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Case study of Milli Watershed in North Solapur

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Abstract - *One of the challenges tackled by human civilization across the globe is water scarcity. A limited supply of freshwater cannot meet the growing water demand. Factors similar to contamination of groundwater and surface water, irregular distribution of water resources, and recurrent drought triggered by extreme worldwide weather outlines have harshly influenced water scarcity. To respond to increasing groundwater predicament and take benefit of the higher levels of runoff non captured by natural recharge, analysis, and effective management of groundwater by introducing various approaches through non-natural recharge of aquifers has converted extensive in India for the last three to four decades. Mainly this study is carried out for Akolekati, Nanaj & Darfal Village in North Solapur Taluka, District Solapur, Maharashtra, India. By studying various approaches of groundwater recharge, analysis, and development of Watershed for Akolekati, Nanaj & Darfal Village, Maharashtra is carried out. An action plan to focus on adequate water management is developed to address the increasing water demand. Various water conservation structures are recommended by taking average annual rainfall, hydrology, and morphology of area into consideration. In these project we focused on all government Scheme for watershed Management like Drought Prone Areas Programme (DPAP), Integrated Watershed Management Programme (IWMP) & others.*
Total water to be conserved using LBS, Earthen Structure, Earthen Nala Bund, Farm Pond, Check Dam, Nala Deepening, Compartment Buding & Horticulture is calculated in this study. If watershed development methods are executed, it will rise the irrigation possible, which eventually upsurges production of crop, leading to an increase in the economic condition and living standard of individuals of North Solapur, India.

Key Words: **Groundwater Recharge1, Groundwater Management2, Water Demand3, Groundwater Crises4, Watershed5, Watershed Management6, Watershed Management Structures7**

1.INTRODUCTION

Integrated watershed management programme is the strategy adopted in the India for sustainable development of dry land areas and a recent comprehensive assessment of watershed programs in India. Watershed is classified depending upon the size, drainage, shape and land use pattern. The area we are studied covers 8504 Ha. so it classified under Milli-watershed. It includes three villages namely Akolekati, Darfal & Nannaj. Many parts of India are facing the water scarcity problem. In their areas the water conservation and management is essential activity. Water conservation means the action taken to reduce water use by improving the efficiency of various uses of water. Solapur district is located in drought prone area of Maharashtra, hence this district is facing drought problem every year. Therefore need of water conservation and management is essential in Solapur district.

1.1 Objectives of the Study

1. To study the water resources conservation and management projects adopted in Solapur district.
2. To give suggestion and recommendation for water conservation and management.

1.2 Problems facing in that area

a) Scarce rainfall and less awareness has caused the drought conditions
b) Poverty due to unemployability.
c) All people are dependant only on farming.
d) Low income levels hence low living standards
e) Lack of water supplies in summer season
f) Farmers adopting tradition method of irrigation
g) Agricultural production in only one season
h) The average rainfall is very less i.e. average annual rainfall of 542.2mm.
i) he rainfall fluctuation is very high
j) Silting of existing water resources like Lake, Wells.
k) Insufficient rainwater harvesting structure.
l) There is significant slope with intense rains resulting in high degree of erosion

2. METHODOLOGY

The methodology adopted for the present area includes the collection of data
• By observation and discussion with local people
• By personal interviews of the local people.
• Through Questionnaires prepared and getting filled them by people.(Annuxure)

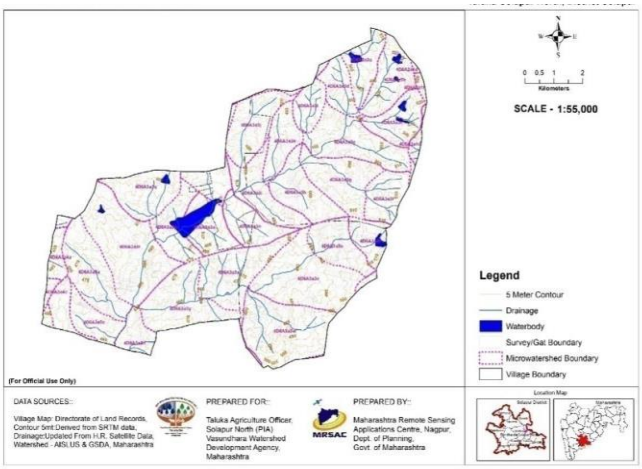
• Through Social Mapping of the areas for developing the social relationship with the local people.
• By GIS Survey including contour map, natural stream line map, water delineation map giving land use details.

3. Study Area

Akolekati village
Akolekati village is located in Solapur North Tehsil of Solapur district in Maharashtra, India. Akolekati is locatedat17.796028 Latitude and 75.8381345 Longitude. The climate of the village is tropical. During Summer, the humidity level is very high and in winter the climate is almost always dry. The unavailability of water in summer is severe. The total geographical area of village is 1872hectares. Akolekati has a total population of 3,430 peoples. There are about 700 houses in Akolekati village.

Darfal village
Darfal village is located in Solapur North Tehsil of Solapur district in Maharashtra, India. Darphal is locatedat17.7965°N, 75.7946°E. It has an average elevation of 11 metres (36 feet). The climate of the village is tropical. During Summer, the humidity level is very high and in winter the climate is almost always dry. The unavailability of water in summer is severe. The total geographical area of village is 3439 hectares. Darfal has a total population of 7,106 peoples. There are about 1,600 houses in Darfal village.

Nannaj village
Nannaj village is located in Solapur North Tehsil of Solapur district in Maharashtra, India. Nannaj located at 17.796028 Latitude and 75.8381345 Longitude. The climate of the villageis tropical.During Summer, the humidity level is very high and in winter the climate is almost always dry. The unavailability of water in summer is severe. The total geographical area of village is 3241 hectares. Nannaj has a total population of 7585 peoples. There are about 1540houses in Nannaj village.



Map No.1 Watershed Map of IWMP

4 BASIC DETAILS OF STUDIED AREA

Watershed development needs basic information about the area like geographical area, population, average rainfall, land under cultivation, Pond and canal, Irrigation facility etc.

Table No.1: Basic details of studied area

Details	Akolekati	Darfal	Nannaj
Geographical area	1810.55 ha	3162.20 ha	2980.98ha
Population	3430	7106	7585
Average rainfall	542.2mm	542.2mm	542.2mm
Irrigation facility	Bore-well &dug wells, lake	Bore-well &dug wells, lake	Bore-well &dug wells, lake

Table No.2: Existing ground water structures in watershed (Tentative Data)

Particulars	Akolekati			Darfal			Nannaj		
	Ponds	Wells	Bore wells	Ponds	Wells	Bore wells	Ponds	Wells	Bore wells
No. of structures	05	150	300	01	250	400	07	260	400
Use limit	-	Private	Private	-	Private	Private	-	Private	Private
Use for drinking purpose	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
Use for irrigation purpose	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
Availability of water for drinking purpose (approximately)	-	Till Nov-Dec	Till Nov-Dec	-	Till Nov-Dec	Till Nov-Dec	-	Till Nov-Dec	Till Nov-Dec
Availability of water for irrigation purpose (approximately)	-	Till Jan	Till Feb	-	Till Jan	Till Feb	-	Till Jan	TillFeb

Table No.3: Crop pattern of study area

Location / Crop	Akolekati Area forcrop Sown	Darfal Areafor crop Sown	Nannaj Area for crop Sown
Jawar	155	670.35	295
Wheat	109.25	470	175
Soya Bean	90	285.65	125
Vegetables	76	203.47	95
Orchards	125.36	312.17	78
Cotton	49.75	265.53	112
Groundnut	65	225	165
Grams	40	160	55
Area available for sown (ha)	710.36	2592.17	1100

5 PROVISIONS IN THE IWMP AND ITS REMEDIES

Provision of treatment in the village watershed as per the IWMP is as follows:

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

1) The shortage water availability in the region especially in the post monsoon has resulted in the scarcity of water in North Solapur

2) The lack of water availability has also resulted in low agriculture production due to unavailability of water for irrigation purposes.

3) Water scarcity over a long period has led to an increase in migration of people to the urban areas for the employment purpose.

4) Due to shortage of drinking water in summer season, supply of water through tankers becomes essential & also decrease the ground water table.

Table No.4 Existing& Proposed Structure under IWMP in Watershed Area

Sr. No.	Structure	Akolekati (No.)	Darfal (No.)	Nannaj (No.)
1.	Proposed loose Boulder Structure	20	16	Nil
2.	Proposed Earthen Structure	15	41	31
3.	Existing Farm Pond	04	03	07
4.	Proposed Farm Pond	06	14	28
5.	Existing Earthen Nala Bund	23	09	34
6.	Proposed Earthen Nala Bund	Nil	Nil	02
7.	Existing Cement Nala Bund	01	05	12
8.	Proposed Cement Nala Bund	02	06	05
9.	Nala Dipenning	02	06	09
10.	Existing Compartment Bunding	534.16 Ha	632.44 Ha	596.19 Ha
11.	Proposed Compartment Bunding	1267.38 Ha	2371.65 Ha	1490.49 Ha
12.	Proposed Horticulture Plantation	Nil	Nil	596.19 Ha

6 TYPES OF PROPOSED WATERSHED STRUCTURE

a) Loose Boulder Structure

These are small structures constructed in the upper ridge of over a gully or nalla, undulating topography and where run off is high. LBS is made up of loosely arranged boulders so as to arrest excess erosion and water loss during the rainy season.

Table No.4 Size of LBS

slope	Size of LBS			
	Bottom Width (m)	Bund Height (m)	Top Width (m)	Side slope
0 to 5% ofwatershed top side(upper reaches)	2.00	0.75	0.50	1:1;1:1
0 to 5% ofwatershed Middleside (middle reaches)	2.50	1.00	0.50	1:1;1:1

Fig -1: Loose Boulder Structure

b) Earthen Structure

An earthen embankment which is constructed across the gully or nala's called as earthen structures

Purpose of Earthen Structure

1. Reduce the velocity of flowing water through the drain.
2. Stop the water and percolate it in the soil.
3. Prevention of soil erosion caused by water and
4 . Prevention of sedimentation in largereservoirs.
5. Plantation on the downstream side of the dam.
6. Accumulation of silt on the inside of the dam increases the catchment area.

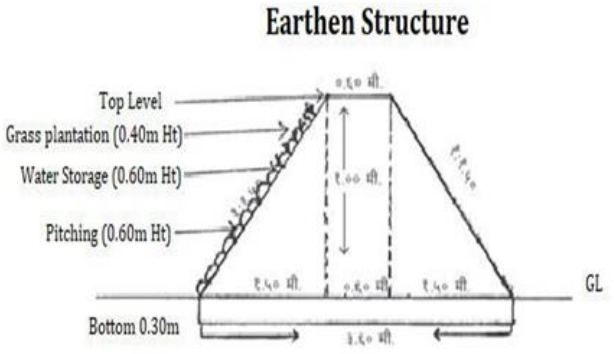


Fig -2: Cross-Section of Earthen Structure

Fig -3:Earthen Structure

c) Farm Pond

Farm Pond is a dugout structure with definite shape and size having proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. It is one of the most important rain water harvesting structures constructed at the lowest portion of the farm area.

Excavation details
a) Top dimensions of pond = 20m x 20m
b) Middle dimensions of pond = 17m x 17m
c) Bottom dimensions of pond = 14m x 14m
d) Depth of pond = 3m
e) Side slope to excavation = 1:1
Side earthen bund details
a) Top width = 2m
b) Height = 1.0m
c) Side slope = 1:1.25

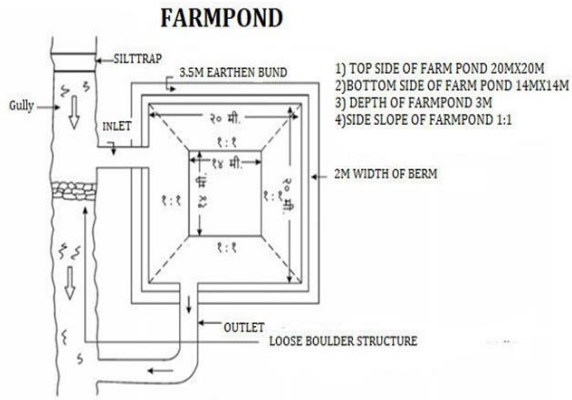


Fig - 4:Top View of Farmpond

Fig - 5:Farmpond at Nannaj

d) Earthen Nala Bund

Nala bunding is one of the important activities of the comprehensive watershed development programme in Maharashtra. Nala bunds are embankments constructed across the nala for storing runoff water, increasing water percolation and improving soil moisture regimes

1. Puddle Trench: Table 5. shows the sizes of Puddle Trench.

Table 5. sizes of Puddle Trench.

Catchment area	Sizes
10 Ha. to 40 Ha.	Width = 2m & Depth = 0.6 m
40 Ha. to 500 Ha.	Width = 2m & Depth = Up to Hard Strata or 1 m Maximum

2. Gorge Pit: Table 6 shows the sizes of Gorge Pit.

Table 6. sizes of Gorge Pit.

Catchment area	Sizes
10 Ha. to 40 Ha.	Width = Width of core wall & Depth = 0.75 m

3. Core wall:

- Height = Up to highest flood level
- Width = 0.6 m
- Side slopes = 1:1

4. Spillway:

- Length of spillway= $\frac{\text{Base width at HFL+24}}{\text{Base width at HFL}}+10$
- Slope = 1:1
- Maximum length allowed for spillway is 30 m.
- If the Hard murum is not available for foundation

then take a 0.6 m width so as to avoid erosion of spillway.

- Construct a header wall of height 0.5 m on downstream side of spillway wall.

5. Stone Pitching:

- The thickness of the rubble pitching should be kept between 0.20 m to 0.25 m with 0.15 m thick murum bedding & done up to HFL
-

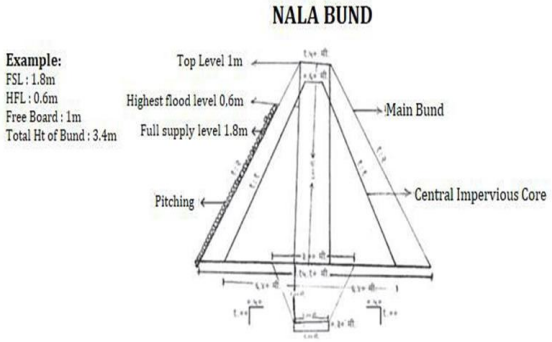


Fig - 6:Cross-Section of Nala Bund

e) Cement Nala Bund

A cement nala bund (CNB) is a bund/obstruction across the nala or stream constructed by using cement concrete to obstruct and store the flowing water. Cement nala bunds are also referred to a few other names---pukka bund, check dam, weir.

Design details:

Details specification of check dam

side slope i) u/s = 1:1 ii) d/s = 1:5

Top Width = 0.5m

Base Width = 10m

Height = 1.5m

Depth of foundation = 1.5m

Length of check dam = 15m

free board = 1m

Bed Width of Drain= 10m

Fig - 6:Check Dam at Darfal

f) Nala Deepening

Remove the silt from the nala & deepening the bed of the nala. You must remove it using proper machines & following scientific techniques. Use a pokeland excavator machine of 210 horsepower, because Pokeland machine have 18 to 20 feet long boom hence, it can easily lift the silt from the bed & pile it on the banks this result in excellent quality & speed completion of work so use a pokeland.

g) Compartment bunding

Compartmental bunding means the entire field is divided into small compartments with pre determined size to retain the rain water where it falls and arrest soil erosion. Compartmental bunding conserves the rainwater in situ, recharges soil profile uniformly, reduces runoff, soil and nutrient losses and increases crop yields on a sustainable basis. This technology is simple and low cost and can be adopted by the farmers easily in the medium to deep black soils in the region.

h) Horticulture Plantation

Horticulture Sector plays an important role in the development of watershed area by the concept of dry land horticulture. The growing of suitable perennial dry land horticultural crops not only brings soil and water conservation insitu, but also makes best use of available moisture resulting in increase in the returns. This creates an eco-friendly environment in addition with generation of rural employment opportunities. The planting materials of suitable horticultural crops like fruit, flowers and perennial Vegetable crops are supplied and planted in the identified beneficiaries lands.

7 RESULT AND DISCUSSION

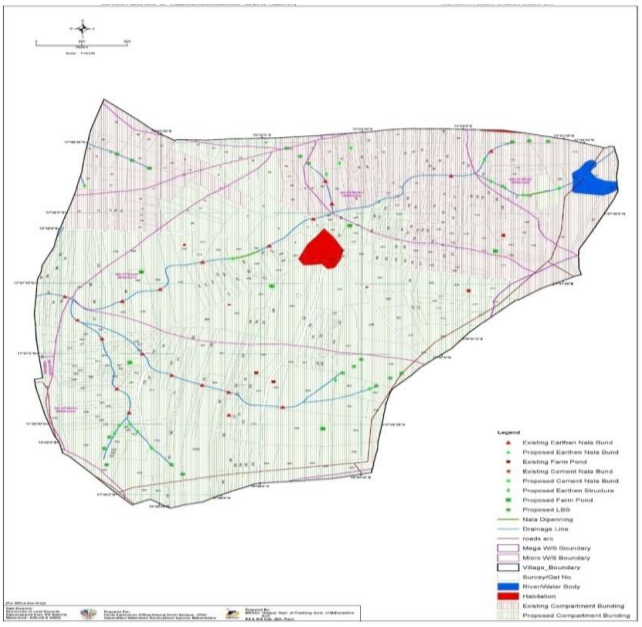
AKOLEKATI

Table 7. Capacity of Proposed Watershed Structure of Akolekati

Sr. No.	Type of Structure	No. of structures	Water to be Stored (m3)	Total water Available (m3)
1	LBS	20	12	
2	Earthen Structure	15	17.5	
3	Farm pond	6	876	
4	Earthen Nala Bunding	-	5390.7	$5.16x10^5$
5	Check dam	2	14000	
6	Compartment Bunding	1267.38 Ha	380.625	
Total =$5.16x10^5$ m3 per year				

Table 8. Cost of Proposed Watershed Structure of Akolekati

Sr.no.	Type of structure	No. of structures	Cost of structure	Total cost in Rs.
1	LBS	20	9150	183000
2	Earthen Structure	15	9806	147090
3	Farm pond	6	160000	960000
4	Earthen Nala Bunding	-	6,01,236	-
5	Check dam	2	769000	1538000
6	Compartment Bunding	1267.38 Ha	28047	35546207
Total cost				38374297



Map No. 2 Map Showing Existing & Proposed Watershed Structure Of Akolekati

A) Annual Water Requirement for demand of Domestic & Animal

Domestic Requirement = 106926.75cub.m.

Animal Requirement=7491.625cub.m.

Total water requirement=1.14x10^{5}cub.m.

B) Cost of water per liters

Total Capacity of Proposed watershed structure = 516000000Liters

Total cost of watershed techniques = Rs. 38374297

Cost of water per liters = 38374297/516000000

Cost of water per liters = Rs. 0.074/lit

DARFAL

Table 9. Capacity of Proposed Watershed Structure of Darfal

Sr.no.	Type of structure	No. of structures	Water to be Stored (m3)	Total water Available (m3)
1	LBS	16	12	9.99x10^5
2	Earthen Structure	41	17.5	
3	Farm pond	14	876	
4	Earthen Nala Bunding	-	5390.7	
5	Check dam	6	14000	
6	Compartment Bunding	2371.65Ha	380.625	
Total =9.99x10^5 m3 per year				

Table 10. Cost of Proposed Watershed Structure of Darfal

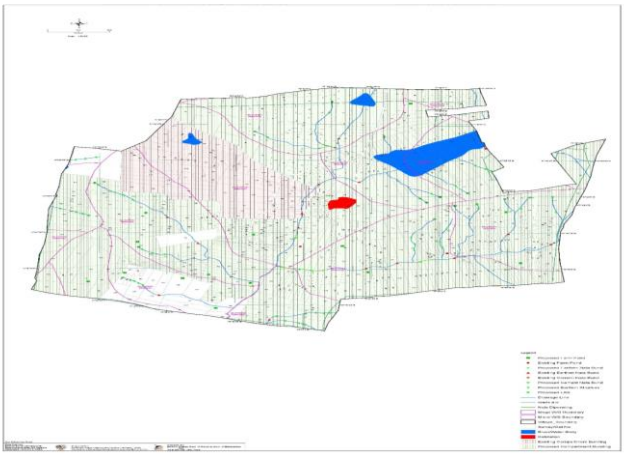
Sr.no.	Type of structure	No. of structures	Cost of structure	Total cost in Rs.
1	LBS	16	9150	146400
2	Earthen Structure	41	9806	402046
3	Farm pond	14	160000	2240000
4	Earthen Nala Bunding	-	6,01,236	-
5	Check dam	6	769000	4614000
6	Compartment Bunding	2371.65Ha	28047	66517668
Total cost				73920114

A) Annual Water Requirement for demand of Domestic & Animal

Domestic Requirement = 221492.950cub.m.
Animal Requirement=25769 cub.m
Total water requirement=2.47x10^{5}cub.m.

B) Cost of water per liters

Total Capacity of Proposed watershed structure = 999000000Liters
Total cost of watershed techniques = Rs. 73920114
Cost of water per liters = 73920114/999000000
Cost of water per liters = Rs. 0.073/lit



Map No. 3 Map Showing Existing & Proposed Watershed Structure Of Darfal

NANNAJ

Table 11. Capacity of Proposed Watershed Structure of Nannaj

Sr.no.	Type of structure	No. of structures	Water to be Stored (m3)	Total water Available (m3)
1	LBS	-	12	
2	Earthen Structure	31	17.5	
3	Farm pond	28	876	
4	Earthen Nala Bunding	2	5390.7	$6.73x10^5$
5	Check dam	5	14000	
6	Compartment Bunding	1490.49 Ha	380.625	
Total =$6.73x10^5$ m3 per year				

Table 12. Cost of Proposed Watershed Structure of Nannaj

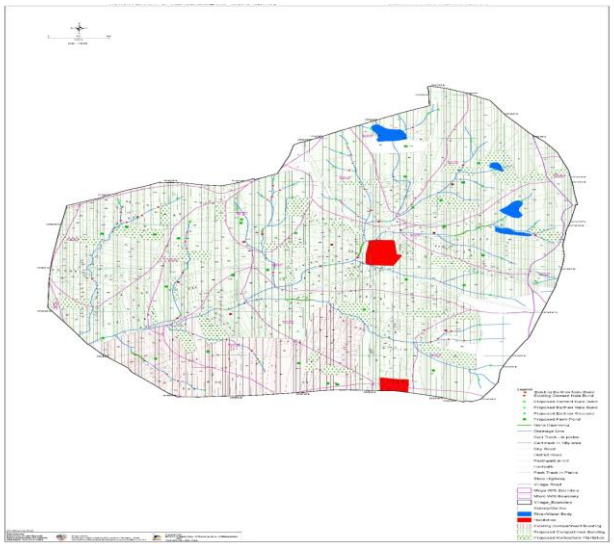
Sr.no.	Type of structure	No. of structures	Cost of structure	Total cost in Rs.
1	LBS	-	9150	-
2	Earthen Structure	31	9806	303986
3	Farm pond	28	160000	4480000
4	Earthen Nala Bunding	2	6,01,236	1202472
5	Check dam	5	769000	3845000
6	Compartment Bunding	1490.49 Ha	28047	41803773
Total cost				51635231

A) Annual Water Requirement for demand of Domestic & Animal

Domestic Requirement = 236490.8cub.m.
Animal Requirement=38921.045cub.m
Total water requirement=$2.75x10^5$ cub.m.

B) Cost of water per liters

Total Capacity of Proposed watershed structure = 673000000Liters
Total cost of watershed techniques = Rs. 51635231
Cost of water per liters = 51635231/673000000
Cost of water per liters = Rs. 0.076/lit



Map No. 3 Map Showing Existing & Proposed Watershed Structure of Nannaj

8 COST BENEFIT RATIO OF PROJECT

The Benefit Cost Ratio (BCR) has been calculated for Akolekati, Darfal & Nannaj. A time series statement is prepared both, the cost incurred and benefits achieved during the same period. They are then summed up and the BCR is calculated as per the formula given below

BCR= Total benefit/ Total cost

Table 13. BCR of watershed structure

Name of Village	Total Cost	Total Benefit	Benefit Cost Ratio (BCR)
Akolekati	38374297	89576396	2.33
Darfal	73920114	329724025	4.46
Nannaj	51635231	138710000	2.68

9 CONCLUSION

In North Solapur 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.

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 ofpeople of in these villages.

2) Availability of water for recharge very less. water of total precipitation (542 mm Avg. Precipitation) is available for artificial recharge. It is found that 85 % 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/streams.

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 groundwater table.

7) Watershed development project is effective for decreasing demand of water from other resources and becomes self dependent from water supply point of view.

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