

A Case Study of Watershed Development in Sangola-Maharashtra

Sharada S. Tanavade¹, P. A. Hangarkar²

¹ Department of Civil Engineering, Fabtech College of Engineering &Research, Sangola- Maharashtra , India

² Department of Civil Engineering, Shri Tuljabhavani College of Engineering, Tuljapur-Maharashtra, India

Abstract: *Sangola is a small city in Solapur district of state of Maharashtra. It is facing acute water scarcity problem due to insufficient rainfall every year. Watershed development techniques like rain water harvesting, checkdam, vanarai bandhara, farm pond etc. are suggested to make the city self sufficient in case of water demand.*

1. Introduction

Watershed development means the process of creating and implementing plans, programs and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a watershed boundary. Watershed development is not so much about managing natural resources, but about managing human activity as it affects these resources. The drainage area of the river provides the natural boundary for managing and mitigating human and environmental interactions. Because human activity includes actions by governments, municipalities, industries, and landowners, watershed management must be a co-operative effort. Effective watershed development can prevent community water shortages, poor water quality, flooding and erosion. The expense of undertaking watershed management is far less than the cost of future remediation.

For development of agriculture and drinking water resources the basic elements required are land and water. Because of tremendous rise in population, urbanization, industrialization and agriculture area, resulting in steep incline water demand line, Indian agriculture sector is lot more dependent upon the monsoon. But from last 3-4 years, due to inadequate rainfall, people are looking towards the underground water as alternative sources without regarding to its recharge resulting in deepening of ground water table 100-200m below the ground surface.

Rainfall is the important element of Indian economy. Although the monsoons affect most part of India, the amount of rainfall varies from heavy to scanty on different parts. There is great regional and temporal variation in the distribution of rainfall. Over 80% of the annual rainfall is received in the four rainy months - June to September. The average annual rainfall is about 125 cm, but it has great spatial variations.

2. Problem Identification

- Average annual rainfall of Sangola is very less i.e. 460 mm
- The rainfall fluctuation is very high i.e. .in the year 2003 rainfall is 377 mm and in the year 2009, it is 683 mm.
- Silting of existing water resources like Lake, Wells.

- Rainwater harvesting structure, scarce rainfall and less awareness has caused the drought conditions at the project place - Sangola.

3. Objectives

- To analyze sources of water resources available, in Sangola.
- To analyze the socio-economic condition of people, in Sangola.
- To compute the water demand and analyze the supply.
- Results & interpretation.
- Guideline for watershed development

4. Methodology

The proposed work is planned in following phases.

Phase I- Literature survey.

In this phase, literature survey of watershed development techniques will be carried out by internet browsing & referring journals like ASCE, NICMAR journal of construction and management, Journal of civil engineering and construction review, Common guidelines for watershed development given by Government of Maharashtra etc.

Phase II – General survey.

- Water resources and requirement.
- Socio- economic survey.
- To know the population, number and types of animal.

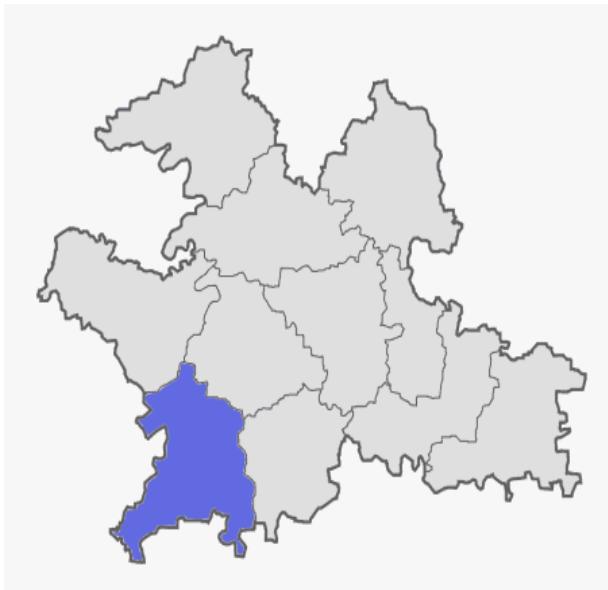
Phase-III -Watershed development measures:

- Calculation for design and approximate cost required for watershed development measures.

5. Watershed Area Details

Location

Sangola is a town with a municipal council in solapur district in the Indian state of Maharashtra. It is situated near the borders of Satara, Sangli District and Solapur District It is located at the intersection of state highway SH-161, SG-3, and SH-71. It lies between North latitude 17°26'16" and East longitude 75° 11'38". The characterized by average rainfall ranging is 460mm.



Map No.1: Location of Sangola in Solapur district of Maharashtra

Rainfall

Rainfall in the country is typically monsoonal in nature. In Sangola city it varies from 160mm to 700mm with average yearly rainfall 460mm.

Rainfall data is very important data in planning the watershed development for study area. It is a meteorological parameter to decide a quantitative approach for arriving at water availability in a watershed. Climate is a determining factor for the management of all aspects of watershed. Amount of rainfall, duration have a profound influence on watershed as to runoff, infiltration, land management etc. Rainfall data for 10 years is collected from meteorological department. Topmost layer of the land is covered with black cotton soil in flat areas. Soft murum exists in steep-slop areas. Depth of soil cover ranges from 0 to 3m. Below this soil amygdaloidal basalt, vesicular basalt & fractured basalt is available.

Availability of Source Water

The sources for water are Pandharpur lift irrigation scheme, dug wells and bore wells.

Existing ground water structures

Table 1: Present status of ground water structures in watershed (Tentative Data)

Particulars	Ponds	Wells	Bore wells
No. of structures	20	90	800
Use limit	Public	Private	Private
Use for drinking purpose	Yes	Yes	Yes
Use for irrigation purpose	50%	Yes	Yes
Availability of water for drinking purpose (approximately)	Till Jan-Feb	Till Nov-Dec	Till Nov-Dec
Availability of water for irrigation purpose (approximately)	Till Dec	Till Jan	Till Feb

Table 2: Existing structures of soil and water conservation in watershed

Type of structure for water & soil conservation	Present situation
Rain water harvesting to Dug wells	Nil
Roof top rainwater harvesting	Nil
Plantation of trees & grass	Insufficient
Gully plugs	Insufficient
Farm pond	Nil
Bench terracing	Insufficient
Contour bunds	Insufficient
Contour trenches	Nil
Check dams	Insufficient
Vanrai bandhara	Nil

These are also very important structures in utilizing rainwater for recharging groundwater. They are also useful for soil conservation. Rainfall in watershed is not sufficient but runoff goes waste due to insufficient no. of rainwater harvesting structures. The watershed area is flat area.

Basic Details of Sangola

Details	Quantity
Geographical area	68.42sq.km
Population	35000
Average rainfall	460mm
Irrigation facility	Bore-well & wells, lake

In order to understand the present position of Sangola in regard to various human social and Infrastructural aspects, a baseline survey based on questionnaire is carried out. This exercise was done with the objective of collecting information on developments/ changes that have taken place in Sangola over a period of more than last fifty years and covered aspects like population growth, improvement in means of communication major occupation of people, sources of drinking water, sources of water for irrigation purpose, type of farming, crops grown in different seasons etc.

The exercise helped to understand the main features such as housing, agriculture pattern, various types of source of income available, display of information on other items like animal & human status, land holding pattern, economic status and many other items of interest about which information is required for the purpose of planning.

6. Problems of Water Scarcity

The water shortage in Sangola has led to various socio-economic problems related to their daily lives. In this section an attempt is made to recognize and understand these issues, in the form of an alternative technology for development. What are the consequences of water scarcity? Which groups suffer more from this problem? How are the social, economic, health related problems likely to be resolved with the check dam project? Interviews and focused group discussions helped us to understand the following issues with reference to water scarcity in Sangola.

- 1) The lack of water availability in the region post – monsoon, has resulted in the shortage of drinking water in Sangola.

- 2) The lack of clean drinking water also resulted in the spread of various waterborne diseases among the people like jaundice, dehydration etc.
- 3) The lack of water availability has also resulted in low agriculture production due to non availability of water for irrigation purposes.
- 4) Water scarcity in Sangola has also resulted in the lack of fodder production and even the common pasture land in the nearby areas of Sangola dried up in the summer season due to low water level. This has severely affected the livestock in Sangola.
- 5) Water scarcity over a long period has led to an increase in migration of people to the urban areas. The people generally migrate to other areas in the summer season for working cutting of sugar cane etc.
- 6) Due to shortage of drinking water in summer season, supply of water through tankers becomes essential.
- 7) Demand for water is also increasing day by day for various purposes.

To solve the entire problem or to reduce intensity of problem water availability as well as water management is very important. To overcome these problem watershed management techniques such as roof top rainwater harvesting, check dam, vanrai bandhara and farm pond are essential. These techniques improve water availability also increase the ground water table. Following techniques are suggested for Watershed development in Sangola:

Roof top rainwater harvesting

Vanrai bandhara



Photo No.3: construction of Vanrai bandhara

Design Details

- a) Available land slope = 5-10(%)
- b) Height of vanrai bandhara = 0.8-1.2 m
- c) Length of the bandhara = 6 m up to 25 m.
- d) Breadth of the bandhara = 2 m to 2.5 m.

Farm Pond

Design Details.

- 1) Excavation details

- a) Top dimensions of pond = 15m x 15m
- b) Bottom dimensions of pond = 9m x 9m
- c) Depth of pond = 3m
- d) Side slope to excavation = 1:1

- 2) Side earthen bund details
 - a) Top width = 0.9m
 - b) Height = 1.0m
 - c) Side slope = 2:1

Check dams

Design details.

- a) Available land slope = 0-15(%)
- b) Horizontal interval (Spacing between two bunds) = depends on site conditions
- c) Dimensions of the Check dams

- a) Top Width = 1.0 m
- b) Base width = 2.0m
- c) Height = 3.0m above ground
- d) Depth of foundation = 1.0m
- e) Length of check dam = depends on site conditions
- f) Freeboard = 0.50m

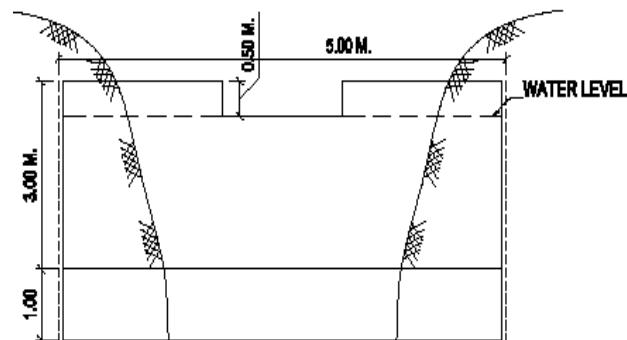


Figure 1: Elevation and cross section of check dam

Inglis formula for calculating yield

Based on studies carried out for catchments in Western Ghat and plains of Maharashtra, C.C. Inglis gave the following relation:

For Non Ghat (Hilly) area with Rainfall P less than 200cm.
Yield = $[P(P-17.78)] / 254$ Where 'P' is precipitation expressed in cm.

Runoff calculations

Average yearly rainfall in Sangola = 46 cm.

A) Runoff by Inglis formula = $[P(P-17.78)] / 254 = [46(46-17.78)] / 254 = 5.11\text{cm}$

B) Total available water = Area of watershed (Sq.m) x Rainfall
 $= 684200 \times 0.46 = 314732\text{cub.m.}$

a) Ground water recharge = Area of watershed (Sq.m) x Avg.fluctuation x Specific yield
 $= 684200 \times 1.5 \times 0.15 = 153945\text{Cu.m.}$

b) Evapotranspiration = (30%) of Precipitation = $0.3 \times 314732 = 94419.6\text{Cu.m.}$

C) Runoff by using basic formula

Runoff = Precipitation - Basin recharge

$$= (314732 - 153945) \text{ Cu.m.} = 16078 \text{ Cu.m.}$$

D) Water available for artificial recharge for watershed development

$$\text{Runoff} - \text{Evapotranspiration} = 16078 \text{ Cu.m.} - 94419.6 \text{ Cu.m.} = 66367.4 \text{ Cu.m.}$$

E) If structures were constructed

a) There would have water recharge by farm pond

$$= [(15 \times 15) + (9 \times 9)] / 2 \times 3 = 459.00 \text{ Cu.m.}$$

(Assuming it is recharged 4 times) = $4 \times 459.00 \text{ Cu.m.} = 1836.00 \text{ Cu.m.}$

b) There would have water recharge by Vanrai bandhara, Check dams,

$$= 66367.4 \times 10\% = 6636.74 \text{ Cu.m. /bandhara}$$

F) Artificial recharge due to roof top rain water harvesting

sr. no	Type of home	No. of home	Water to be stored (Cu.m.)
1	Shed	200	3974
2	Slab	400	14904
3	flat roof soil	100	1987

Total water available in one monsoon = 20865 cu.m. For Sangola

G) Total water requirement for domestic and animal

a) Domestic

$$\text{Population} = 35000$$

For drought area water requirement per capita = 70 liter

$$= 35000 \times 70$$

$$= 2450000 \text{ liter /day}$$

$$\text{Annual water requirement for domestic} = 2450000 \times 365$$

$$= 894250000 \text{ liter}$$

$$= 894250 \text{ Cu.m}$$

b) Animal

Total no of cows = 900, Total no of buffaloes = 800, Total no of goat = 1500,

Total no of sheep = 1000

Water requirement per animal is, cows: 60 liter/day, buffalo: 65 lit/day, goats: 10 lit/day, sheep: 7 lit/day. (Veterinary doctor data)

Total water requirement for animal = 46720000 liter/year = 46720 cub.m

Total water requirement for domestic and animal = 894250 + 46720 = 940970 cub.m.

H) Relation of demand and supply:

For Sangola city water supply is from Pandharpur river scheme. Capacity of city reservoirs is not sufficient and water demand is increasing day by day. Hence Sangola city depends upon Pandharpur river scheme for water supply.

$$\text{Demand} = 940970 \text{ cub.m}$$

$$\text{Supply} = 912500 \text{ cub.m.}$$

$$\text{Extra water requirement} = 940970 - 912500 = 28470 \text{ cub.m.}$$

Water available for artificial recharge for watershed development = 66367.4 Cu.m.

Water to be recharged in watershed

S.No	Type of structure	No. of structures	Water to be recharged (Cub.m)	Total water available (Cub.m)
1	Farm pond	4 Nos.	7344	
2	Check dam	2 Nos.	13273.48	66367.4
3	Vanrai bandhara	3 Nos.	19910.22	
4	Rain water harvesting	700 Nos.	20865	
Total = 61392.7				

Hence 92.50% water will be recharged if we construct water conservation structures.

7. Recommendations

Social Aspects

The Awareness regarding usage of available water should be developed. As per government rule maximum depth of bore well is 200 feet. If this rule is followed then ground water level is maintained. For the kharif season crop is Maize, Bajra and rabbi season crop is jawar. These crops are not cash crops. If the cash fruits like Pomegranate, Grapes, etc. are cultivated, then economic condition of farmer is increased. Select the crops/fruits which require minimum water. If drip irrigation and mulching film are used for crops/fruits then 50% of water is saved.

In watershed area different water conservation structures are suggested taking into consideration average annual rainfall. Cost of each structure varies according to material used, construction procedure and labour charges etc. Water conservation capacity of each structure is different. Total water to be recharged depends on precipitation in the watershed area. Recharging capacity of watershed is about 92.50% of water available for recharge.

Silt removal from lakes and wells

Due to excessive silting of lakes and wells, water storage capacity has depleted. There is 8 to 10 feet silt deposited. Removal of silt at proper interval is necessary to increase water storage capacity of lakes, wells and reservoirs. It also increases ground water level considerably. Solid waste and silt must be cleaned and wells should be protected against such pollution so as to make use of available water.

Rain water harvesting

Rain water harvesting can be implemented so as to conserve available rain water. It can be utilized as and when necessary.

Check dam

There are insufficient check dams across the stream, and they are not in condition. They require regular maintenance.

Vanrai bandhara

Vanrai bandhara is low cost structure .locally available soil or sand filled with cement bag. If bandhara is constructed with local people's participation then the cost of bandhara is very less. Vanrai bandhara is constructed at 100 feet interval.

Forestation

Planting of trees in a methodical and planned manner and using them wisely, to minimize the effect of reckless deforestation can be adopted as a tool here.

Cost of watershed techniques for proposed entire watershed

Sr.no.	Type of structure	No. of structures	Cost of structure	Total cost
1	Farm pond	4 Nos.	53000.00	212000.00
2	Check dam	2 Nos.	107500.00	215000.00
3	Vanrai bandhara	3 Nos.	15420.00	46260.00
4	Rain water harvesting	700 Nos.	20550.00	14385000.00
		Total cost		14858260.00

8. Conclusion

In Sangola the demand for water is going on increasing with the increase in population. So efforts are made to increase recharging of water by various water and soil conservation structures. Rainwater is naturally and freely available source and which is properly utilized by means of water harvesting and recharging techniques.

- 1) Perennial source of water is not available. If watershed development techniques are implemented, it will result in increase in the living standard and economic condition of people of Sangola city.
- 2) Availability of water for recharge - About 61392.7 cub m. water of total precipitation (460mmAvg. Precipitation) is available for artificial recharge. It is found that 92.50% of this available water can be recharged in watershed area.
- 3) For watershed development project runoff is very important factor. It is easy to make rise in water table, due to check to the flow of water or runoff. Runoff occur in nallas/streets.
- 4) Watershed management project can effectively solve problem of drinking water.
- 5) Various watershed measures like RWH, farm pond, check dam, vanrai bandhara, should be implemented to cope up with the drought conditions.
- 6) Maintenance programme for water storage structure should be done regularly like removing silt in the lake, wells and check dam it will result in increase water storage capacity of above structures and increase ground water table.
- 7) Watershed development project is effective for decreasing demand of water from Pandharpur lift irrigation scheme and Sangola city becomes self dependent from water supply point of view.

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