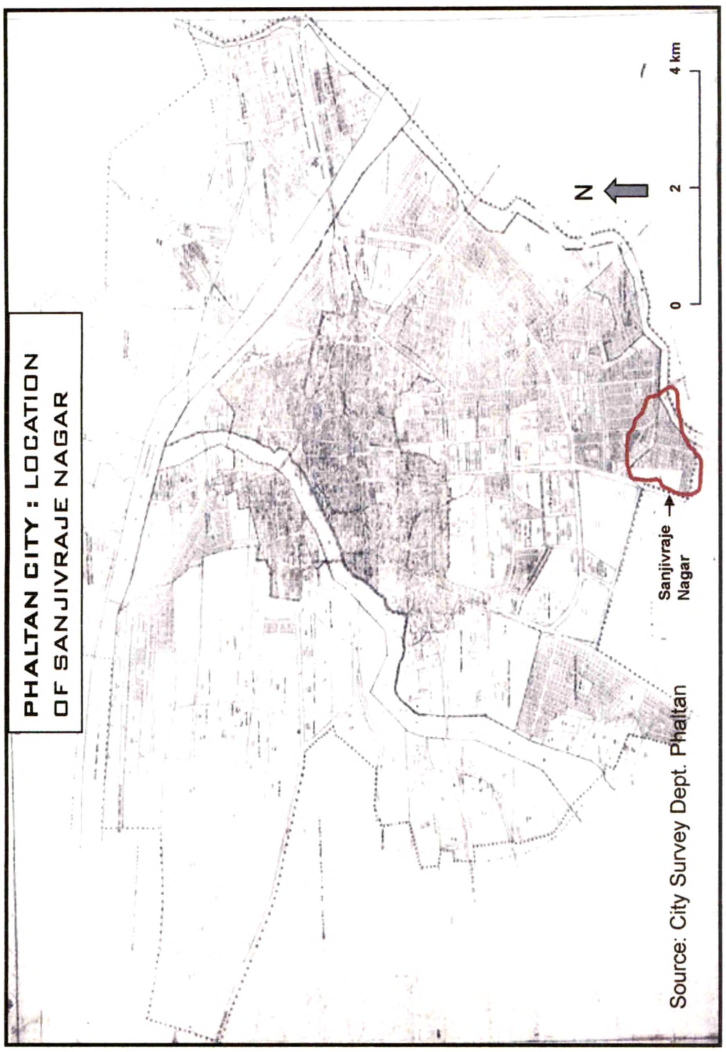

PHALTAN CITY : LOCATION
OF SANJIVRAJE NAGAR
N
0
2
4 km
Sanjivraje
Nagar
Source: City Survey Dept. Phaltan

Fig. 5.3

of water, the dependability of the source in term of period of water availability and the duration of stress conditions were the other aspects covered in the field surveys. Based on survey conducted in Sanjivraje nagar, the per capita daily water requirement has calculated as 50 liters. For this campus of different population size, the daily water requirement is calculated as size population size x 50 liters per day.

Based on Rainfall pattern, Roof top catchments, paved and unpaved catchments, runoff coefficient (collection efficiency), and the roof top rainwater harvesting potential is calculated with the help of following formula.

Annual Rainwater Harvesting Potential (ARHP)

= Rooftop catchments (in sq.m) x Rainfall in m x Runoff coefficient

ii) Demand and Supply –

At present Sanjivraje campus residential population is 1600 and its demand of water is 80000 liters per day ;(per person per day 50 liters) but it receives only 50,000 liters per day from Nagarparishad water supply scheme. In summer season, the demand and supply gap is 30000 liters per day. The difference has expected to rise in 2015, when the projected demand would be 250000 liters per day, catering to a projected population of campus approximately of 5 thousand.

iii) The Potential –

Rooftop rainwater harvesting has a huge potential in selected water scarcity zone of Phlatan city. The illustrative calculation for water harvesting potential for a 376 buildings with geographical area of 97150 sq,m.(total) can harvest approximately 20296200 liters annually (Table 5.8).

Table 5.8
Annual Rainwater Harvesting Potential (ARHP) in Sanjivrajenagar suburban Area of Phaltan City (2006)

Average annual rainfall is 460 mm (0.46 m)

Name of Places	Types of roof catchments	Quantity	Catchments area in sq. m	Runoff coefficient	ARHP in cubic meters	ARHP in liters
Houses & Buildings	Concrete	244	53919.12	0.6	14881.67	14881670
	Bricks	09	822.96	0.5	189.28	189280
	Metal sheet	36	3566.16	0.7	1148.30	1148300
	Tile	03	450.00	0.8	165.6	165600
Schools	Concrete	02	792.6	0.6	218.75	218750
	Metal sheet	03	507.48	0.7	163.40	163400
Banks, Post & others	Concrete	05	1941.3	0.6	535.79	535790
	Bricks	02	1306.00	0.5	300.38	300380
	Metal sheet	03	1455.00	0.7	468.51	468510
Shopping centers	Concrete	04	1615.44	0.6	445.86	445860
	Bricks	02	301.74	0.5	69.40	69400
	Metal sheet	07	2296.00	0.7	739.31	739310
Total paved catchments	Concrete	11	857	0.6	236.53	236530
	Bricks	08	630	0.5	144.9	144900
	Tile	37	1375	0.8	506.00	506000
Total unpaved catchments	Soil slopes	-	370	0.3	51.06	51060
	Rocky	-	342	0.2	31.46	31460
	Total	**376**	**72547.8**		**20296.2**	**20296200**
Per Day Rainwater Harvesting Potential is					**55. 60** **(20296.2 / 365)**	**55600** **(20296200 / 365)**
Per Person Per Day Rainwater Harvesting Potential is					**0.034** **(55.60 / 1600)**	**34.75** **(55600 / 1600)**

Source – Data collected by field Survey & Compiled & Processed by Researcher.

Thus all the rainwater-harvesting structures meet the 55600 liters water demand of day. Per person per day 34.75 liters water demand could be meet through rooftop annual rainwater harvesting potential (Table 5.8).

iv) Cost of Water Harvesting

As listed in table 5.9 the cost of installing the cement concrete tank for storing the rooftop rainwater is about Rs. 7550/-. Whereas approximate cost of injecting the bore well and dug well is about Rs. 3550/- .

Table 5.9

I) Approximate cost of cement concrete tank for water harvesting

Item	Unit	Cost (Rs.)
PVC piping for rainwater pipes 101.6 mm diameter & 7.62 m length	meters	550
Cement concrete tank 5000 liters (Construction of tank near the house at a depth of 5 Mtrs.)	liters	5000
Other materials	-	1000
Worker payment	-	1000
Total per rainwater harvesting structure cost	-	7550

II) Approximate cost of injecting bore well or dug well for water harvesting

Item	Unit	Rate (Rs.)
PVC piping for rainwater pipes 101.6 mm(4 inch) diameter & 7.62 m (25 ft) length.	Meters	550
For borehole or dug well recharge system installation cost	-	1000
Other materials	-	1000
Workers payment	-	1000
Total	-	3550

Source – Data collected from City market in 2006.

The afore said analysis reveals that the potential created by rooftop rainwater harvesting will definitely mitigate the need of the Sanjivraje nagar suburban area of the Phaltan city. Thus it could be equally well adopted for the entire city successfully.

iii) ROOFTOP RAINWATER HARVESTING IN RURAL AREA

In previous section an attempt has been made to measure the rooftop rainwater harvesting potential in selected urban water scarcity zone in Phaltan city. It is proved that about 70 percent water demand could be meet through rooftop rainwater harvesting measure. Similarly in the ensuring section an attempt is made to measure the rooftop rainwater harvesting potential in selected water scarcity zone of rural water scenario.

For the purpose of rooftop rainwater harvesting potential in the area of first priority zone, 15 villages are selected (fig. 5.4). The data for these villages reveals that in summer season (May 2006) per day per person water availability is about 25 to 30 liters only which is inadequate. The wells are the only source of water supply in there villages. However, in the month of April and May all the percolation tanks, wells and bore wells dries up and water level goes down up to 45 feet from the surface created drinking water problem more serious. The Panchayat Samity of Phaltan provides the drinking water through water tanker for these villages every year.

ii) Source and demand of water

In all these 15 villages, domestic and drinking water source is only groundwater. Total 35 dug wells and 41 bore wells (public) supplies drinking and domestic water to all villages. On an average every village has installed 4 hand pumps for drinking water purpose.

Actual demand of water in all selected villages is 1240550 liters (Table 5.10) (minimum 50 liters per day per person) but they receive only 850000 liters daily water (as per field survey).

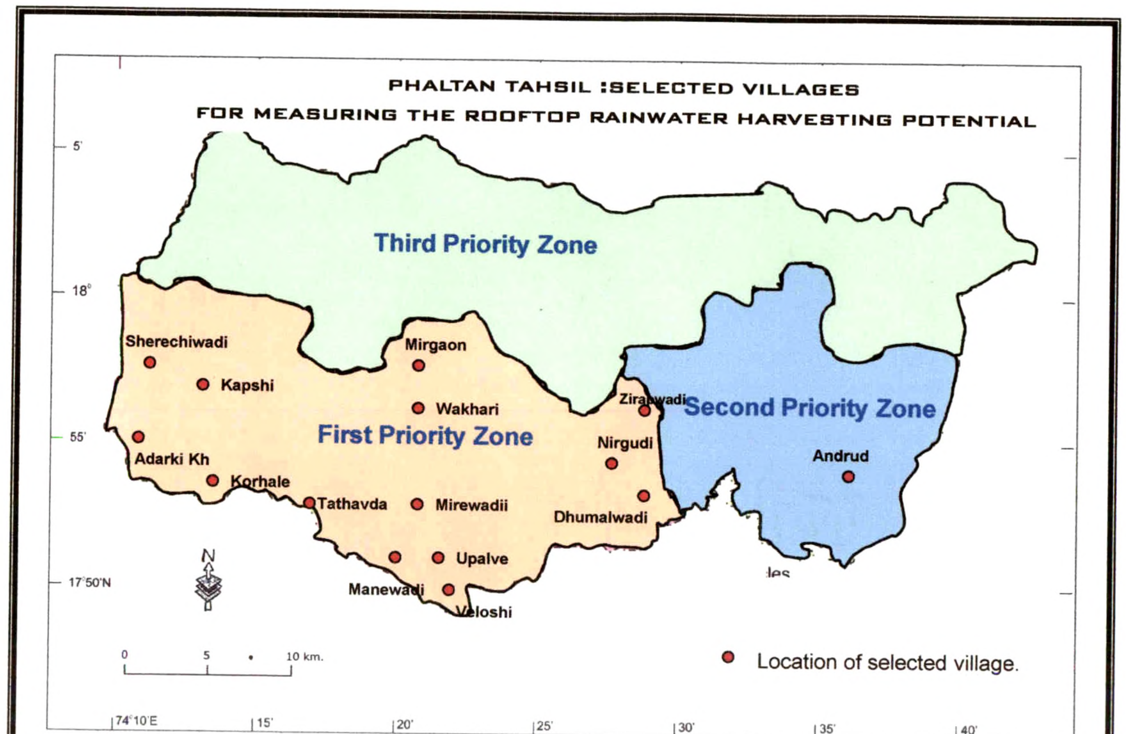

PHALTAN TAHSIL :SELECTED VILLAGES
FOR MEASURING THE ROOFTOP RAINWATER HARVESTING POTENTIAL
Third Priority Zone
Second Priority Zone
First Priority Zone
Sherechiwadi
Kapshi
Adarki Kh
Korhale
Tathavda
Mirgaon
Wakhari
Mirewadii
Upalve
Manewadi
Veloshi
Zirapwadi
Nirgudi
Dhumalwadi
Andrud
N
0
5
10 km.
Location of selected village.
5'
18°
55'
17°50'N
74°10'E
15'
20'
25'
30'
35'
40'

Fig. 5.4

✓

iii) The potential:

Most of the houses in rural area are constructed with sloping roofs that use corrugated galvanized iron sheets. This type of roof surface is suitable for rooftop rainwater harvesting and its rainwater collection efficiency is more than 70% which is more than the other type of roof surface like concrete (60%), bricks pavement (50%).

The analysis of table 5.10 reveals that the annual rainwater harvesting for 15 villages from roof surface is about 531551 sq. meters. Whereas it is about 6952 sq. mtrs. from paved surface area and about 4331 from unpaved surface area. The total comes to about 5, 42,834 sq. mtrs. water. It will support about 41.61 percent daily water need of 24,811 people.

iv) Storage of harvested water

All villages should individually store the collected rainwater in constructed cement tank or plastic tank located near the house.

In above villages, 35 dug wells, 41 bore wells and 60 hand pumps are in operation in village residential area (Gaonthan). Dug wells, bore wells and hand pumps are the best for direct and indirect groundwater recharge facility. Collected rainwater from rooftop, paved and unpaved catchments drains in to these groundwater sources to inject the dug wells, bore wells & hand pumps.

Taking into consideration the importance of these schemes, Government of Maharashtra support the grants for community based rooftop rainwater harvesting programme and also sanctions gives the grants or subsidy for construction of village pond and for such schemes for the development of groundwater recharge.

Table no. 5.10

Phaltan Tahsil: Proposed Rooftop Rainwater Harvesting Potential in Selected Rural Areas

Average rainfall is 500 mm (0.5 m)

Sr. No.	Selected Villages	Population	Number of Houses	Total Rooftop Catchments in sq.m	Total Paved Surface in sq.m	Total Unpaved Surface in sq.m	ARHP from Rooftop Catchments in cu.m (Collection Efficiency 70%)	ARHP Paved Surface in cu.m (Collection Efficiency 50%)	ARHP Unpaved Surface in cu.m (Collection Efficiency 30%)	Total Annual Rainwater Harvesting Potential in cu.m	Annual Rainwater Harvesting Potential in liters	Daily Rainwater Harvesting Potential in liters	Daily Demand of Water (Total Population X 50 liters Water)	Support the Daily Water Demand Through Roof top RWH in %
1	Mirewadi	460	86	11438	230	781	4003.3	57.5	117.15	4177.95	4477950	12268.36	23000	53.34
2	Upalave	2594	494	63726	1020	911	22304.1	255	136.6	22695.7	22695700	62180.00	129700	47.49
3	Zirapwadi	1968	333	44622	590	391	15617.7	147.5	58.65	15823.85	15823850	43353.01	98400	44.06
4	Nirgudi	2702	510	60180	340	180	21063	85	27	21175	21175000	58013.70	135100	42.94
5	Andrud	1974	354	45312	185	93	15859.5	46.25	13.95	15919.7	15919700	43615.62	97350	44.88
6	Manewadi	464	93	12183	205	178	4264.05	51.25	26.7	4342	4342000	11895.89	23200	51.27
7	Tathavada	1529	263	35242	617	243	12334.7	154.25	36.45	12525.4	12525400	34316.16	76450	44.89
8	Dhumalwadi	1080	223	29659	441	196	10380.65	110.25	29.4	10520.3	10520300	28822.74	54000	53.37
9	Kapshi	3940	281	35687	590	207	12490.4	147.5	31.05	12666.7	12666700	34703.29	197000	17.61
10	Mirgaon	1729	347	44069	583	192	15424.1	145.75	28.8	15598.65	15598650	42736.03	86450	49.43
11	Korhale	564	94	12408	175	81	4342.8	43.75	12.15	4398.7	4398700	12051.23	28200	42.73
12	Adarki Kh	2121	412	47792	718	310	16727.2	179.5	46.5	16953.2	16953200	46447.12	106050	43.80
13	Wakhri	2186	417	49623	695	250	17368.05	173.75	37.5	17579.3	17579300	48162.46	109300	5.30
14	Veloshi	619	114	14820	210	115	5787	52.5	17.25	5256.75	5256750	14402.05	30950	46.53
15	Sherechiwadi	908	185	24790	353	203	8676.5	88.25	30.25	8795.2	8795200	24096.44	45400	53.07
	Total	24811	4206	531551	6952	4331	186042.85	1738	1738	188430.5	188430500	516247.94	1240550	41.61

Source: Compiled & Processed by Researcher based on field work & village record.

▪ MIRGAON VILLAGE ROOFTOP RAINWATER HARVESTING POTENTIAL : A MICRO LEVEL STUDY

Mirgaon is a village in Phaltan tahsil, located at a distance about 20k.m. to the south from Phaltan city, and receives only 400 to 500 mm of annual rainfall. The total geographical area of the village is 870 hectares.

Water need of the village

- **Water demand**

Daily water demand per day	= Total population x 50 liters / person
	= 1729 x 50 = 86450 liters
Yearly water demand	= 86450 x 365
	= 3, 15, 54,250 liters.

Following related data required for rooftop rainwater harvesting potential is collected by house to house visit and from village record. Based on the data collected regarding rooftop area, paved area and unpaved area & annual rainfall following is the estimate calculated for Annual Rainwater Harvesting Potential.

Types of catchments	**Area**		**Collection efficiency**
e) Rooftop Area-	44069sq.m.	-	70% (0.7)
f) Paved Area-	583sq.m.	-	50% (0.5)
g) Unpaved Area-	192sq.m.	-	30% (0.3)
Total Catchments Area	= 44844sq.m.		

Average annual rainfall is 500 mm (0.5 m)

- **Annual Rainwater Harvesting Potential (ARHP) =**

(Area of roof catchments in sq.m. x Rainfall in meters x Runoff coefficient)

(ARHP) = Rooftop Area Potential + Paved Area Potential + Unpaved Area Potential

= (44060 x 0.7 x 0.5) + (583 x 0.5 x 0.5) + (192 x 0.3 x 0.5)

= 15424.15 + 145.75 + 28.8

= 15598.7 cubic meters (15598700 liters)

Daily water availability in year (365 days) = 15598700 / 365

= 42736.16liters

Per person per day water available =42736.16liters/1729 people

= 24.72 liters

Daily water availability in only dry days (210 days) = 15598700 / 210

= 74279.52 liters

Per person per day water available = 74279.52 liters / 1729 people

= 42.96 liters

In Mirgaon village, the total rooftop catchments area available for rainwater harvesting is 44844 sq.m. The volume of rainwater (available after loss) is 15598700 liters. (15598.7 cubic meters) From all roof catchments daily water available would be 42736.16 liters in a year. Per person per day water available in a year would be 24.72 liters.

During only dry days (210 days) daily water available would be 74279.52 liters & per person per day water available in dry days will be 42.96 by the roof water harvesting potential. Thus rooftop rainwater harvesting would mitigate about 86 percent of water need during dry days.

- **Conclusion:**

The aforesaid analysis reveals that annually harvested rooftop rainwater harvested will supply demand of about 42736.16 liters (49.43%). And during dry days i.e. (210 days) it will meet the water demand of about 85.92%.

The rooftop harvested water can be injected in the 2 public wells presently available in the village gaonthan area. Another means could be made available to store the water are cement concrete tank and village pond. Eastern side of the village gaonthan having gully shape is suitable for constructing village pond.

The afore said case study of Mirgaon village reveals that in rural areas rooftop rainwater harvesting is feasible to mitigate about 85 percent water demand during dry days. Hence this system can be well applied to all the villages which would enable to solve the problem partly.

SUMMARY:

In this chapter an attempts has been made to measure the rainwater harvesting potential through surface & rooftop rainwater harvesting technique.

The overall studies show a potential of making available additional potential up to 50% (estimated) annual water demand through these techniques.

A study of surface rainwater harvesting shows that the smaller catchment area of the micro water harvesting structures like contour bunds, farm ponds, percolation tanks are the more efficient for the runoff collection. Farm ponds and small pits can also harvest good amount of rainwater, for example a pit of one cubic meter size can store 1000 liters of water.

The suggested and excavated network of 130 number of farm ponds will collect the runoff potential of about 22.75 million cubic meters in a year.

In the small watersheds of upper Banganga basin located at Malewadi, Kuravli and Dalavdi villages in Girvi revenue circle, by constructing the series of tanks or cascade of tanks, the overflow from the upstream tank will led to the storage area of the next tank down the course of the stream. This system to harvest runoff generated during rainy season would be it's subsequently used.

Surface water harvesting helps to improve moisture and recharge in the downstream areas of water scarcity villages in Phaltan tahsil. When rainwater is harvested it percolates into the ground, raises the level of the water table, making it available for agricultural and domestic use.

The study of rooftop rainwater harvesting in both rural and urban areas seems to be successful and would be applied on large scale to mitigate the increasing demand of water.

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