RESEARCH ARTICLE

SITE SELECTION FOR WATER HARVESTING STRUCTURES IN ANAIYUR CATCHMENT USING WEIGHTED OVERLAY ANALYSIS

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Abstract: Harvested rainwater is an alternative source of water in arid and semi-arid regions around the world. The present study aims to identify suitable sites for water harvesting structures in Anaiyur catchment, Kamuthy block, Ramanathapuram district by using Geographic Information System (GIS) and weighted overlay analysis. It help the decision makers in determining suitable sites for water harvesting structures based on slope, drainage network and stream order of the study area. Produced suitability site map will help in the site selection of harvesting structures such as percolation tanks, storage tank, and check dams.

Keywords: Rainwater harvesting, Site Selection, Weighted Overlay Analysis

INTRODUCTION

Farmers of arid regions are faced with low average annual rainfall and variability in temporal and spatial distribution (Kahinda *et al*., 2008). Rain Water Harvesting (RWH) is a method for inducing, collecting, storing and conserving local surface runoff in arid regions. It will be solution to increase the availability of water for crop production, cattle grazing etc. It also offers the potential of converting the unproductive land into productive land (Ciuff, 1989).A wide variety of micro-catchment, macro-catchment and in situ RWH techniques are available. Ponds, dams, terracing, percolation tanks, and Nala bunds are the most common types of RWH techniques in arid and semi-arid regions (Oweis, *et al*., 2012).

The success of RWH systems depends heavily on the identification of suitable sites and their technical design (Al-Adamat *et al.,* 2012). Many researchers have developed and applied various methodologies and criteria to identify suitable sites and techniques for rainwater harvesting (Ahmad, 2013, Al-Adamat, 2008, De Winnaar, *et al.,* 2007).

Nowadays, the Geographic Information System (GIS) and Remote Sensing (RS) offer cost-effective and time-saving methods for identifying suitable sites for RWH (Ziadat *et al.,* 2006, Mbilinyi *et al.,* 2007, Ray-Shyan *et al.,* 2018). Ziadat *et al.* (2012) applied a GIS approach for identifying the suitability for RWH interventions in Jordan by integrating biophysical criteria such as slope, vegetation cover, soil texture, and soil depth with socio-economic parameters such as land owner and then modified the criteria. Mahmoud and Alazba (2014) presented a geographic information system (GIS) methodology based on a decision support system (DSS) that uses remote-sensing data, filed survey, and GIS to delineate potential in situ rainwater harvesting areas. The GIS-based DSS implemented as well as evaluated the existing rainwater harvesting structures in the study area. Adham *et al.,* (2016) identified three main sets of criteria for selecting RWH locations and the main characteristics of the most common RWH techniques used in arid and semi-arid regions. The most important criteria for the selection of suitable sites for RWH were slope, land use /cover, soil type, rainfall, distance to settlements/streams, and cost. The task performed in this paper was to identify the suitable sites for rainwater harvesting structures using weighted overlay analysis in GIS environment.

MATERIALS AND METHODS

Study area

Anaiyur catchment of Kamuthy block, located at Ramanathapuram District, Tamil Nadu, India was selected for this study. The latitude 10.87 and longitude 78.83 are the geo-coordinate of the Lalgudi block (Fig. 1). The northern part of Anaiyur has cropped areas and water bodies. The southern part is bounded by barren lands and urban settlements. Akila *et al.,* 2020 presented different three vegetation indexes namely Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI), and Leaf Area Index (LAI) of the study area. Baladeepa *et al.,* 2020 estimated the land surface temperature of the study area using the Landsat 8 images.

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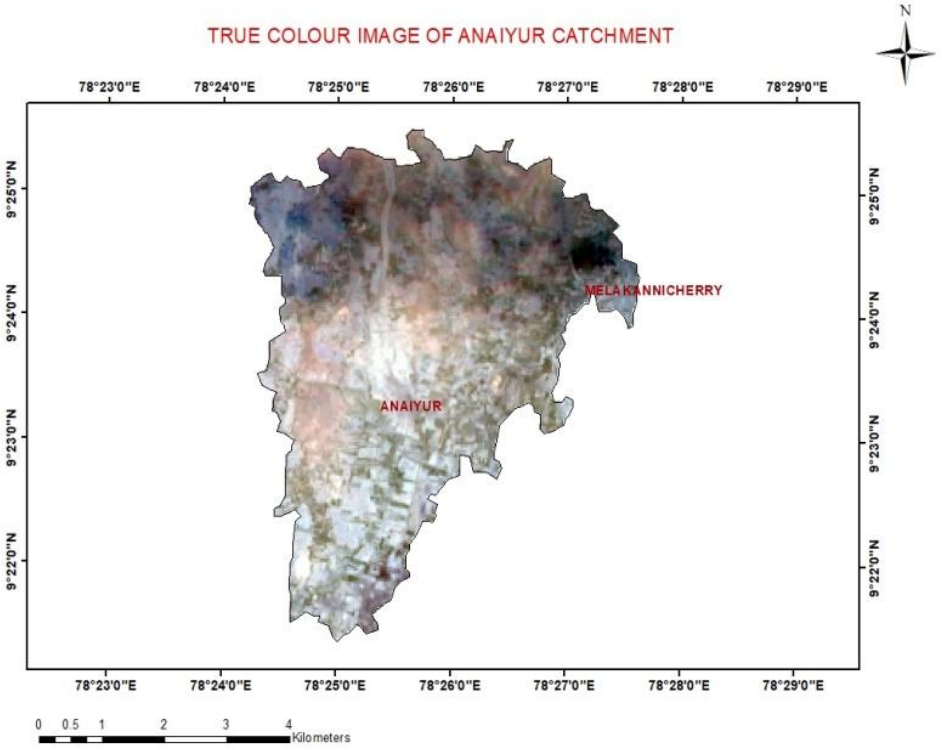

Figure 1. Study Area-Anaiyur catchment

Site Selection for Water Harvesting Structures

The Weighted Overlay tool applies one of the most used approaches for overlay analysis to solve multicriteria problems such as site selection and suitability models. Hence, weighted overlay tool was used for identifying the suitable sites for water harvesting structures in the study area. The most important criteria for the selection of suitable sites for RWH were slope, land use/cover, soil type, rainfall, distance to settlements/streams, and cost Adham *et al.,* (2016). In this study, three thematic maps namely slope, drainage network and stream order were prepared in GIS environment and was used to identify the sites based on certain criteria. The slope map, drainage network map and stream order map was obtained from the Shuttle Radar Topographic Mission (SRTM) DEM downloaded from the USGS Earth Explorer website for the study area.

Slopes <5% are suitable for ponds, slopes <10% are suitable for percolation tanks, and slopes <15% are suitable for check dams (Krois &Schulte, 2014, Mati *et al.,* 2006, Ramakrishnan, *et al.,* 2009). The rainwater harvesting structure should be constructed along the drainage network. Hence the drainage network is given with maximum score. For construction of rainwater harvesting structures, Stream order value is also given with maximum score. The suitability scores for different parameters are represented in Table 1.

Table 1. Suitability scores given for Slope and Stream Order

S. No.	Parameter	Range	Suitability score
1	**Slope (%)**	0.0 - 0.5	5
		0.5 - 1.0	9
		1.0 - 1.6	7
2	**Stream Order**	1	5
		2	9
		3	7

The final scores were reclassified to generate the output map showing various classes of suitable site for RWH sites. The factors selected were given equal weightage as all will have equal influence in selecting the sites. The weighted overlay analysis was done combining all the layers using ArcGIS. The output raster from image is reclassified and hence the site suitability map is obtained for proposing rainwater harvesting structures.

RESULTS AND DISCUSSION

Slope is also a major factor in site selection, implementation and assessment of RWH. Using DEM (30 m resolution) and ArcGIS 10.0, the slope was extracted for catchment area and reclassified map of slope is shown in Fig. 2. RWH interventions are located on the hydrographic network and their location is influenced by slope, the distance from the water course etc. The reclassified map of the stream network is shown in Fig. 3.

The suitable areas is integrated further with other structural considerations layers to determine spatial positioning for each rainwater harvesting structure is shown in Fig. 4. The water harvesting structures like farm ponds, percolation ponds, and check dams may be constructed at the identified sites.While proposing the new sites for water harvesting structures, Landuse map, Lithology map, Geology map should be included for increasing the accuracy of identification of sites. A comparison of newly proposed sites and existing water harvesting structures may be done for enhancing the planning strategies.

The following water management strategies can be adopted for better crop production. Enhancing agricultural water use efficiency by avoiding water losses at all scales, adopting efficient irrigation scheduling, and using environment adapted crops and varieties, etc. Water conservation and the use of nonconventional water resources, i.e., wastewater, brackish water and seawater along with the corresponding resistant or tolerant species to produce forage and food.

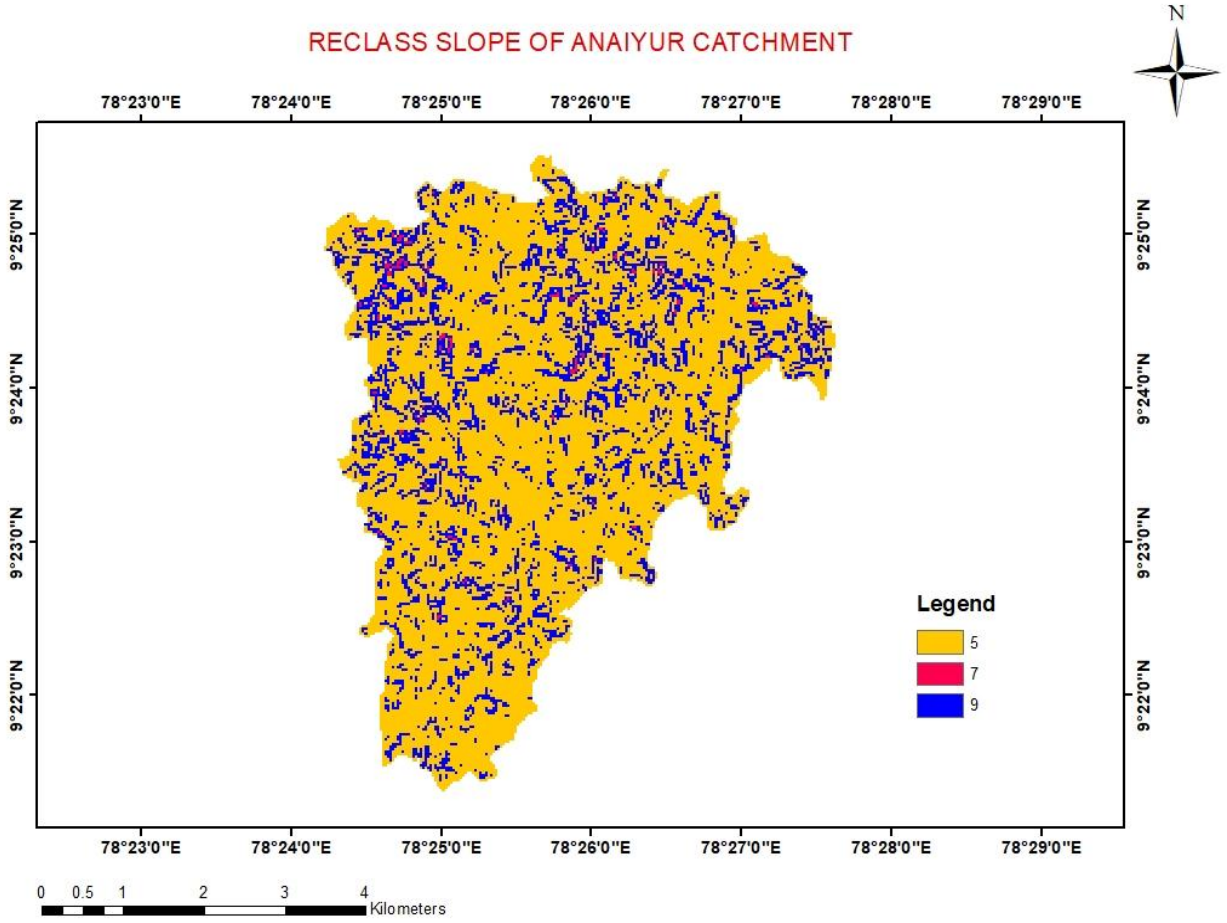

Figure 2. Reclassified Slope Map of Anaiyur Catchment

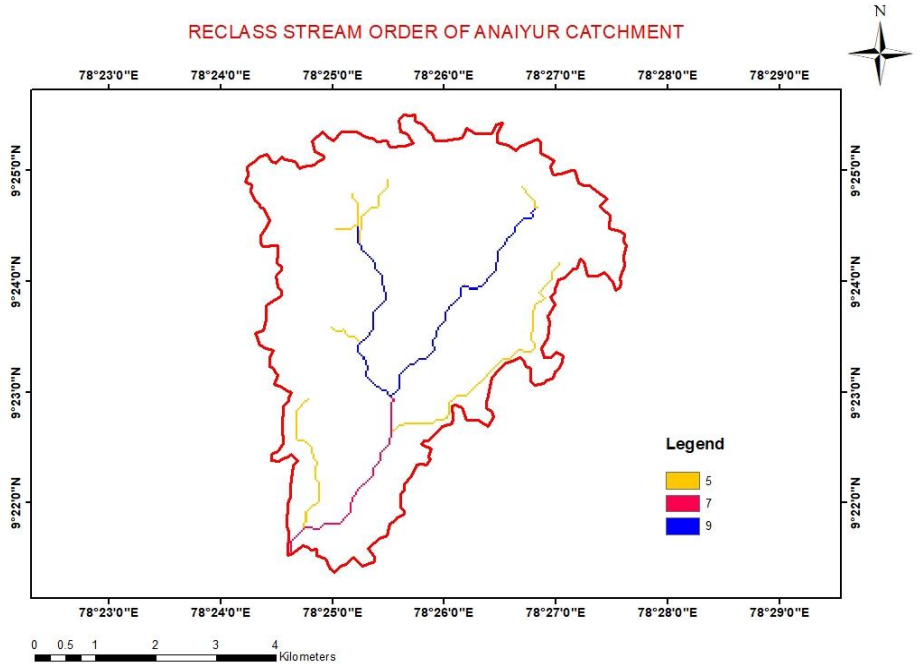

Figure 3. Reclassified Stream Map of Anaiyur Catchment

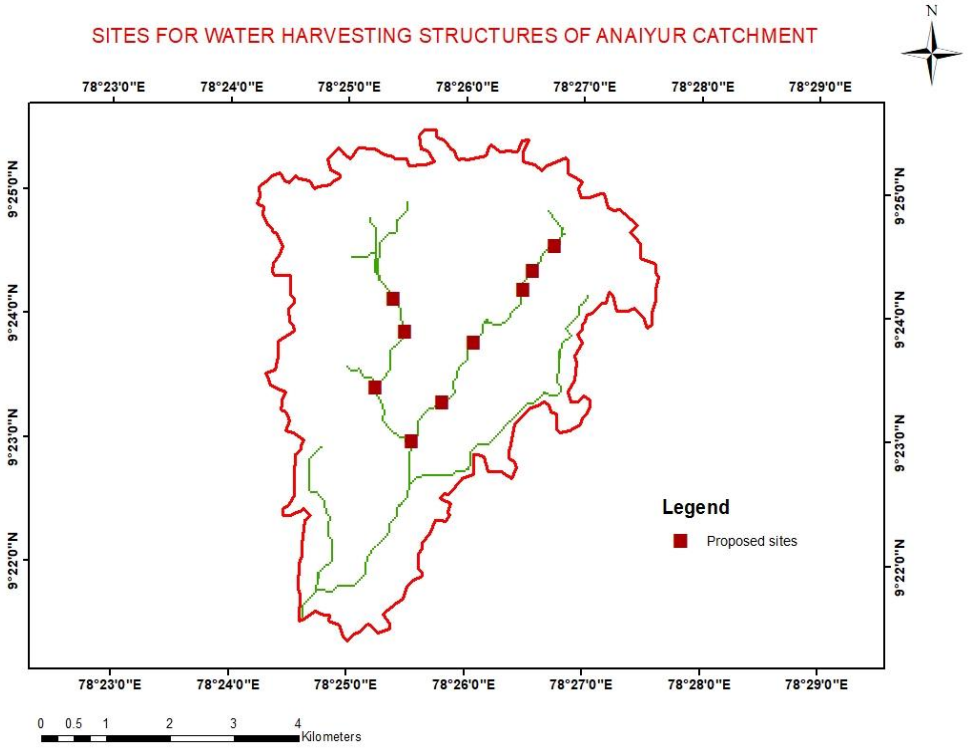

Figure 4. Sites for Water Harvesting Structures in Anaiyur Catchment

CONCLUSION

Water is the most limiting factor for crop production in arid and semiarid areas. Appropriate water resource management will undoubtedly enhance crop production and accomplish sustainable development.RWH and management techniques have a significant potential for improving and sustaining the rainfed agriculture in the region. In this study, suitable areas for RWH in Anaiyur Catchment have been identified by using a GIS-based weighted overlay analysis. The suitability map showed different locations suitable areas for RWH. It is valuable because it can enhance water availability and land productivity in the arid regions.

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