RESEARCH FRONT

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

WATERSHED MANAGEMENT : A WAY TO SOLVE WATER SCARCITY IN SEMI ARID MAHARASHTRA USING GEOSPATIAL TECHNIQUES

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Abstract

Water scarcity is a serious issue in arid and semi arid regions. In this paper a study of Vita micro watershed of semi arid Yerla River basin, Maharashtra is carried out to solve water scarcity. The objectives of the study are to study morphometric parameters, to study land use and land cover classification and to identify suitable sites for watershed management structures in the study area using geospatial techniques. SOI toposheets, IMD monthly rainfall data, GPS, Google Earth images, ArcGIS software and technical watershed development guidelines of Soil Conservation and Agriculture Department, Govt. of Maharashtra are followed for identification of suitable sites for various watershed management structures. Based on the field observations, LULC analysis, morphometric analysis and interpretation of maps identified potential sites for loose boulder structures, contour trenches, farm bunds, farm ponds, check dams and percolation tanks are proposed in Vita micro watershed using ridge to valley approach. In this micro watershed 36 structures are proposed due to which it is estimated about 63.9 TCM water would be available. Proposed structures are helpful to reduce soil erosion and recharge waterlevel.

Key words: Watershed management, Semi arid region, Geospatial Techniques, Vita, Yerla River Basin, Maharashtra

INTRODUCTION

Water is a elixir of life. It is a need to look forward towards sustainable approach to develop watershed at micro level to reduce runoff and improve the groundwater recharge. Proper treatment of micro watersheds provides a solution for meeting the frequent drought situations (Tideman, 2007). The Government of India has been deploying considerable resources in different watershed development programmes since mid 1960s (Sharda et al., 2008). Watershed management techniques are useful to solve water scarcity problem. Geomorphic approach is indispensible in site suitability for watershed management structures. Morphometric analysis of micro watershed is helpful to understand the drainage characteristics and geomorphology of area. Rao et al. (2012) stated that morphometric parameters are of immense utility in watershed prioritization for watershed management structures at micro-watershed level. Sreedevi et al. (2009), Singh et al. (2014) and many others stated that geospatial technologies provides significant impetus to morphometric analysis and their utilization in water resources management. Saptarshi and Raghavendra (2009) and Telore (2016) carried out geoinformatics based evaluation of watersheds to ascertain site suitability for watershed management structures in various parts of India. Unde and Telore (2013) stated that watershed development programmes are useful for the sustainable development of semi arid and arid regions. Phadnis (2013), Pallavi and Deshmane (2013) have given emphasis on the management of water resources in drought

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

prone area. Gavade et al. (2011) used criteria like stream order, slope angle, soil type and settlement for suggesting suitable sites. Proper management of micro watersheds are helpful to eradicate water scarcity in the arid and semi arid regions.

OBJECTIVES

To study land use and land cover classification of Vita micro watershed. To carried out morphometric analysis of Vita micro watershed. To identify suitable sites for watershed management structures in Vita micro watershed using geospatial techniques.

STUDY AREA

Total geographical area of Vita alias Vite micro watershed is 4.23 km^2. The area lies in the western part of Khanapur Tahsil of Sangli District of Maharashtra. It is located on the left bank tributary in the eastern central plateau region of the Yerla River basin (Figure 1). Vita is a headquarter of Khanapur Tahsil and major city of the district. Phaltan - Sangli (SH 110) passes through north south and Kadegaon - Khanapur (SH 78) passes through east west to micro watershed. The area receives 685 mm average annual rainfall, which is average rainfall of Vita station for the period of 1980 to 2012. Vita city is located in the downstream reaches. The tributary flows from north to south and exhibits dendritic drainage pattern (Figure 5A). Minimum and maximum values of height varies from 670 to 730 m shows 60 m of moderate relative relief and absolute relief of the area is 730 m. Almost fifty percent area of micro watershed is occupied by urban settlement and activities (Figure 3A to F). Millets like jowar, bajra and vegetables are cultivated prominently in the Kharif season in upper reaches. Grape orchards are observed in northern and north western part of micro watershed. Gullies having occupied by farmers for the cultivation of grapes, etc. (Plate 1C). Cattle grazing observed in scrub land area. Details of the morphometric parameters are given in Table 1, cross section and sediment sample locations in Figure 2, various maps are shown in Figure 3A to G and photographs are shown in Plate 1A to F.

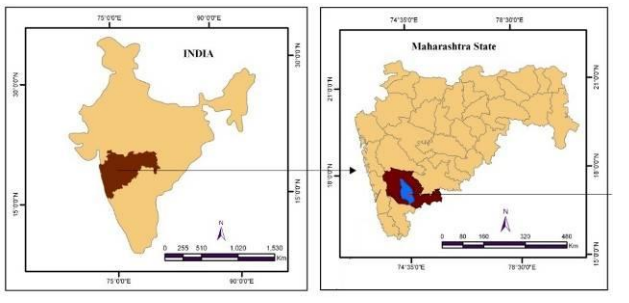
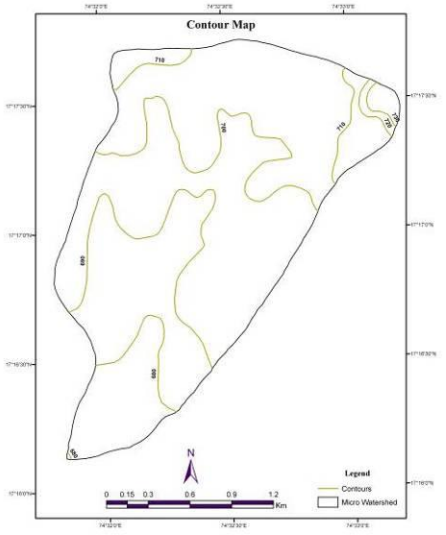


Figure 1: Location map of the study area



MATERIALS AND METHODOLOGY

Various thematic maps such as drainage map and stream ordering map, contour map, elevation map, slope map, aspect map, LULC map and DEM are prepared using toposheet

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no. 47 K/5 of 1:50,000 scale in ArcGIS 9.3 software. Ground truth checkup made with the help of handheld GPS during field visit. SOI toposheet of 1980 and Google Earth image of 2013 are used to study LULC classification. The morphometric parameters viz. stream ordering, stream length, bifurcation ratio, drainage density, stream frequency, relief ratio, elongation ratio and circularity ratio are calculated based on the formulas suggested by Horton (1945), Strahler (1964) and Miller (1953). These parameters are measured from the toposheets. Technical watershed development guidelines of Govt. of Maharashtra are followed for suitable site selections (Govt. of Maharashtra, 2006). Based on the field observations, morphometric analysis, land use and land cover analysis and interpretation of maps identified potential sites for loose boulder structures, contour trenches, farm ponds, check dams and percolation tanks in Vita micro watershed.

RESULTS AND CONCLUSION

Morphometric Analysis

Vita micro watershed is developed on third order tributary of the Yerla River basin. Drainage density and stream frequency values are 2.16 km/km^2 and 2.59 streams/km^2 respectively indicates coarse texture due to highly resistant sub-soil material and low relief. The calculated Millers form factor ratio of the study area is 0.34 suggests the elongated shape. Circularity ratio is 0.65 indicates elongated shape. Elongation value in 0.66 indicates less elongated shape. Compactness coefficient value of area is 0.96 indicates less hazardous micro watershed. Length of overland flow is 0.23 km. The mean bifurcation ratio of the study area is 2.0616 is low indicates that structure does not exercise a dominant influence of the drainage pattern. The area is characterised by an undulating topography with an average slope of about 0.4 per cent. Slope of the area ranges between 0 to 10.26 degrees of which 85 percent area lies below 1.57 degrees (Figure 2B). Aspect map shows slope is towards south-west and south (Figure 2C). Details of linear, areal and relief morphometric parameters are given in Table 1.

Slope (%)	Form Factor (Ff)	Circularit Ratio (Rc	Elongatio Ratio (Re	Drainag Density (Dd)	Stream Frequenc (km/km^2	Compactnes Coefficient (Cc)	Length o Overland flow (Lg
0-10.2	0.34	0.65	0.66	2.16	2.59	0.96	0.23

Basin Length (km)	Perimeter (P) (km)	Number of Streams			Stream Length (km) (Lu)			Mean Stream Length (km)	Bifurcation Ratio (Rb)			Mean Rb
		I	II	III	I	II	III		I	II	III	
3.54	9.04	8	2	1	6.02	0.49	2.63	2.88	12.10	0.18		6.14

Table 1: Morphometric parameters of Vita micro watershed

Cross Section and Textural Analysis

First cross section is taken on the mainstream in the source region of micro watershed from 0.37 km from its source. The channel profile having wide width of 18.7 m and low depth of 4.17 m and cross sectional area is 77.98 sq. m (Figure 2, CS1). Both banks are having steep slopes with clay and silt materials. Agricultural lands are observed on both

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

sides of the bank. Second cross section is taken in upper reaches on mainstream from 0.77 km from the source. The channel width is 17.68 m and depth is 1.2 m and cross sectional area is having 21.21 m^2 (Figure 2, CS2). The area is occupied by agricultural lands and hence clay contents are common. Third cross section is taken 1.61 km from the source of mainstream of micro watershed on western side stream. The channel width is 17.68 m and depth is 1.2 m and cross sectional area is 21.21 m^2 (Figure 3, CS3). Gentle slopes are observed on both banks and area is surrounded by agricultural fields.

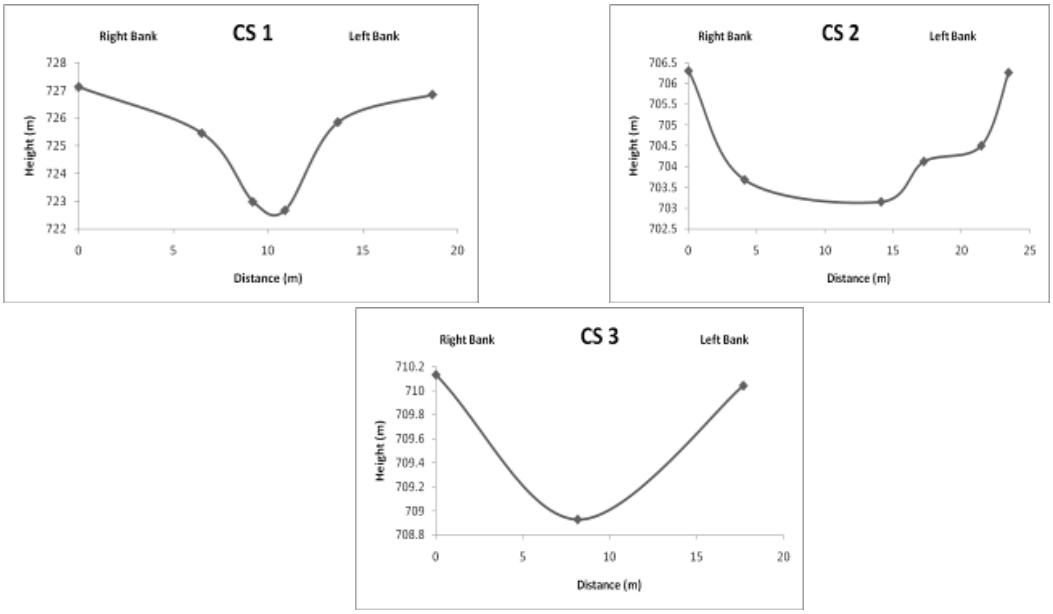

Figure 2 Cross section and sediment sample locations at Vita

Land use and Land cover Analysis

LULC analysis of the Vita micro watershed is carried out using change detection method for 34 years period. SOI toposheet of 1980 and Google Earth image of 2013 are used for the classification. LULC maps are presented in Figure 3D and E. Five major categories found including agriculture, vegetation, settlement and water bodies and roads. The result shows that the major change is the alteration form agriculture land to settlement area caused by urbanization. Based on the maps observation most significant change observed during this period is expansion of built up area by 15.13% and its rate of change is 0.0188 km^2 per year. Built up area in this urban micro watershed is expanded by 15.13 percent and its rate of change is 0.0188 km^2 per year. It is found that the sprawl of built up area encroaches area of agricultural as well as vegetation area and built up area expand outward side. Roads are also increased by 0.23 %. While agriculture area is reduced by 14.65 % and its rate of change is 0.0182 km^2 per year. Vegetation cover is also reduced by 0.709 % and its rate of change is 0.0009 km^2 per year.

Watershed Management Structures

In Vite micro watershed six watershed management structures are proposed using ridge to valley approach (Figure 3G). 5 loose boulder structures are proposed in the upper reaches to reduce gully erosion on first order streams. 15 contour trenches and 9 farm bunds are proposed in the upper plateau surface to reduce soil erosion and recharge sub surface water level. 7 farm ponds are suggested in the middle reaches in soils of less percolation. 9 check dams are proposed in the middle and lower reaches on first and second order streams. 1 percolation tank is proposed on the third order streams in soils which prevent water logging

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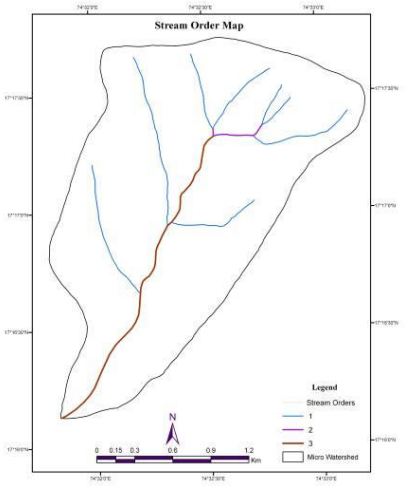
(Print) 2320 – 6446, (Online) 2320 – 8341

in middle reaches (Figure 3G, Table 2). In this micro watershed 37 structures are proposed due to which it is estimated about 51.9 TCM water would be available. Proposed structures are helpful to reduce soil erosion and increase waterlevel. Details of estimated water runoff is given in Table 2.

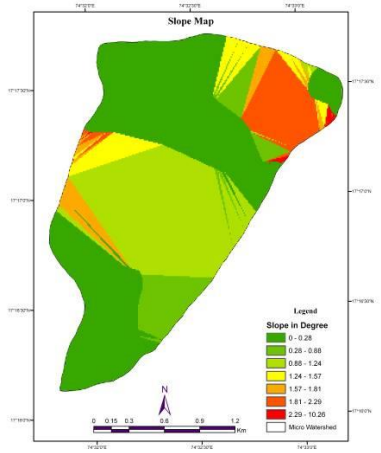
Micro Watershed and Estimated Runoff (TCM)	Number of Watershed Management Structures												Total Estimated Runoff (TCM)		Total Estimated Runoff (TCM)
	LBS	LBS	CT	CT	FB	FB	FP	FP	CD	CD	PT	PT			
	E	P	E	P	E	P	E	P	E	P	E	P	E	P	
Dharpudi	2	7	3	8			7	7	10	13	1	1	23	**36**	59
Estimated Runoff							4.9	4.9	30	39	20	20	54.9	**63.9**	118.8

LBS: Loose boulder structure**, CT:** Contour Trench**, FB:** Farm Bund**, FP:** Farm Pond**, CD:** Check Dam**, PT:** Percolation Tank **E**: Existing, **P** : Proposed

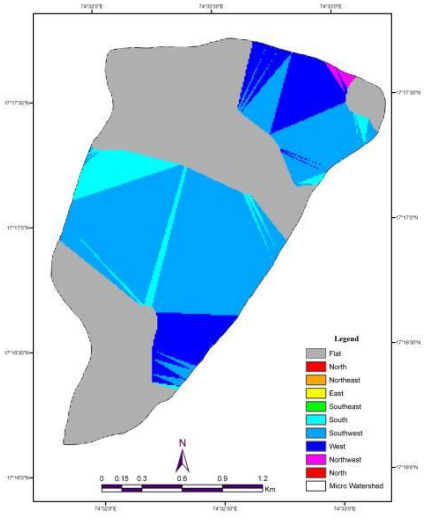
Table 2 Details of watershed management structures and its runoff



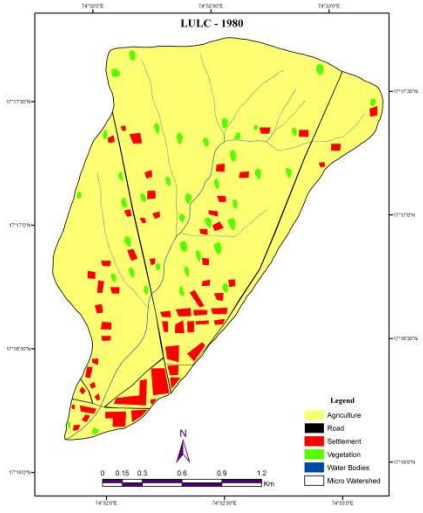
A. Drainage and Stream Ordering Map



B. Slope Map



C. Aspect Map



D. Land use and Land cover map of 1980

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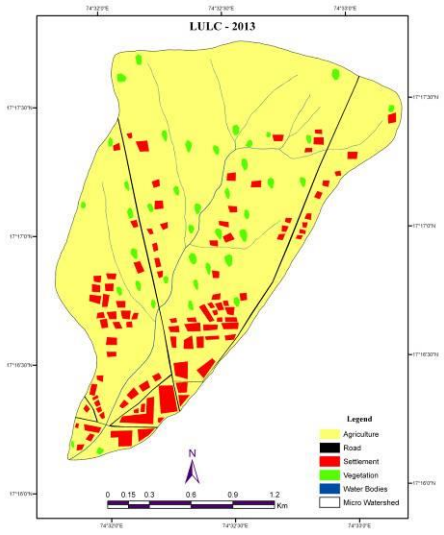
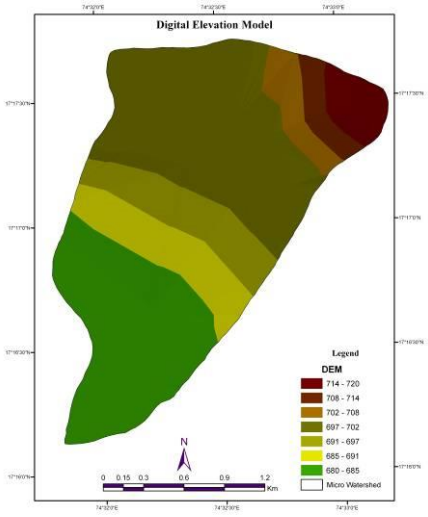
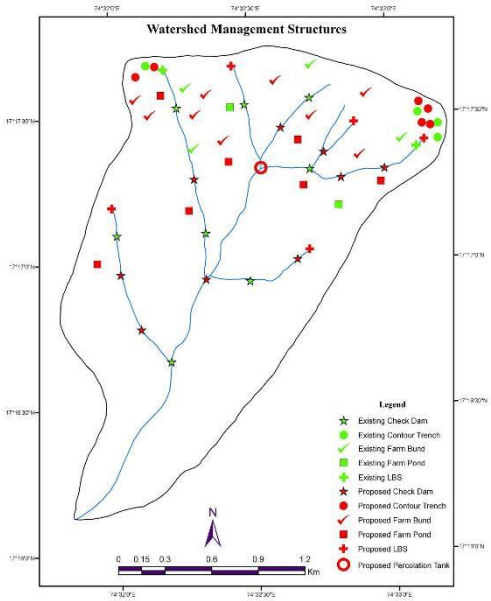
(Print) 2320 – 6446, (Online) 2320 – 8341



E. Land use and Land cover map of 2013



F. Digital Elevation Model



G. Watershed Management Structures

Figure 3 Various maps of Vita micro watershed

A. Bird eye view of Vita, open scrub

B. Part of Vita city

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C. Gullies having occupied by farmers

D. Onion exfoliation

E. Red bole of above 1.5 m thickness

F. Field observation to suggest suitable sites for conservation

Plate 1 Photographs of Vita micro watershed

Acknowledgements

First author is thankful to University Grants Commission, Ministry of Higher Education, Govt. of India, New Delhi for providing Teacher Fellowship under the 12th Plan for completion of the study, which is a part of authors Doctoral work vide file no. F. No. 36 - 03 / 12 (WRO).

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