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Identification of Site Specific Interventions for Yarehalli Micro-watershed Using Geospatial Techniques

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The 761.2 acres of the Yarehalli micro-watershed in the Channagiri taluk of the Davanagere district served as the study's site. In 2017 the rainfall recorded was 931.8 mm of total rainfall, of which kharif rainfall made up 60.2%, rabi rainfall 20.1%, and summer rainfall 19.6%. This study's goal is to pinpoint the site-specific interventions that should be made in accordance with the Integrated Mission for Sustainable Development (IMSD) principles. The sites are located by superimposing thematic maps of slope, runoff potential, soil permeability, and stream order created with ArcGIS. The findings indicate that 57.31% of the overall area is suitable for check dam construction, compared to 23.17% for agricultural ponds, 8.57% for percolation ponds, and 1.12% for gully plugs. Locations for the water harvesting constructions that collect water in the structures are indicated.

Keywords: Micro watersheds; farm pond; structures and economy.

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1. INTRODUCTION

Earth constantly contains the same amount of water. It undergoes a specific transformation from one form to another. Even though the globe is two-thirds water, only two percent of the water is actually useable for irrigation and drinking. For sustainable use, proper management of the available water is crucial. The majority of potable water is found in groundwater, which is a component of the earth's interior. The immediate indicator of a region's water richness is the growth in its groundwater storage. Techniques for collecting water are extremely important in boosting groundwater recharge.

The most valuable resource on earth and a necessity for life itself is water. The finest method for properly capturing unused surface runoff and boosting groundwater recharge is called "water harvesting." Water harvesting devices must be placed in areas with abundant runoff water and conducive conditions for improved infiltration. The method that is utilised to effectively capture surface runoff is harvesting [1,2]. Technically speaking, water harvesting refers to a system that collects rainfall from its surroundings as it falls rather than letting it become runoff. In order to successfully use this water for agriculture and drinking during the off-monsoon season, it is possible to raise the grgroundwater echarge and level of the water table by building water collecting structures in the proper locations. These buildings also stop flooding and act as a barrier to soil erosion. One class of rainwater harvesting structures that is frequently used is the percolation pond. Other types include farm ponds, check dams, and gully plugs. In this study, ArcGIS is used to locate the ideal locations for building rainwater harvesting structures in the Yarehalli micro-watershed [3-5]. In this study, the choice of a rainwater harvesting structure is made in accordance with the recommendations made by NRSA's IMSD (Integrated Mission for Sustainable Development) (National Remote Sensing Agency, Hyderabad). One of the projects proposed by the Department of Space is the Integrated Mission for Sustainable Development, which aims to use satellite remote sensing technology to offer workable answers to numerous issues.

2. MATERIAL AND METHODS

The present study was taken in Yarehalli micro-watershed located in Channagiri taluk of Davanagere district, Karnataka state and has total area of 977 ha which lies between 75^0 51' 37.585" to 75^0 53' 29.93" East longitudes and 13^0 58' 59.959" to 14^0 1' 3.722" spread across Dongraghatta, Sunageri, Haronahalli and Yarehalli villages. The average annual rainfall of the study area is 612 to 1054 mm. The major soils are sandy clay & clay soil. The main cropping season is Kharif. Major crops in the Davanagere district are paddy, ragi, jowar, maize, groundnut and sunflower. It is falling under the Survey of India toposheet of D43P13 (1:50,000).

An automatic Weather station installed in Yarehalli micro watershed under KWDP-II, Sujala-III, project and through the station collected hydrological parameter at 15 minutes interval (Rainfall, Atmosphere Temperature, Humidity, soil moisture *etc*.) was used has standard sources for developing the water balance model. Infiltration studies were carried out extensively based on soil series wise and compared with different soil phases and scenarios [6]. The instantaneous runoff process was estimated from each 15 minutes of Rainfall intensity over the basic infiltration capacity of each soil phase.

Stream order map can be generated from DEM data. It is done by choosing the “Hydrology” option from “Spatial Analyst Tools”. To start with, the DEM should be geo-referenced and transferred to a projected coordinate system. Then Flow direction map of the area is determined. Then Flow accumulation of the area is then prepared by eliminating the values which are below five hundred in the flow accumulation map. This Flow accumulation and flow direction maps are used to generate a stream network. After generating the stream network, identify the stream order in micro-watershed from Fig. 1 shows the stream order map [7].

The permeability of soil is an important parameter that determines the rate of infiltration. The entire micro-watershed is classified into two permeability groups, namely Low and High based on the type, texture and nature of the soil is shown in Fig. 2 [7].

The slope is an important parameter for site selection of water harvesting structures. The runoff, recharge, and movement of surface water depend on the slope of the area. A slope map can be generated from DEM. It is done by the "surface option" from Spatial Analyst Tools. The derived slope map is classified base on a slope in degree into 3 categories as per IMSD Guidelines as Nearly level (0-1%), Very Gentle slope (1-3%), and Gentle slope (3-5%). The classified slope map is shown in Fig. 3 [7].

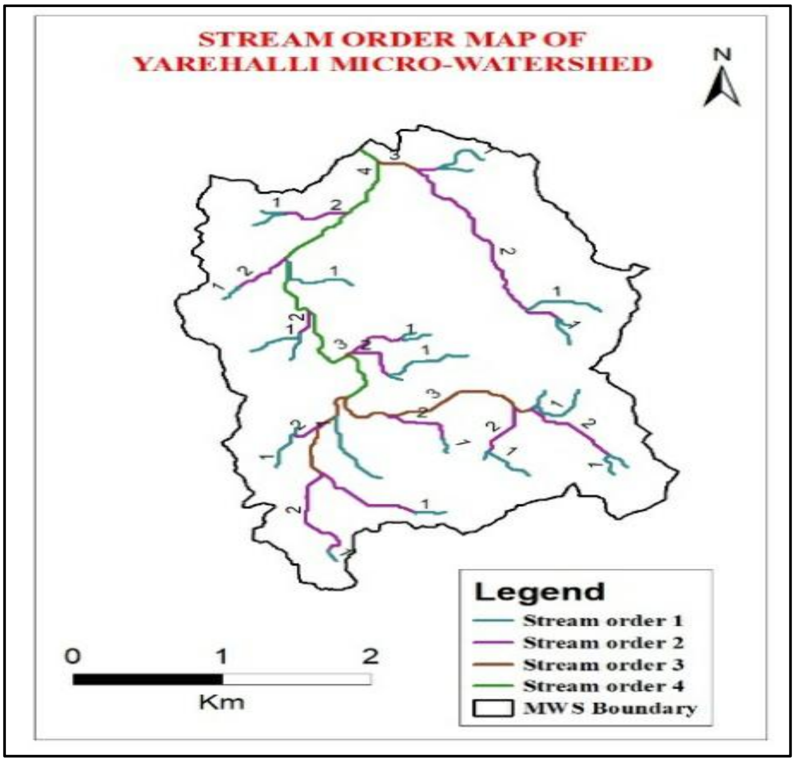

Fig. 1. Stream order map of Yarehalli micro-watershed

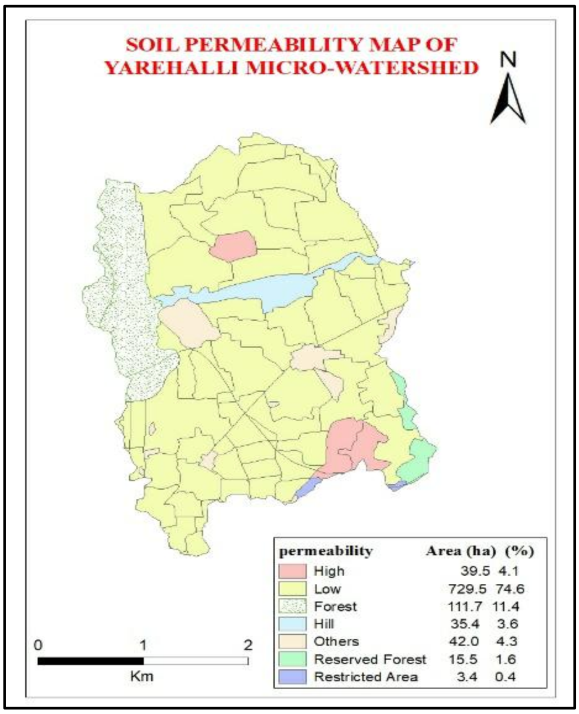

Fig. 2. Permeability map of Yarehalli micro-watershed

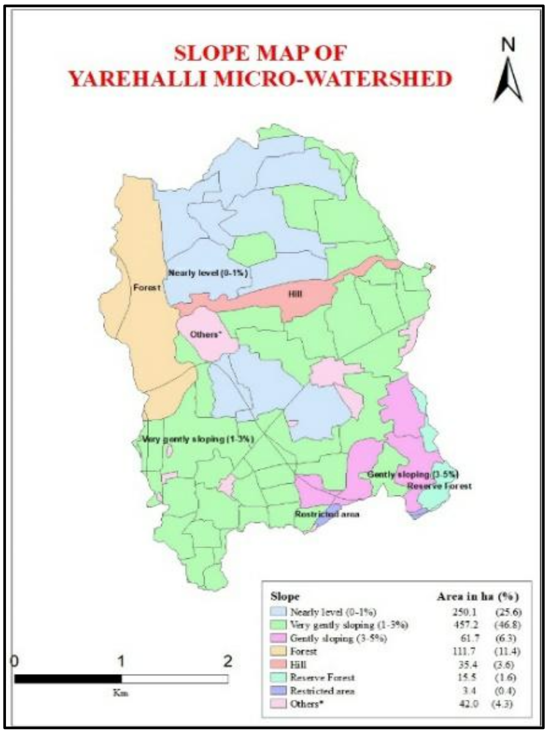

Fig. 3. Slope map of Yarehalli micro-watershed

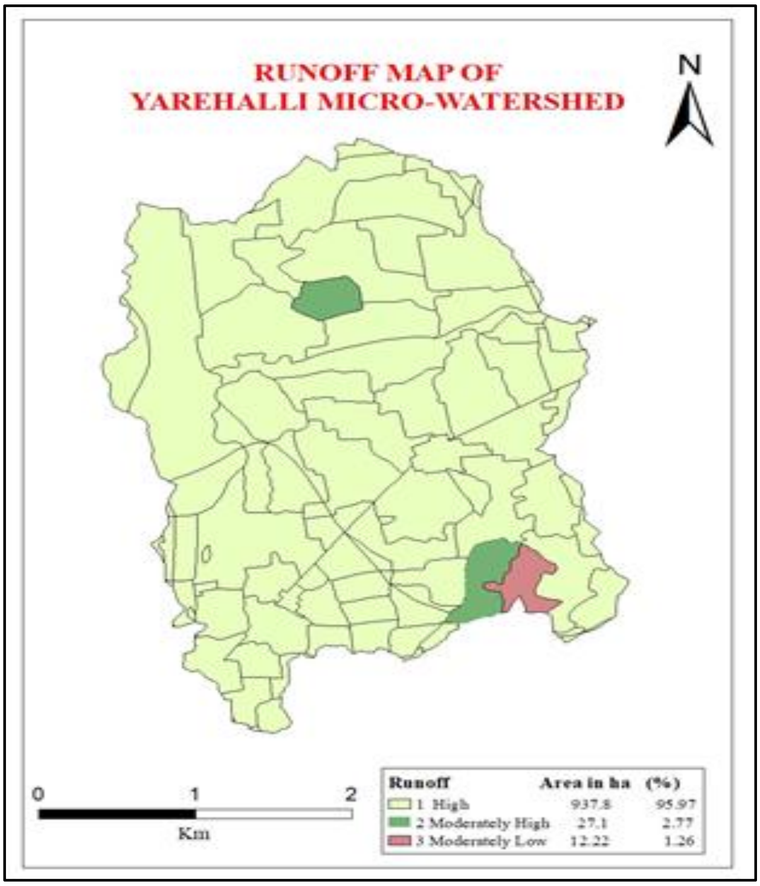

Fig. 4. Runoff map of Yarehalli micro-watershed

Table 1. IMSD guidelines

Structure	Slope (Degree)	Permeability	Runoff	Stream Order
Farm Pond	0-5	Low	Medium/High	1
Check Dam	< 15	Low	Medium/High	1-4
Gully plug	15-20	Low	High	1
Percolation Pond	<10	High	Low	1-4

The fundamental infiltration method is used to determine the runoff contribution of the unit area of each soil phase and create the runoff potential map. Calculations are made to determine the runoff contribution of each soil phase's unit area to the overall runoff. Micro-watersheds were categorised into three groups, High, Moderately High, and Moderately Low, based on this runoff potential. In Fig. 4, the runoff potential map is displayed [7].

Identification of Suitable Sites for Water Harvesting Structures: Stream order maps, permeability maps, slope maps, and runoff potential maps are used to determine the best locations for rainwater harvesting structures. These maps are overlaid using ArcGIS' "Intersect" option from the "Overlay" menu [8].

Selection of Type of Water Harvesting Structures: According to IMSD guidelines, a percolation pond is typically recommended for recharging aquifers and used in situations when surface storage is only temporarily available. High stream order and permeability are necessary site requirements. For surface storage and well-defined, straight stream channels with level banks, check dams are utilised. Farm ponds are often utilised for limited irrigation and animal storage. The ideal site for the farm ponds must have a small catchment area, a gradual slope, and a narrow, lengthy depression. Table 1 lists the IMSD site selection criteria for water harvesting structures [7].

3. RESULTS AND DISCUSSION

Land use, Soil type, Slope, Runoff potential, Soil permeability, and Stream order maps are overlaid to identify and choose the type of water harvesting structures. The IMSD guidelines form the foundation for the assigned criteria. Figure shows the suggested locations for check dams, gully plugs, farm ponds, and percolation ponds. Fig. 5 displays the Check dam's potential locations.

Fig. 5 depicts the suggested locations for check dams, farm ponds, percolation ponds, and gully plugs. According to the analysis, 57.3% of the entire area is suitable for building a farm pond, 29.17% for a check dam, 08.57% for a percolation pond, and 01.12% for a gully plug. The examination of meteorological and topographical data can be used to determine where water harvesting structures should be placed. The proposed check dam might be helpful for ground water table augmentation and protecting irrigation. The viability of other variables, such as the economy, social repercussions, practical feasibility, etc., must be taken into account for the effective implementation of these structures. Additional surface water resources can be developed by building various rainwater harvesting structures under various land use/cover units and by expanding the storage capacity of the existing large tanks within the micro-watershed region with the right planning for water conservation measures [9,10].

Table 2. Topographical analysis of rain water harvesting structures

Sl. No.	Rain water harvesting structures	Area (ha)	Area (%)
1	Check Dam	559.91	57.31
2	Farm Pond	284.99	29.17
3	Percolation Pond	083.73	08.57
4	Gully Plug	010.95	01.12
5	Others	037.42	03.83
Total		977	100

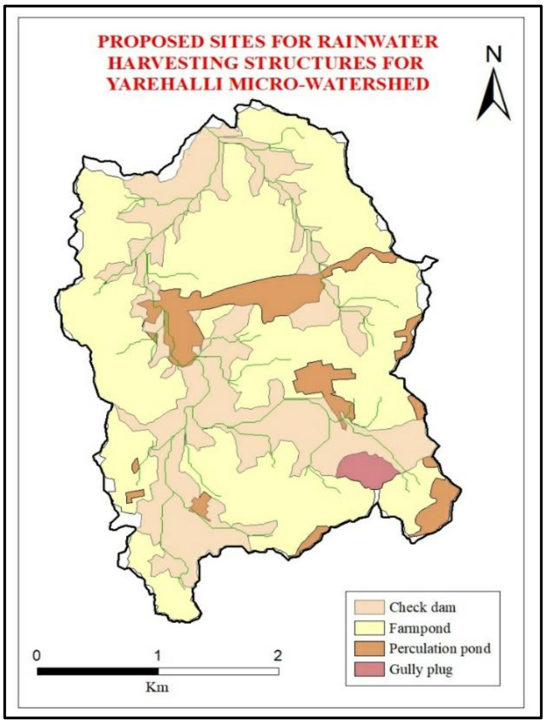

Fig. 5. Proposed site for rainwater harvesting structures in Yarehalli micro-watershed

4. CONCLUSION

In order to enhance water resources and create diverse water conservation measures, this study explained the role and significance of remote sensing and GIS technology. The water resource development plan makes proposals for where to locate acceptable places for water conservation facilities based on the prioritisation established from ground truth data. The drainage, slope, hydro geomorphology, soil, and land use/land cover thematic maps were created and integrated to identify site-specific interventions. Based on the location priority map, check dams were recommended at high priority areas to delay the flow of water by obstructing it and so increase the percolation of water for ground water recharge. The right kinds of constructions are chosen for this area, according to IMSD.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ammar A, Michelriksen, Mohamedouessar, Coenritsema. Identification of suitable sites for rain water harvesting structures in arid and semi-arid regions. Int. Soil & Water Cons. Res. 2016;4(1):108–120.
2. Bamne Y, Patil KA, Vikhe SD. Selection of appropriate sites for structures of water harvesting in a watershed using remote sensing and geographical information system. Int. J. of Emerging Tech. Adv. Engg. 2014;4(11):270-275.
3. Binyam AY, Desale KA. Rainwater harvesting: An option for dry land agriculture in arid and semi-arid Ethiopia. Int. J. Water Resources & Environ. Engg. 2015;7(2):17-28.
4. Durbude DG, Venkatesh B. Site suitability analysis for soil and water conservation structures. J. Indian Society of Remote Sens. 2004;32(4):399-405.
5. Gavade VV, Patil RR, Palkar JM, Kachare KY. Site suitability analysis for surface rainwater harvesting of Madha Tahsil, Solapur, Maharashtra: A geoinformatics approach. 12th ESRI India User Conference. 2011;316-322.
6. Jagdale SD, Nimbalkar PT. Infiltration studies of different soils under different soil conditions and comparision of infiltration models with field data. International Journal of Advanced Engineering Technology. 2012;3(2):154-157.

7. Naseef AU, Thomas TR. Identification of suitable sites for water harvesting structures in Kecheri river basin. Procedia Tech. 2016;24(2):7-14.
8. Jasrotia AS, Abinash Majhi, Sunil Singh. Water balance approach for rainwater harvesting using remote sensing and GIS techniques, Jammu Himalaya, India. Water Resources Management. 2009;23(3):3035-3055.
9. Girish Kumar M, Agarwal AK, Rameshwar B. Delineation of potential sites for water harvesting structures using remote sensing and GIS. J. Indian Soc. Remote Sens. 2008;36(8):323–334.
10. Shukla JP, Akinchan Singhai, Sandipan Das, Ajaykumar K, Kadam S, Bundela, Mahesh K. GIS-based multi-criteria approach for identification of rainwater harvesting zones in upper Betwa sub-basin of Madhya Pradesh. Environ Dev Sustain; 2017. Available:https://doi.org/10.1007/s10668-017-0060-4

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