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WATERSHED MANAGEMENT ANALYSIS USING GEOSPATIAL TECHNIQUE: A CASE STUDY OF CHANDANI WATERSHED IN MAHARASHTRA

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ABSTRACT:

The study of watershed management is important for rural development. Application of Geospatial technique in the study of water resource management is increased on large scale in last 3 decades. The present study is carried out forwatershed analysis in dry track of Ahmednagar district. For the present work researcher has selected Chandani watershed of Dhora basin in part of Pathardi and Shevgaon tahsils. River Dhora is right bank tributary of River Godavari having an area of 138.46 km² and order of the stream is 6th. Maximum height found at the source which is 885m and height at the confluence with river Nani is 480 m. Slope of the basin is 14.16% and it receives 585 mm average rainfall, there is a rainfall station at Pathardi.

Study tries to focus on find out suitable sites for water harvesting structures in Chandani watershed. Site selection is totally depending on the physiography of the area. It helps to recharge aquifers and reduce water scarcity in the study area in some extent. Analysis is carried out with the help of following methodology, such as watershed delineation, morphometric analysis, preparation of maps using GIS softwares and Digital Elevation data. With the help of geospatial technique and field observation suitable sites are selected for proposed water harvesting structures in the study area. If the solved water scarcity problem sustainable rural development of the region is possible.

KEYWORDS: *River Chandani, Geospatial Technique, Watershed Management, Rural Development.*

INTRODUCTION :

A watershed is a geo-hydrological unit which drains at a common point. The entire area that supplies water to a stream or river, that is, the drainage basin or catchment area, is also called as the watershed of that particular stream or river. Watershed is a region or area delineated with a well-defined topographic boundary and outlets. Geomorphic analysis of a river basin is essential for watershed management.

Worldwide it is observed that watershed management is a scientific way of sustainable water resource development (Tideman, 2007). Watershed management analysis is an extremely important to minimize drinking and domestic water scarcity. Geomorphic analysis is carried out for watershed management and at some extent minimize water scarcity problem of the study area.

Watershed management is the

process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within the watershed. The concept of watershed management is based on the recognition of inter relationships between land use, land cover, soil, water and the slope of terrain.

Geospatial technology involves Global Positioning Systems (GPS), Geographical Information System (GIS) and Remote Sensing (RS). This technology offers a radically different way in which we produce and use maps required to manage our communities. Chandani watershed has been selected for present work, which is located in part of Pathardi and Shevgaon tahsils of Ahmednagar district. Remote Sensing (RS) and Geographical Information System (GIS) techniques are used for the analysis and preparation of appropriate maps of Chandani watershed.

Purpose of watershed management practices:

- To Increase infiltration.
- To Increase water holding capacity.
- To prevent soil erosion.
- Increase water storage capacity.

Aim and Objectives:

Main aim of the present study is to minimize the water scarcity problem of the study area.

- To study the hydrological characteristics of the Chandani watershed.
- To study the morphometric characteristics of the Chandani watershed.
- To identify suitable sites for watershed management structures in the Chandani watershed.

STUDY AREA:

Chandani watershed is located in parts of Pathardi and Shevgaon tahsils of Ahmednagar district in Maharashtra.Latitudinal extension is 19° 04' 50'' N to 19° 18' 23'' N. Longitudinal extension is 75° 06' 33'' E to 75° 15' 02'' E. Source of Chandani watershed is in the Pathardi tahsil and outlet of the watershed is in the Shevgaon tahsil.Maximum height found at the source region which is 885m and lowest height is 480m found at the confluence of River Chandani with River Nani near Warur village in Shevgaon tahsil. Total length of the watershed is 25.46 km; out of them only 3.03 km length is in the Shevgaon tahsil and remaining 22.43 km length is in the Pathardi tahsil. Chandani watershed (6^{th} order stream) is a part of River Dhora.Chandani watershed is located North-East direction of the Ahmednagar city; distance from the city is 50 km.Perimeter of the watershed is 66.026 km. covered an area 138.46 km^2.Slope of the basin is 14.16% and it receives 585 mm average rainfall, there is a rainfall station at Pathardi.

There are 19 villages located in the watershed namely Ranjani, Kelwandi, Shirsatwadi, Mohari, Damalwadi, Bhandewadi, Dhaytadakwadi, Handalwadi, Karegaon, Tanpurwadi, Walunj, Dule-Chandgaon, Malegaon, Kherde, Sangavi-Khurd, Sangavi-Budrukh, Pagori-Pimpalgaon, Prabhu-Pimpari, Susre and Pathardi town is located in this watershed.All villages are located in the Pathardi tahsil; there is no anyone village of this watershed in Shevgaon tahsil.Average rainfall is 585 mm received in 40 to 45 days in this watershed. About 70% to 80% annual rainfall is received during monsoon period (June to September). The average temperature ranges between 9^0c (during Dec.) and 41^0C (during April and May).Soil varies from reddish brown to dark gray and commonly grouped as light to medium black.In very few places deep black soil is observed. Erratic nature of rainfall affects the moisture content in the soil, therefore, this zone is commonly known as drought prone area.

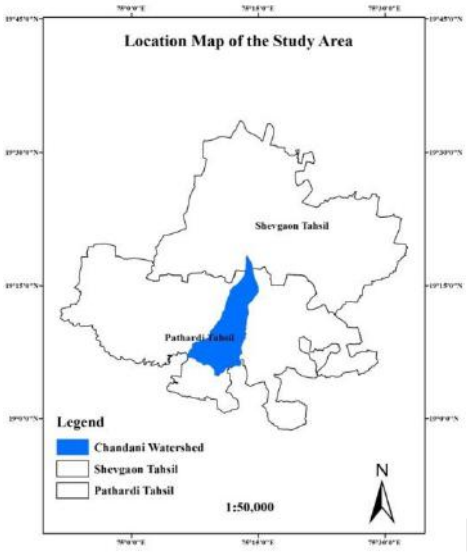


Figure - 1 : Location Map of the Study Area

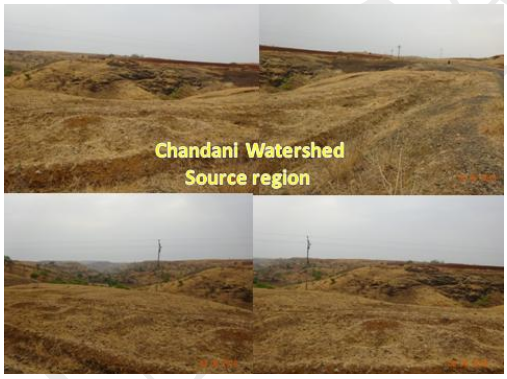


Photo - 1: Chandani Watershed Source Region at the Southern side of Pathardi Town

Photo - 2: Interaction with villagers at Damalwadi village in Pathardi Tahsil

METHODOLOGY:

To fulfillment the objectives following methodology is used.

Pilot survey of the selected watershed is completed. Review of literature is carried out from varies sources. Hydrological data is collected, which is available on the site of Rainfall Recording and Analysis, Department of Agriculture, Maharashtra State. CartoSat 1 DEM data of 30 m spatial resolution

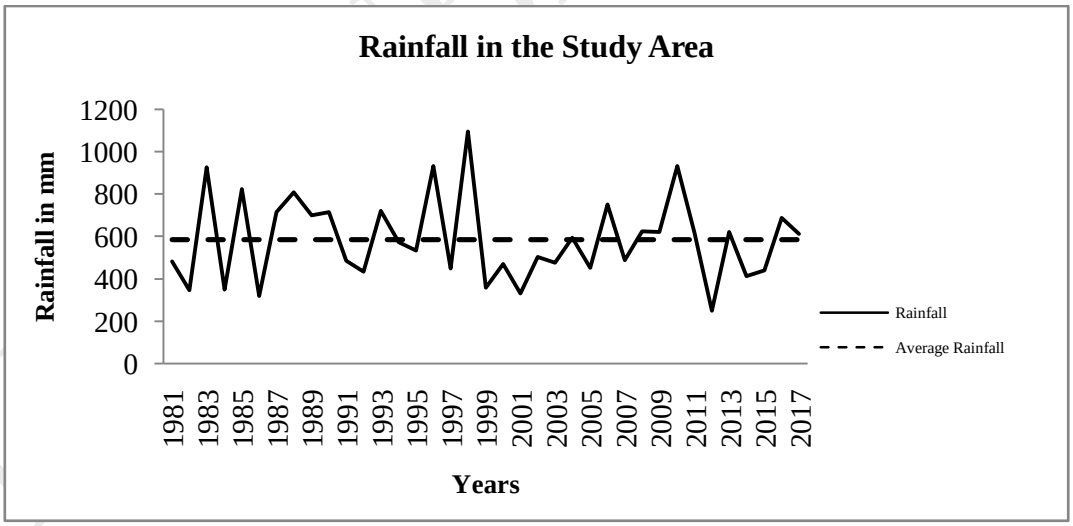
is used to analysis of Chandani watershed. Geomorphic conditions, land-use land-cover and present status of watershed is observed during the field survey and discuss with the local people. Delineation of watershed from Survey of India toposheet No. 47 M/3 and 47M/4 (Scale:- 1:50,000).Digitization is completed with the help of Global Mapper v15.1 software.Various maps are prepared including contour, drainage and stream ordering.Detailed morphometric analysis of the Chandani watershed is carried out using standard formulas of Strahler's Method (1964). Analysis of these data is also statistically correlated.Suitable sites are identified for the proposed water harvesting structures construction in the watershed on the basis of field observation and morphometric analysis.

REVIEW OF LITERATURE:

- Gonenc et al. (2008) observed that multidisciplinary approaches are required and groups of natural scientists, engineers, social scientists and managers must collaborate and develop recommendations for sustainable management of watershed.
- Chadha and Neupane (2011) studied the significance of geomorphic analysis of watershed for the optimization of recharge structures. Authors provide technique for optimum utilization of the available runoff at different locations within the watershed based on stream ordering and geomorphic analysis of the drainage area.
- Jain et al. (2011) evaluated a sub-watershed in Sabarmati Basin for site suitability of water harvesting structures. In the study, overlay of water resources and other natural resource data was done on ASTER DEM. Authors identified new potential sites for water harvesting structures.
- Unde M.G. and Telore N.V. (2012): Suggested the watershed development programme is essential for sustainable development of the drought prone region, Authors studied the Nidhal watershed in Satara district of Maharashtra.

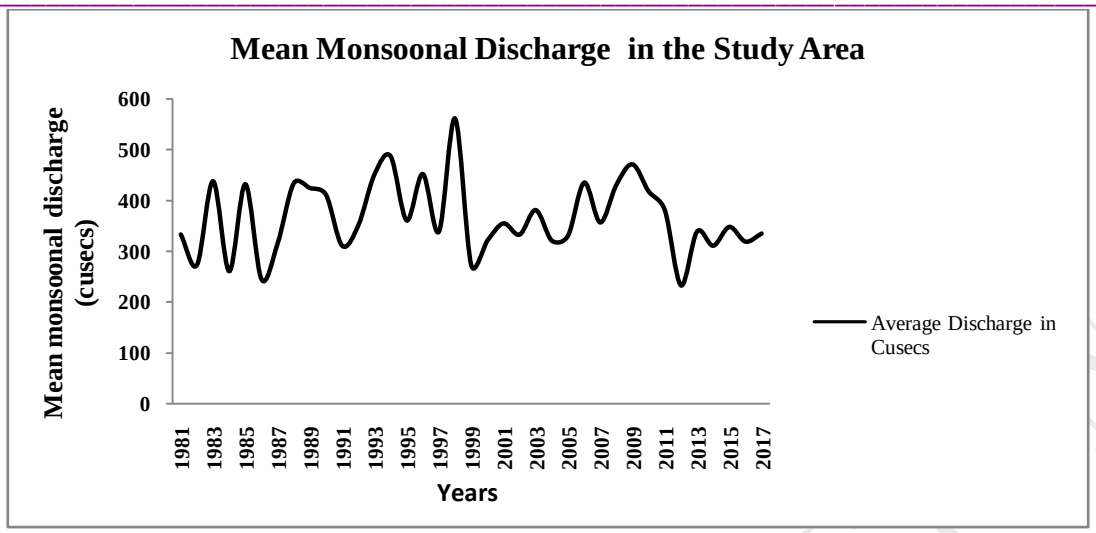
HYDROLOGICAL CHARACTERISTICS:

Rainfall is one of the important parameter of hydrological study. Rainfall and discharge data of 37 years have been taken from Rainfall Recording and Analysis, Department of Agriculture, Maharashtra State.



Graph - 1: Rainfall graph of the Study Area

Above graph shows rainfall at Pathardi rainfall station. Average rainfall is found 585.09 mm. 37 years rainfall is taken into consideration for analysis. Maximum rainfall is received 1095 mm in the year 1998. Minimum rainfall received 250 mm in the year 2012. Maximum years are found received below average rainfall, this is shows the drought prone condition of the region.



Graph - 2: Mean Monsoonal Discharge graph of the Study Area

The total runoff generated the mainstream of the watershed is the function of total precipitation received on the watershed. However, all the precipitation received is not converted into discharge due to hydrological losses. Interception by vegetation cover, temporary storages in ponds and lakes, infiltration and evapo - transpiration are principal losses. Therefore to study the relationship between rainfall and discharge are essential for watershed management studies for suggesting watershed management structures. Rainfall and discharge relationship is established for the Chandani River basin at Pathardi station. The correlation coefficient is calculated as 0.797, which shows strong positive correlation between average rainfall and mean discharge of the Chandani River basin.

Morphometric Analysis of the Watershed:

Morphometric variables which are determine the shape, size and genetic aspect of drainage basins. Use of GIS and DEM is helpful to delineate watershed characteristics such as watershed boundary, drainage network and contributing sub and micro watersheds for inventory and planning purposes. Survey of India Toposheets and Landsat archive data provides geo spatial information of topography, soils and geology, vegetation and land use land cover. GIS and Remote Sensing both techniques are helpful to analyze dynamic hydrologic and geomorphic processes for decision making purposes.

Table -1: Bifurcation ratio of the drainage basin in the Study Area

Stream Order (μ)	Number of Streams (Nμ)	Bifurcation Ratio(R_b)
1	465	4.30
2	108	3.72
3	29	4.14
4	7	3.5
5	2	2.0
6	1	-

Mean bifurcation ratio of Chandani watershed is 3.53Values range between 3.0 and 5.0 in the same way as they range in the basins developed over hilly and highly dissected regions.

Negative correlation is found between stream number and stream order in the Chandani watershed, which is -0.77.

Table - 2:Linear Aspects of the Drainage basin in the Study Area

Stream Order (μ)	**Number of Streams**(Nμ)	**Total length of streams in km** (Lμ)	**Log** Nμ	**Log** Lμ	**Mean Stream Lengths (MSL =** Lμ/ Nμ)
1	465	201.310	2.66	2.30	0.432
2	108	89.300	2.03	1.95	0.826
3	29	40.160	1.46	1.60	1.384
4	7	21.130	0.84	1.32	3.018
5	2	26.610	0.30	1.42	13.35
6	1	9.850	0	0.99	9.850
Total	**612**	**388.36 km**			

Table - 3 : Morphometric Parameters of the Study Area

Morphometric Parameters	**Calculated Value**
Area (Sq. km)	138.46 km²
Perimeter (km)	66.02 km
Drainage Density	2.80p/sq.km
Stream Frequency	4.42p/sq.km
Texture Ratio	9.26
Basin Length (km)	25.816 km
Elongation Ratio	0.51
Circulatory Ratio	0.39
Form Factor Ratio	0.20

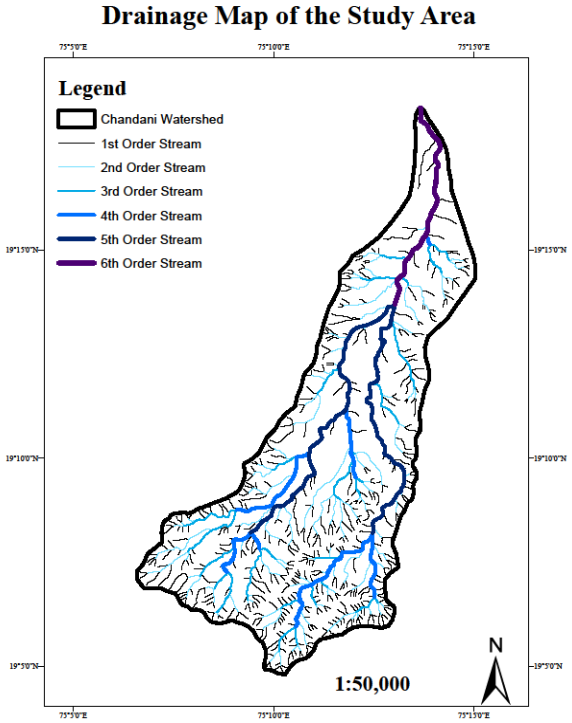


Figure - 2 : Drainage Map of the Study Area

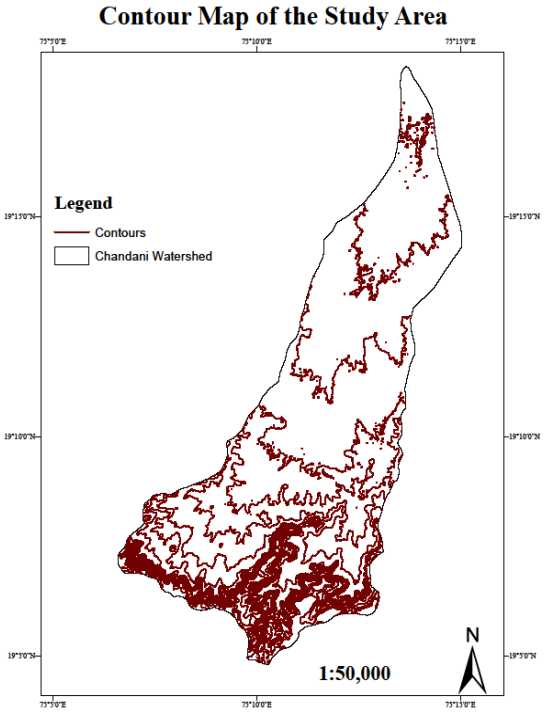


Figure - 3 : Contour Map of the Study Area

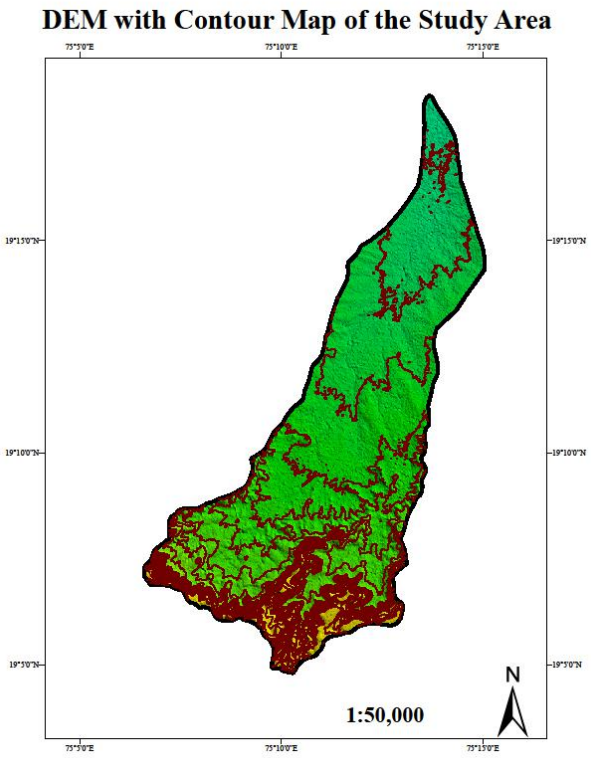


Figure - 4 : DEM with Contour Map of the Study Area

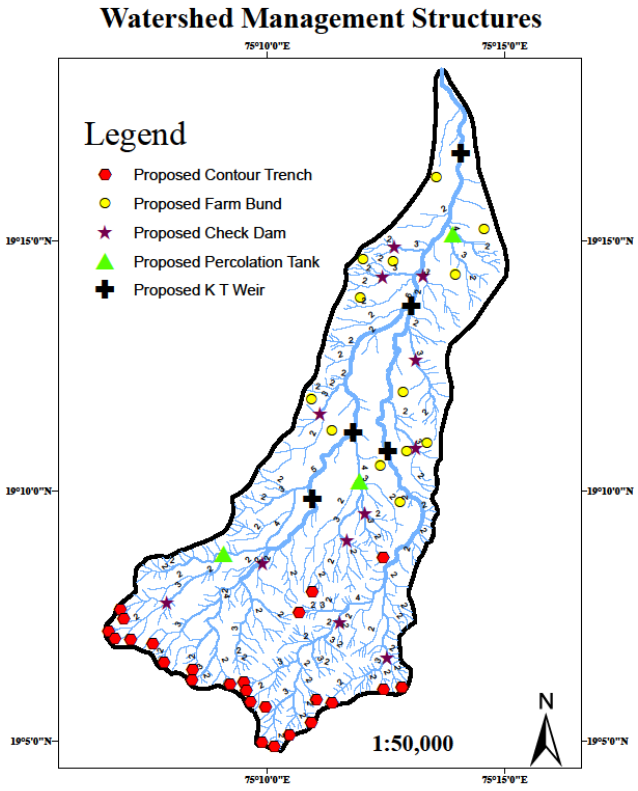


Figure - 5 : Watershed Management Structures (WMS) proposed in Chandani Watershed

Identify the sites where maximum scarcity of water is found. On the basis of field observations and morphometric parameters total 58 watershed structures are proposed in the Chandani watershed, out of them 25 contour trenches, 13 farm bunds, 12 check dams, 3 percolation tans and 5 KT weirs are included.

Proposed Watershed Structures:

1. Contour Trench

Contour trench (CT) is a trench dug along a contour line. CT's are constructed in the ridge area, basically located in upper reaches of a micro watershed.

2. Farm Bund

Farm bunds are proposed in the plateau reaches of micro watershed on agricultural land or non-agricultural land to minimize soil erosion and improve soil moisture profile. Bunds can support to increase groundwater level.

3. Check Dam:

Earthen or cement check dams can be constructed across bigger first order or second order streams. It would help to recharge ground water level in the study area as well as to reduce soil erosion.

4. Percolation Tank:

Percolation tank is an artificial reservoir, which are constructed across stream, submerging a land area with adequate permeability to facilitate sufficient percolation to collect surface water run-off and allow it to percolate within the permeable land. This is one of the effective methods of refilling groundwater table.

5. K T Weir:

K T Weirs are commonly used to control the flow rates of rivers during periods of high discharge. Sluice gate (or in some cases the height of the weir crest) can be altered to increase or decrease the volume of water flowing downstream.

Applicability to the society:

- Water scarcity of the region will be reduced.
- Socio-economic status of the local people would be increased.

SUGGESTIONS:

- Awareness programme for the local people to maintain the existwatershed structures and developed new watershed structures.
- Plantation in the study area as well as along the roads.

FINDINGS:

Watershed management technique is improving the ground water level. Recharge the underground aquifers. It reduces the intensity of scarcity of drinking water. Watershed management it helps to conservation of soil and water. Watershed management leads to increase production of food,

fodder and fuel in the Chandani watershed. Ultimately, watershed management is uplifted socio - economic well-being of the people in the study area.

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