Original Research Article

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

Abstract

The study was carried out in Yarehalli micro-watershed, Channagiri taluk of Davanagere district covering an area of 761.2 ha. Out of total rainfall of 931.8 mm (2017), *kharif* rainfall accounted for 60.2%, Rabi rainfall 20.1% and summer rainfall 19.6%. The objective of this study is to identify the site specific interventions as per the Integrated Mission for Sustainable Development (IMSD) guidelines. ArcGIS is used for the spatial analysis and the sites are located by overlaying thematic maps of slope, runoff potential, soil permeability and stream order. The result shows that the 57.31 percent of the total area is ideal for constructing check dam, 23.17 percent for farm pond, 8.57 percent for percolation pond and 1.12 percent for gully plug. Locations of water harvesting structures are suggested by conducting meteorological and topographical analysis. However, for the practical implementation of these structures, viability of other considerations such as economy, social implications, practical feasibility *etc.* need to be considered.

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Key words: Micro watersheds, farm pond, structures and Economy

Introduction

The amount of water present in earth is always constant. It is transformed from one form to another in a specified manner. Though two by third of earth is filled with water, the usable water for irrigation and drinking purpose is only two percentage of total available. Proper management of the available water is very important for the sustainable utilization. The major share of usable water is present in the inner part of earth known as groundwater. Increase in the ground water storage of a region is the direct measure of water richness. Water harvesting technique plays a vital role in increasing the ground water recharge.

Water is the most precious resource on the earth which is essential for the existence of life. Water Harvesting is the best technique that can be used effectively to trap the unutilized surface runoff and thereby increase the groundwater recharge. Water harvesting structures have to be located at places where runoff water is available in excess and conditions are favourable for enhanced infiltration.

Harvesting is the technique which is used to effectively trap the surface runoff. In technical terms, water harvesting is a system that collects rainwater from where it falls around its periphery rather than allowing it to go as runoff. By constructing water harvesting structures in appropriate sites it is possible to increase the ground water recharge and level of water table, so that we can effectively use this water for irrigation and drinking purpose in the off-monsoon season. Also, these structures act as a barrier to soil erosion and prevent flooding. Percolation Ponds, Farm Ponds, Check Dams, and Gully Plug are some of the type of rainwater harvesting structures that are widely in use.

In this study the suitable sites for constructing rainwater harvesting structures in Yarehalli micro-watershed is identified using ArcGIS. In this study, selection of rainwater harvesting structure is done on the basis of IMSD (Integrated Mission for Sustainable Development) guidelines put forwarded by NRSA (National Remote Sensing Agency, Hyderabad). Integrated Mission for Sustainable Development is one of the projects put forwarded by the department of Space for providing practical solutions to various problems through the technology of satellite remote sensing.

Material and Methods

The present study was taken in Yarehalli micro-watershed located in Channagiri taluk of Davanagere district, Karnataka state and having 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 study area is 612 to 1054 mm. The major soils are sandy clay & clay soil. The main cropping season is Kharif. Major crops in Davanagere district are paddy, ragi, jowar, maize, groundnut and sunflower. It is falling under the Survey of India toposheet of D43P13 (1:50,000).

Automatic Weather station installed in Yarehalli micro watershed under KWDP-II, Sujala-III, project and through 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 extensively based on soil series wise and compared with different soil phases and scenarios (Jagadale, *et.al*, 2012). The instantaneous runoff process was estimated from each 15 minutes Rainfall intensity over basic infiltration capacity of each soil phase.

Stream order map can be generated from DEM data. It is done by choosing "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 Figure 1 shows the stream order map (Naseef and Thomas, 2016).

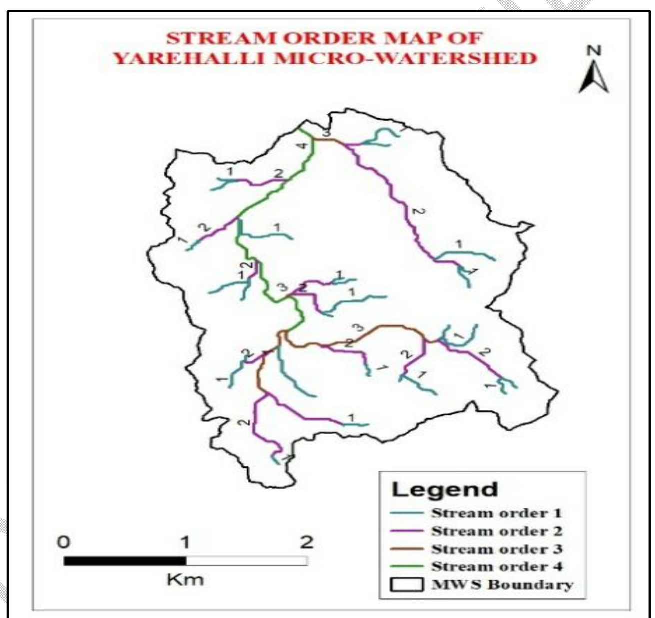

Fig. 1. Stream order map of Yarehalli micro-watershed

Permeability of soil is an important parameter which 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 Figure. 2 (Naseef and Thomas, 2016).

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. Slope map can be generated from DEM. It is done by "surface option" from Spatial Analyst Tools. The derived slope map is classified base on 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 Figure 3 (Naseef and Thomas, 2016).

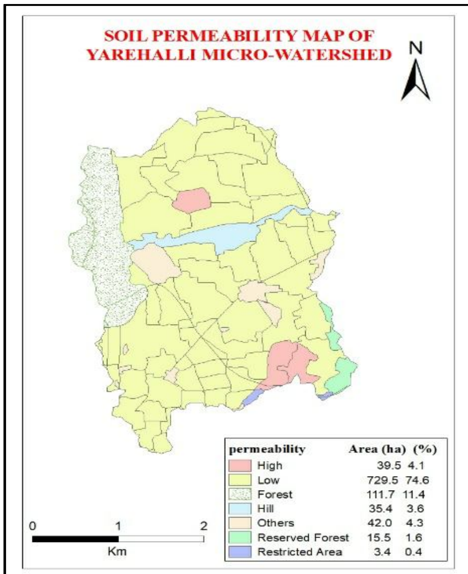

Fig. 2. Permeability map of Yarehalli micro-watershed

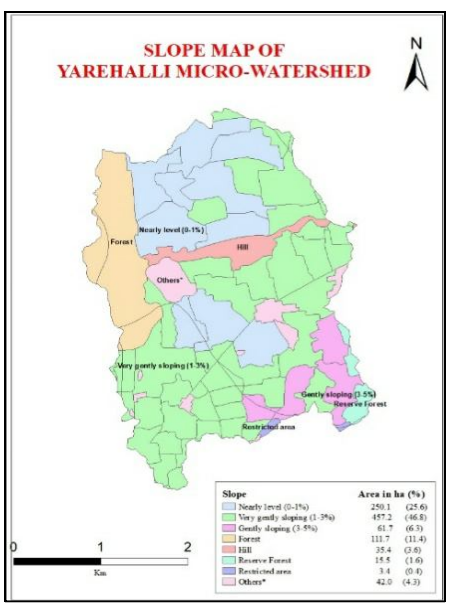

Fig. 3. Slope map of Yarehalli micro-watershed

The runoff potential map is prepared by calculating the runoff contribution of unit area of each soil phase using basic infiltration method. The runoff contribution of unit area of each soil phase to the total runoff is calculated. Based on this runoff potential, micro-watershed were divided into three categories namely High, Moderately high and Moderately low. The runoff potential map is shown in figure 4 (Naseef and Thomas, 2016).

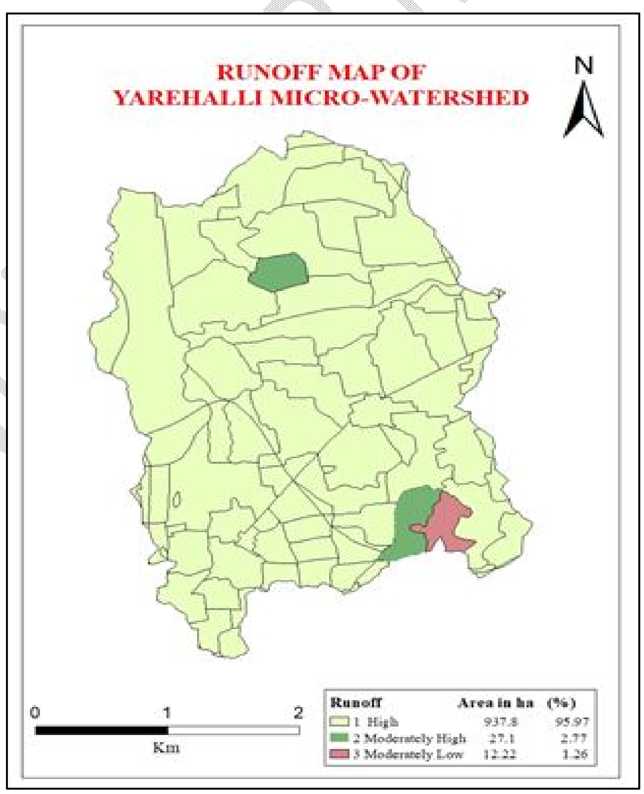

Fig. 4: Runoff map of Yarehalli micro-watershed

Identification of Suitable Sites for Water Harvesting Structures : Stream order map, Permeability map, Slope maps, and Runoff potential map are used for identifying the suitable sites for rainwater harvesting structures by overlaying of these maps are done by using "Intersect" from "Overlay" option of "Analysis Tools" in ArcGIS, (Jasrotia *et.al.*, 2019)

Selection of Type of Water Harvesting Structures: As per IMSD guidelines, percolation pond is normally suggested for recharging aquifer and used where surface storage is available for a restricted period. The required site conditions are high permeability and higher stream order. Check dams are used for surface storage and site conditions are well defined straight stream channel with level banks. Farm ponds are normally used for livestock storage and restricted irrigation. Narrow elongated depression, gentle slope and small catchment area are the required site condition for the farm ponds. The IMSD site selection criteria for water harvesting structures are given in Table 01 (Naseef and Thomas, 2016).

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

Results and Discussions

Identification and selection of the type of water harvesting structures is made by overlaying Land use, Soil type, Slope, Runoff potential, Soil permeability and Stream order map. The criteria assigned are based on the IMSD guidelines. Proposed sites for percolation ponds, Farm ponds, Check dams and Gully plug are shown in figure. Proposed sites for Check dam is shown in figure 5.

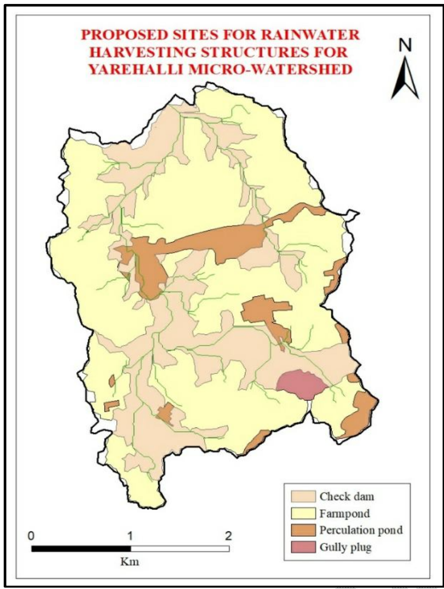

Fig. 5. Proposed site for rainwater harvesting structures in Yarehalli micro-watershed

The proposed sites for check dams, farm ponds, percolation ponds and gully plug are shown in Fig. 5. The study area reveals that 57.3 percentages of the total area is ideal for constructing farm pond, 29.17 percentages for check dam, 08.57 percentages for percolation pond and 01.12 percentages for gully plug. Locations of water harvesting structures are suggested by conducting meteorological and topographical analysis. Proposed check dam could be useful for protective irrigation and percolation pond augment ground water table. However, for the practical implementation of these structures, viability of other considerations such as economy, social implications, practical feasibility etc., need to be considered. By adopting proper planning for water conservation measures, additional surface water resources can be developed by constructing different rainwater harvesting structures under different land use/cover units and also by increasing the storage capacity of the existing major tanks within the micro-watershed area.

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

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4	Gully Plug	010.95	01.12
5	Others	037.42	03.83
Total		977	100

Conclusion

This study outlined the function and significance of remote sensing and GIS technologies in the development of water resources and the formulation of various water conservation strategies. Based on the prioritisation determined from ground truth data, the water resource development plan offers suggestions for locating suitable locations for water conservation facilities. In order to identify site-specific treatments, the thematic maps of drainage, slope, hydro geomorphology, soil, and land use/land cover were developed and combined. Check dams were suggested at high priority locations based on the location priority map to slow down the flow of water by obstructing it and so boost the percolation of water for ground water recharge. According to IMSD, the appropriate sort of structures are chosen for this particular area.

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