ISSN
(Print) 2320 – 6446, (Online) 2320 – 8341

SURFACE RAINWATER HARVESTING POTENTIALITY IN DROUGHT PRONE AREA OF SATARA DISTRICT: A GEOGRAPHICAL ANALYSIS

Dr. Gaikwad V. P.,
Prof. Pawar S. N.,
Prof. Divate S. P.
Assistant Professors, Dept. of Geography, Dahiwadi College, Dahiwadi,
Tal. Man Dist. Satara, Maharashtra (India)

ABSTRACT

Surface rainwater harvesting practiced very widely in the drought prone tahsils of Satara district. It is found many percolation tanks constructed a post-independence of India, are still in use. We find that the surface rainwater harvesting structures are more prevalent in area covered with basalt hard rock in the region. Surface rainwater harvesting is justified by the nature of rainfall in semi-arid areas. If not managed, it quickly evaporates or runs as flash floods into saline sinks. Thus, the starting point of rainwater harvesting is to capture rainwater where it fall for purposes of meeting the water needs of that area. Any excess can then be transferred for use in downstream areas. The main objective of this study is measures three type of surface rainwater harvesting potential in rural area; one is runoff rainwater harvesting potential in hilly area, second is recharge and storage of rainwater harvesting potential in plateau area and third is artificial ground water recharge through rainwater harvesting potential. We also suggest suitable sites of the rainwater harvesting structures with the help of physiography of the area and also estimated rainwater harvesting potential in the region.

Keywords: Rainwater Harvesting, Potential, Artificial Recharge, Physiography etc.

INTRODUCTION

Last few years Maharashtra state is facing scarcity of water due to uneven rainfall accompanied by mismanagement of water. The severity of problem is increasing day by day. It is a challenging task to supply water for the vast population along with agriculture and industrial area. The scanty and irregular pattern of rainfall adversely effects on the agriculture system practiced in drought prone regions that abate development of all aspect in the region. Today there is need to planning of area which is not sufficient water to human being needs. Especially Man, Khatav and Phaltan tahsils have come under rain shadow area or drought prone area considering to Satara district. In this tahsils agriculture problem arises due to irregular and uncertain rainfall. In the present year end of monsoon until now no rainfall or no any positive condition lies in this region. That’s why this region is in need to constructing highest numbers of surface rainwater harvesting structures. This modern technology applied to helping recharge underground water level.

ISSN
(Print) 2320 – 6446, (Online) 2320 – 8341

OBJECTIVES

1. To Study the physiographic and climatic condition of the area
2. To suggest suitable geographical sites for constructing surface rainwater harvesting structures.
3. To measures the rainwater harvesting potential in the area.

DATA SOURCE AND METHODOLOGY

The entire study is based on secondary data. Secondary data is obtained from Grampachayat office, socio-economic abstract of Satara district, population census of Satara (2011), Gazetteer and books. The data is analyzed and computed by using some statistical methods and shown by diagrams, graphs and tables. For calculating the runoff potential of the farm pond for specific region, use the following formula given by Maharashtra Agriculture Department.

R = KPA / 10

STUDY AREA

Satara district is situated in western part of Maharashtra state. The total geographical area of district is 10480 sq. km. extending from 1705’ to 18011’ north latitudes and 73033’ to 74054’ east longitudes. This district is bounded by border of Pune district in north, Solapur in east, Sangli in south and Raigadh and Ratnagiri in west. The physiography of Satara district is covered by hills and plateaus of main Sahyadri Mountain having hight over 1200 meters above sea level to the subdued basin of Nira river having average hight of 600 meters above sea level. The western region of the district I known as high rainfall region especially in

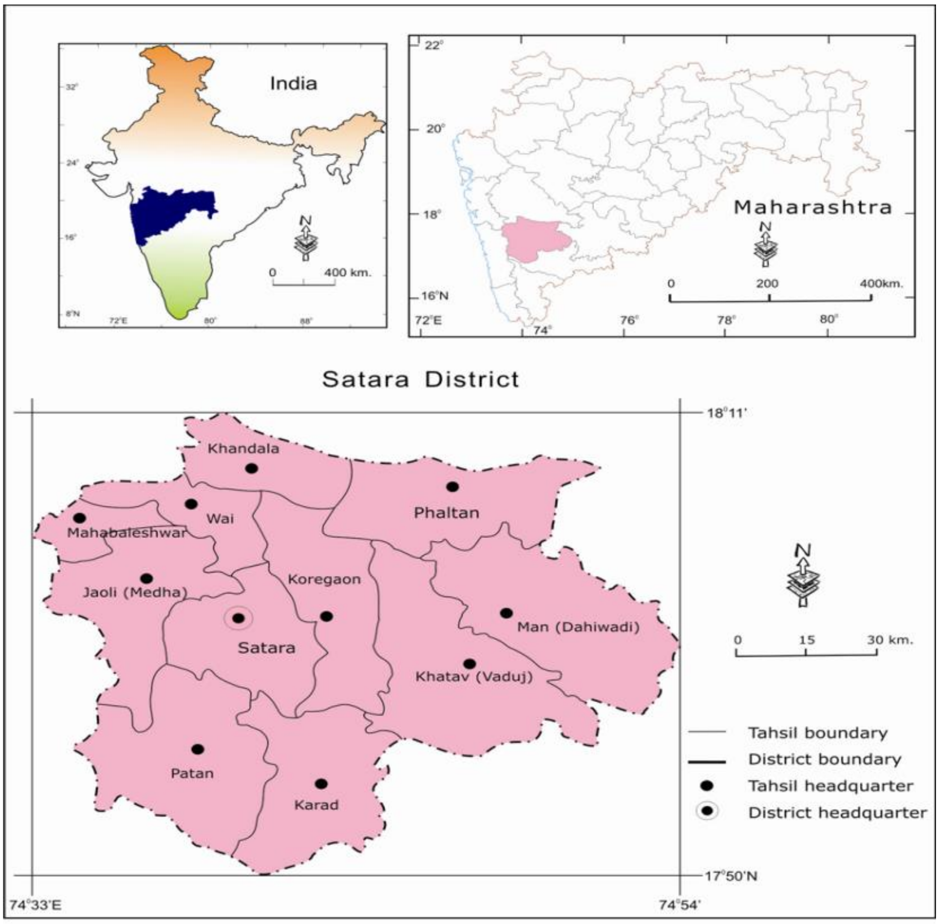

Fig. 1.1 : Location of Study Area

Mahabaleshwar have over 6000 mm annual rainfall while eastern part of the district including Man, Khatav, Phaltan tahsils is known drought prone area having average annual rainfall about 500 mm.

1. Runoff Rainwater Harvesting Structures Suitable in Hilly Area

These are normally multi-purpose measures, mutually complementary and conducive to soil and water conservation, afforestation and increased agricultural productivity. They are suitable in areas receiving low to moderate rainfall mostly during a single monsoon season and having little or no scope for transfer of water from other areas. In the highest elevation zone different measures applicable as based on slope and rainfall. Following Suitable rainwater harvesting structures have suggested in suitable locations in the study area.

1.1 Continuous Contour Trenching (CCT) or Contour Bunds

Main Objectives and Application **-** The trenches break the slope at intervals and reduce the velocity of surface runoff. The water retained in the trench will help in conserving the soil moisture and ground water recharge (Ministry of Drinking Water and Sanitation Govt. of India, 2007).

Site Selection Criteria **-** Contour trenches are rainwater harvesting structures, which can be constructed on hill slopes as well as on degraded and barren waste lands in both high- and low- rainfall areas. Table 5.7 shows the slope wise suitable design and potential of the CCT. The CCT constructing at 4 to 8 per cent sloping sites of hilly area is harvesting about 0.27 to 0.318 TCM rainwater in per hectare area.

1.2 Loose Boulder Structures or Stone Bunds

Main Objectives and Application -The main objectives for these structures are to control channel erosion along the gully bed and to stop waterfall erosion by stabilizing gully heads. (FAO (ed) 1986).

Site Selection Criteria- The geological formation of the Deccan trap is suitable for constructing loose boulder structures in all parts of the study region.

Design and Potential of Structure **–** Table 1 shows the technical measurement and more suitable sites for constructing loose boulder structures in the region.

1.3 Nala Bunds or Earthen Structures

Main Objectives and Application **-** These are soil and water retaining structures built across gullies in hilly areas.

Site Selection Criteria **-** These structures are constructed across gullies, nala or streams to check the flow of surface water in the stream channel and to retain water for longer durations in the previous soil or rock surface.

Design and Potential of Structure -Site should be in relatively flatter nala reaches, the slope of the nala should not be more than two per cent. The catchment area of the nala bund should not be less than 40 ha. The total catchment area of the stream should normally be between 40 and 100 ha. Nala bunds are normally 10 to 15 m long, 1 to 3 m wide and 2 to 3 m high,

ISSN
(Print) 2320 – 6446, (Online) 2320 – 8341

generally constructed in a trapezoidal form. It is estimated harvesting 1 to 2 Thousand Cubic Metre (TCM) rainwater per annum.

Table 1

Dimensions of Runoff Harvesting Structures

Sr.No.	Type of RWH Structures	Designed dimensions (m)				Cross sectional area of storage (m3)	Reduction in storage capacity due to siltation (%)
		Top width	Bottom width	Height	Length		
1	CCT	0.8	0.6	0.3	270	0.21	31.6
2	LBS	0.6	2	1.2	20-30	1.56	9.5
3	ENB	1.1	9.3	4.2	30-50	21.84	21
4	CNB	1.2	2.3	2.6	30-50	4.55	5

Source: National Rainfed Area Authority, Planning Commission, Government of India, New Delhi, November, 2011

Table 2

Suitable Sites for constructing Runoff RWH Structures in Hilly area

Suitable Structures	Sites in First Priority Zone	Sites in Second Priority Zone	Sites in Third Priority Zone
i) CCT ii) Loose Bolders iv) Nala Bund	Mahimangad, Varugadh, Shikhar-Shingnapur,Tathavada, Kulakjai, and Jire-Pathar (Man)Shitabai, Mhaskoba and Mahadev hills (Phaltan)Solaknath, Bhushangad, Vardhangad, Bapsha etc.(Khatav)	Pandavgad,Khambatki hills (Khandala), Bhairavgad, Jaigad, Dategad, Gunvantgad, Chandoli (Patan), Harneswar,Chavneswar, Jaranda, Nandgiri and Chandan(Koregaon),Ajinkyatara, Yavateswar,Sajjangad and Pateswar (Satara)	Mandhardevi, Pasarni,Vairatgad etc.(Wai),Pal, Sadashivgad and Vasantgad,AgashivaDongar (Karad),Makarandgad (Jaoli)

Source : Based on RWH Structure Design and Geographical Location

2. Recharge and Storage Rainwater Harvesting Structures in Plateau Area

2.1 Gabion Structures or Small Bandharas -

Site Selection Criteria **-** Gabion is low height structure, commonly constructed across small stream to conserve stream flow with practically no submergence beyond stream course. The boulders locally available are stored in a steel wire mesh and put across the stream channel as a small dam by anchoring it to the stream side.

Design and Potential of Structure **-** The height of such structure is 0.5 metres and is normally used in 10-15 metres wide streams. Every gabion structures have harvest two TCM rainwater in per hectare area of the catchment.

ISSN
(Print) 2320 – 6446, (Online) 2320 – 8341

Suitable Sites in the Region -The hard basaltic rock structure has suitable for constructing gabion structures in the drought prone region of the study region.

2.2 Cement Check Dam

Site Selection Criteria **-** Check dams are constructed across small streams having gentle slope and are feasible both in hard rock as well as alluvial formation. A check dam acts like a mini percolation tank.

Design and Potential of Structure **-** Normally the dimensions of the Check dam are; length 10 to 15 metres, height 2 to 3 metres and width 1 to 3 metres, generally constructed in a trapezoidal form. If the bedrock is highly fractured, cement grouting is done to make the foundation leakage free. Per check dam water storage capacity is 2-3 TCM. Check dams serves mainly two purposes: the first is to provide direct irrigation when rain fails, and the second is to facilitate the recharging of surrounding wells through percolation of water. Additionally, check dams provide water for other uses also.

2.3 Percolation Tank

Site selection criteria

In the States of Maharashtra, the percolation tanks have been constructed in basaltic lava flows and crystalline rocks. Normally constructed on second or third order streams, as the catchment area of such streams would be of optimum size. The location of tank and its submergence area should be in non-cultivable land and in natural depressions requiring lesser land acquisition (GoI, CPCB, 2001).

Suitable Sites in the region

The location of the tank should preferably be downstream of runoff zone or in the upper part of the transition zone, with a land slope gradient of 3 to 5%.

The adjoining foot hills sites of eastern plateau region as an elevation of 400 to 700 metre is highly suitable for constructing percolation tank. The drought prone tahsil are Khatav, Man and Phaltan is the highest need of constructing percolation tanks for mitigating the water scarcity problems in this zone. Some part of tahsil of Khandala, Koregaon, Patan and Satara is the moderate favorable for constructing percolation tanks in second priority zone.

Advantages

There should be adequate area suitable for irrigation and sufficient number of ground water abstraction structures within the command of the percolation tank to fully utilize the additional recharge. The area benefited should have a productive phreatic aquifer with lateral continuity up to the percolation tank. The depth to water level in the area should remain more than 3 m below ground level during post-monsoon period. (GoI, CGWB, 2007)

2.4 Farm Pond

Site Selection Criteria **–** Farm ponds are small size excavations on a farm, positioned to collect runoff or drainage water with the intention of utilizing it for supplementary irrigation or for augmenting groundwater reserves through percolation (Athavale, 2003). If any watershed management programmes farm ponds is an important component and useful in storing water for irrigation. They also retard sediment and flood flow to the downstream river system. Provide drinking water for livestock and human beings in arid areas. In a relatively flat terrain (Slope is 3%) with good soil cover, a farm pond has an earth section with usually 3:1 side slopes on the waterside and 2:1 side slope on the downstream face.

Design and Potential of Structure – Per farm pond about 2.19 TCM capacity for an individual farmer should preferably by built in near our farm in an open area of about 30 m x 30 m size. Since the rainwater from this area is to be collected in the pond, the area should be such that agriculture and cattle grazing may be prevented during the monsoon season to prevent pollution of water.

For calculating the runoff potential of the farm pond for specific region, use the following formula

R = KPA / 10

Where

R = Total Runoff Potential in Cu.m

K = Runoff (in per cent) available based on average rainfall and soil type (Assumed K is Fertile Soil – 8 to 10 %, Red Soil – 20%, Mediam fertile soil – 10 to 15%)K=10%

P = Annual Average Rainfall in mm (P=500 mm)

A = Watershed Area in hectare (A= 4 ha)

Example: R = KPA / 10

= 10 x 500 x 4 / 10

= 2000 cu.m

Runoff has available in above calculation is 2000 cu.m., but we assumed only 50% runoff available for direct use, so it is 1000 cu.m., runoff available of this farm pond. Based on this formula following table shows the size and storage capacity of the farm pond in applicable for western Maharashtra.

Table 3

Design and Storage Capacity of the Farm Pond

Farm Pond Size in m	Storage Capacity in TCM
15 x 15 x 3	0.441
20 x 20 x 3	0.876
25 x 25 x 3	1.461
30 x 30 x 3	2.196

Source: Department of Agriculture Government of Maharashtra, 2010

Suitable Sites in the Study Region –The ponds are located in a horizontal line to allow the trench to act as conducting channels for water. The junction of two drainage channels or large natural depression should be preferred for constructing farm pond. Average rainfall is not more than 1000 mm. In the study region Man, Khatav, Phaltan and Khandala tahsil has highly suitable for constructing farm pond.

ISSN
(Print) 2320 – 6446, (Online) 2320 – 8341

Table 4
Existing (2001) and Proposed (2011) Surface RWH Potential in Satara District

Sr. No	RWH Structures	TCM Unit	Existing Surface RWH Potential in 2001		Proposed RWH Potential in 2011	
			Area/Number	Total RWH Potential in TCM	Area/Number	Total RWH Potential in TCM
1	i) CCT (Slope 0 to 4 %)	0.27/ha	9295	2509.65	6965 ha	1880.55
	ii) CCT (Slope 4 to 8 %)	0.318/ha	7095	2256.21	10572 ha	3361.89
2	Loose Boulder Structures or Stone Bunds	-	168820	-	10000	Control Runoff Speed
3	Gabion Structures or Small Bandharas	2 / Bandhara	30	60	55	110
4	Chain of Earthen Structures	0.0075/Structure	67946	509.59	2060	15.45
5	i) Soil Nala Bunds (40 to 80 ha)	3 / Bund	-	-	12758	38274
5	Cement Check Dams	8 / Check Dam	645	5160	735	5880
6	Percolation tanks	20 / Tank	110	2200	20	400
7	Farm ponds in cultivated area	0.70/Pond	315	220.5	2348	1643.6
8	Sub-Surface Dam	-	-	-	10	Ground Water Recharge
			Existing RWH Potential –	12915.95	Proposed RWH Potential -	51565.49
			Additional Surface RWH Potential is – 38649.54 TCM			

Source: Based on Primary and Secondary Data 2001-2011

CONCLUSIONS

- In study region, people from all 11 tahsils, are affected by water quality and availability. The Satara district presently uses only a small part of its water endowment and there is still huge potential for it to meet its water needs through developing water harvesting system. The theoretical potential of rainwater harvesting for meeting the need is enormous.
- More than 50% area fall under hilly and forest. However, most of the rainfall drained away on high sloping (20 to 30%) sites. In summer season 40% land area is still waiting for sufficient drinking and irrigation water. So it is urgently needed of adopting various types of surface and rooftop rainwater harvesting.
- A study of surface rainwater harvesting methods, all information shows that the smaller the catchment area of the micro water harvesting structures like contour bunds, farm ponds, percolation tanks are the more efficient is the runoff collection.
- Surface water harvesting may improve moisture and recharge in the downstream areas of water scarcity villages in drought prone area of the district. When rainwater is harvested it percolates into the ground, raises the level of the water table, making it available for agricultural and domestic use.

REFERENCES

1. Agrawal, A., Narain, S. and Sen, S., (1999) : In Citizens Fifth Report – Part I : National overview, 5th Volume in the series on state of India's Environment, published by Center for Science and Environment, New Delhi.

2. Athavale R. N.(2003); Water Harvesting and Sustainable Supply in India, Centre for Environment Education, Ahmedabad, Rawat Publications Jaipur and New Delhi.
3. Bansil P.C. (1998) : Water Management in India, Concept Publishing Company, New Delhi - pp. 365
4. GoI, CGWB (2000); Rainwater Harvesting and Artificial Recharge to Groundwater: a guide to follow. 2000
5. GoM (2010); District Agriculture Department, Soil and Water Conservation Training Manual (in Marathi)
6. GoI, CGWB (2007); Manual on Artificial Recharge of Ground Water, Published by Ministry of Water Resources, Central Ground Water Board, Faridabad, India.
7. GSDA & CGWB (2011): Report of Dynamic Groundwater Resources of Maharashtra, 2008-2009, Prepared by Groundwater Surveys Development Agency, Pune
8. Khilare C. J., *et al* (2012): Rooftop Rain Water Harvesting Potential: A Case Study of Dahivadi College Building and Campus in Man Tahsil of Satara District, Proceeding of International Conference SWRDM-2012, Shivaji University, Kolhapur Pp. 86-89.