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Identifying Appropriate Location for Water Harvesting Structures Using Remote Sensing and Geographical Information System

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Abstract
Sustainable water resource development and management necessarily depends on proper planning, implementation, operation and continuous monitoring. In India, potable water supply to all people in both rural and urban is a major unsolvable problem to the government because of increasing population and decreasing water resources. The Remote sensing and GIS technology has a vital role to play in water resource studies, and it has to be effectively used to replace, complement and supplement the earth resources with time and cost effective methodologies. In this study, digital image processing based interpretation and classification of Landsat ETM+ Imagery was used to identify and extract landform features, and SOI toposheet number 58 F/4 and 58F/8 with 1:50000 scale was used to delineate watershed. All the spatial and non spatial, statistical data were entered in GIS software to analyse and produce a model. The model used to select appropriate site for construction of farm ponds, loose rock check dams, water absorption trench and recharge beds in and around the study area for rain water harvesting and improving the level of ground water permanently.

Keywords: Remote Sensing, Geographical Information System, Watershed, Water Harvesting Structures

1. Introduction
Two thirds of the earth's surface is covered by water. Water is one of the precious and vital resources essentially required for subsistence of the life and social progress of any country. Now a days derived for is water resources are increasing due to expanding of population and inadequate monsoon rains. The proper utilization of surface runoff and precipitation by following appropriate methods and procedure such as constructing WAT (Water Absorption Trench), recharge bed and farm pond etc, in suitable sites is essential for effective management and sustainable development of water resources on long term basis.

A watershed is the entire region drained by a waterway that drains into a lake or reservoir or the total area above a given point on a stream that contributes water flow at that point[1]. The watershed can be delineated through identification of ridge line/water divide between two adjacent rivers or lakes with respect to the flow of water by natural streams into them. It is a natural boundary best suited to the development of natural resources in general and soil and water resources in particular[2]

Watershed management is the process of creating and implementing plans, programme, and projects to sustain and enhance watershed functions that affect the watershed the plant, animal and human communities within a watershed. For watershed management, GIS can be used effectively became it is a spatial entity. In addition, it has tools for deeper analysis of various parameters working in the watershed. S.Kaliraj and S.Selvaraj in their study on Water Resource Development and Conservation Action Plan for Theni Allinagaram Municipality of Theni District, Tamil Nadu using RS and GIS Technology for Water Absorption Trench (WAT), Loose Rock Check Dam (LRCD) recharge bed and form ponds etc[3]. P.Rajesh Prasanna and Madan Kumar had conducted a study for Kundapallam Watershed using Remote Sensing and GIS[4]. Patrick L. Lawrence and Kevin Czajkowski in their project for providing an appropriate location for constructing a water harvesting

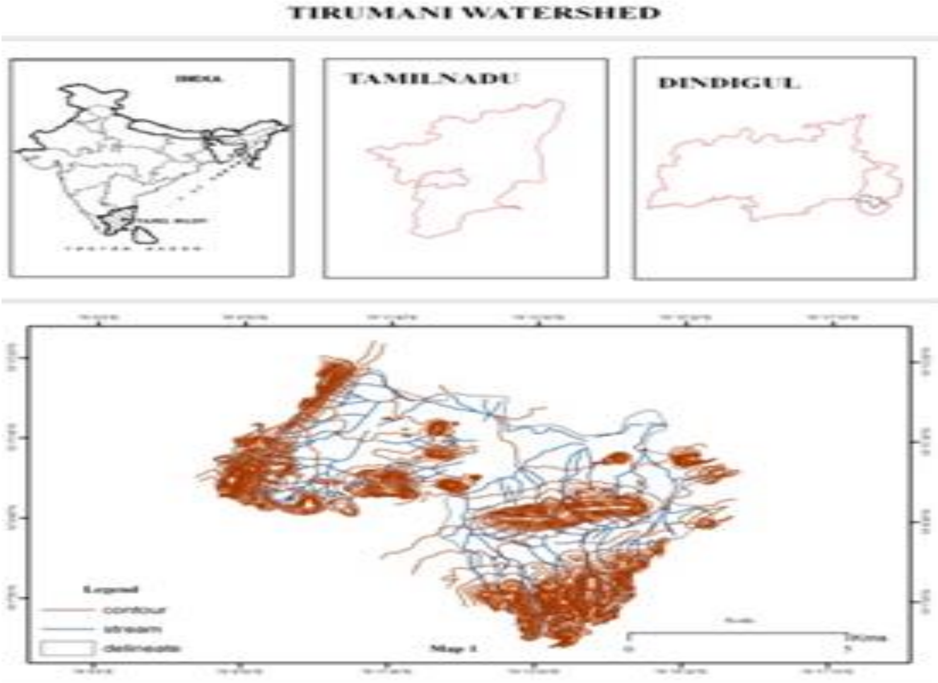
Structures such as check dam in the Maumee Watershed, OHIO[5].

Nithya Priya.J. In her study on Use of GIS on Watershed Management attempted to create a watershed module for rain water harvesting[6]. Jenith Christoper.J. Study was related to Comprehensive Watershed Development and Planning using GIS[7]. Mathan Kumar has studied for Micro Watershed Analysis for Sustainable Development using Remote Sensing and GIS in Walajapet block, Vellore District- Tamil Nadu[8]. Shanti Karanjit deals with controlling watershed deterioration and implement management strategies for Bhema watershed Khed taluka, Maharashtra[9]. After review the former studies, in this study, flow accumulation, soil, geology, hydro geomorphology and Land Use and Land Cover (LU/ LC) has been used to find the appropriated locations for water harvesting structures and also create a model for this study.

3. Methodology

Study Area

The study area is Tirumani watershed Dindigul District in Tamil Nadu. The Tirumani watershed locating in between 78°10’E to 78°15’E and 10°8’N to 10°13’N. Map 1 explains the details of the study area



3.4.2 Methodology

The toposheets were rectified in Arc GIS. For which the personal geodatabase (watershed database), dataset (watershed_dataset), feature classes such as streams (line), contours (line), delineate (polygon) were created. Using the created feature classes the layers were digitized and their attribute values such as altitude values of contours (altitude) and order of the streams were provided using “Add field” in “*Open Attribute table*”. Triangular Irregular Network (TIN) was created using contour as input. Digital Elevation Model (DEM) was generated by providing TIN as input ((i.e. the raster form of TIN). Using DEM slope and flow direction was created. Aspect was generated using the output of slope. Flow accumulation was generated based on flow direction. The stream feature has been converted in to raster by means of stream order field.

Soil, geology and hydro-geomorphology maps were rectified and feature classes were created in the same watershed dataset. The rectified geology, hydro geomorphology and soil maps extracted using delineated watershed boundary. Using feature classes the rectified maps were digitized. Weightage1 and weightage2 fields were added and the values were fed for soil, geology, Land Use and Land Cover (LU/ LC) and hydro geomorphology layers. The Table 1, 2,.3 and represents the weightages of soil, Geology, LU/ LC and hydro geomorphology respectively

Table 1: Weightage Assigned to Soil

Type	Weightage 1	Weightage 2
Amy	0	1
Pvd-Igr	1	3
Vyg	1	2
Cvp-vy	1	2

Table 2: Weightage Assigned to Geology

Type	Weightage 1	Weightage 2
Charnockite	1	2
Granitic gneiss	1	2
Quartzite	0	1

Table 3: Weightage Assigned to LU/LC

Type	Weightage1	Weightage2
Water bodies	0	1
Settlements	0	1
Forest	1	2
Vegetation	1	3
Wasteland	1	3

Table 4: Weightage Assigned to Hydro-geomorphology

Type	Weightage1	Weightage2
Bazadazone	0	2
Fragments of disserted pediment	1	3
Fragments of fresh/Active pediment	1	3
Insul berg	0	1

Residual hill complex	0	2
Tor complex	0	1
Tank	0	1

The soil, geology and hydro-geomorphology layers were converted to raster feature using Weightage 1 and Weightage 2 fields separately.

ETM+ 2006 satellite image was rectified in ERDAS IMGINE 9.1. Training sites for water bodies, forest, cultivable land, wasteland, settlement were digitized. In signature editor file the image was classified using the training sites by applying maximum likelihood classifier.

The raster classified image was converted in to the vector by using dissolve tool. Weightage 1 and weightage 2 fields were added and the values were fed for the layer. Using weightage1 and weightage2 fields converted the layers were as raster format separately.

In raster calculator was used with following formula

Weightage 1=Flow accumulation *Soil*Geology*Hydro Geomorphology*LU/ LC

And get a weightage1 output

Weightage 2 = Flow accumulation + Soil + Geology + Hydro Geomorphology + LU/ LC + reclass Weightage 1and get a weightage2 output.

Model is a graphical tool for creating a model in ArcGIS. Tracking the tool inside the model window and double click the box, a new window will open to specify input and output and link the Add connection tool and run the model. The model has been saved in the JPEG format.

Triangular Irregular Network (TIN)

TIN is a digital data structure used in geographic information system (GIS) for the representation of a surface. A TIN is a vector based representation of the physical land surface or seat bottom, made up of irregularly distributed notes and lines with three dimensional co-ordinates that are arranged in a network of non-overlapping triangles. A TIN comprises a triangular network of vertices, known as mass points, with associated co-ordinates in three dimensions connected by edges to form a triangle tessellation. TIN layer is created for the study area using contour value.TIN is closely arranged at the centre and south eastern part of the watershed. The TIN value ranges between 240 and 840 mts.

Digital Elevation Model (DEM)

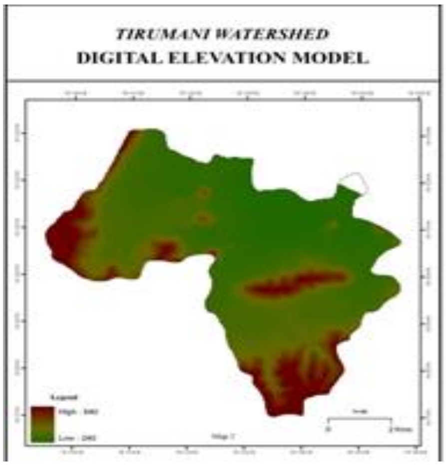
DEM is a digital representation of elevation information in a raster or grid form DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. A topographic surface arranged in a data file as a set of regularly spaced x, y, z co-ordinates where z represent elevation. DEM layer was created for the study area using TIN layer. This is the raster form of TIN. The low range of DEM is presented in the north eastern part of the watershed and high range present in the southern and east parts of the watershed. It is clearly shows in the Map 2.

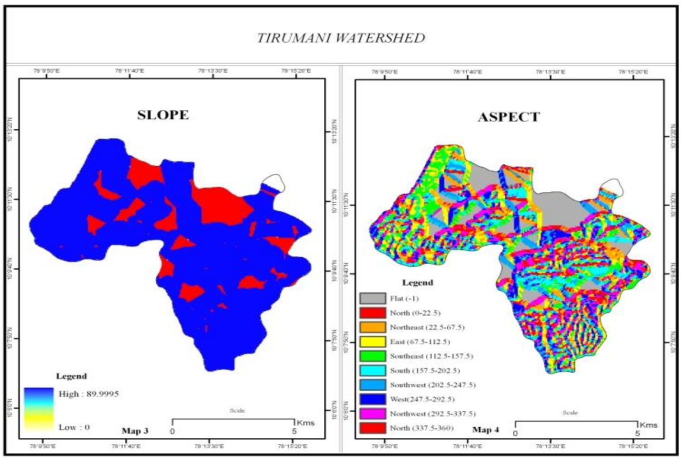
Slope

Slope identifies the steepest downhill slope for a location on a surface. Slope is calculated for an each triangle in TINs and for each cell in raster. The lower slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope can be calculated as percent slope or degree of slope. The slope layer was created using DEM. Map 3 shows the slope ranges between in the watershed is 0° to 89.995°. The steep slope noticed in the south eastern and west parts of the watershed.

Aspect

Aspect is the direction that a slope that a slope faces. It identifies the steepest down slope direction at a location on a surface. It can be thought as a slope direction or the compass direction a hill faces. Aspect is calculated for each cell in raster. The aspect layer was created using slope as input. The aspect ranges 1° to 360°. Map 4 portrays aspect value is high contain north partern and the low (flat) in the north eastern and south eastern parts of the watershed.



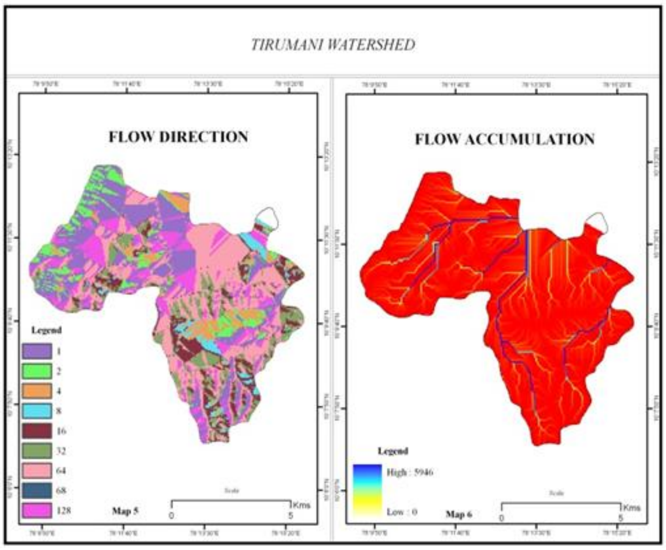


Flow Direction

Create a raster of flow direction from each cell to its steepest down slope neighbor. The flow direction in a network is determined by, the connectivity of the network locations of sources and sinks in the network the enabled or disabled state of features. The flow direction layer was created using DEM. The flow direction ranges between the watershed 1 to128 mts (Map 5).

Flow Accumulation

The Flow Accumulation function calculated accumulated flow as the accumulated weight of all cells flowing into each down slope cell in the output raster. If no weight raster is provided, a weight of one is applied to each cell, and the value of cells in the output raster will be the number of cells that flow into each cell. The result of flow accumulation is a raster of accumulated flow to each cell, as determined by accumulated the weight for all cells that flow into each down slope cell. The flow accumulation layer created using flow direction. Map 6 explains the flow accumulation ranges between the watersheds is 0 to 5946. The high value of flow accumulation is present in the west and north part of the watershed



Soil

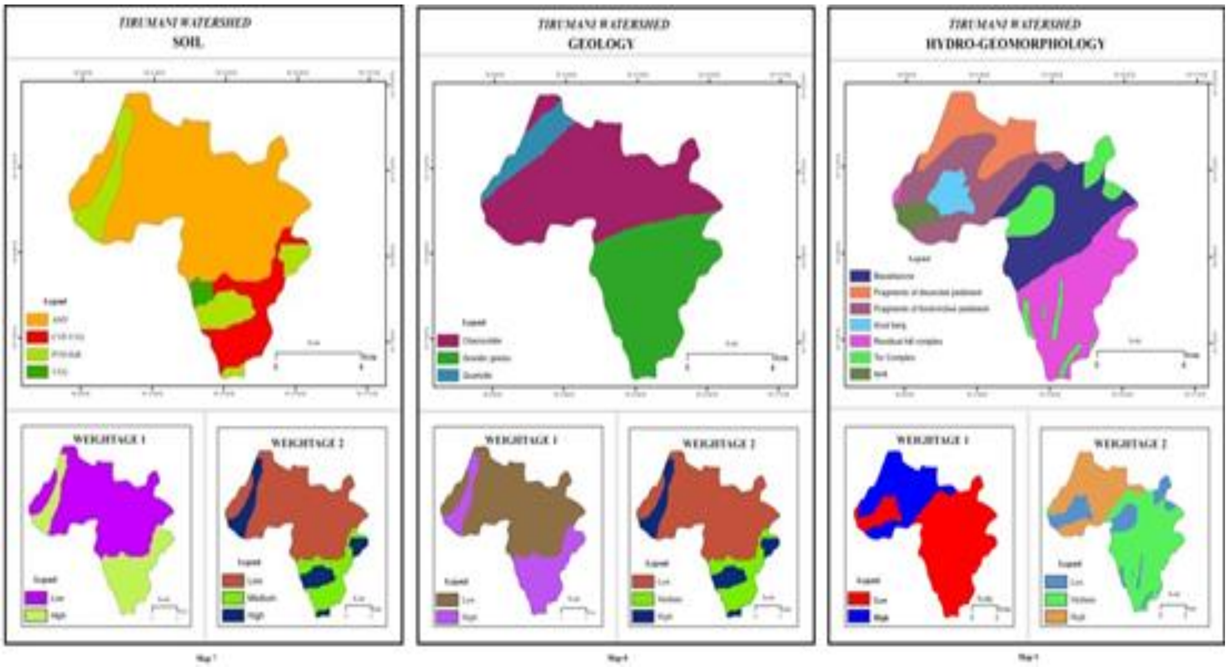
The watershed is covered by Ammayanur series, Palaviduthi and Irugur series, Vylogan series and CVP-VGR series of soil types. The large area is under Ammayanur series and small area is covered by CVP-VYG series. It is clearly explains in the Map 7.

Geology

The watershed is covered by the Charmockite. Granitic gneiss and Quartzite. The large area has Charmockite and Granitic gneiss and small portion is covered by quartzite (Map 8).

Hydro-geomorphology

The watershed is covered by bazada zone, fragments of dissected pediment, and fragments of fresh/active pediment, insul berg, residual hill complex, tor complex, and tank. The most of the area is covered by residual hill complex, fragments of fresh/active pediment and small area is covered by tor complex, tank and insul berg (Map 9)



Land use and land cover

The watershed image was classified for water bodies, settlements, forest, vegetation and wasteland. The majority of the area is covered by wasteland, forest and a small area is covered by vegetation, water bodies and settlements parameters (Map 10). This layer was used for identifying the location of water harvesting structure.

Raster Calculator

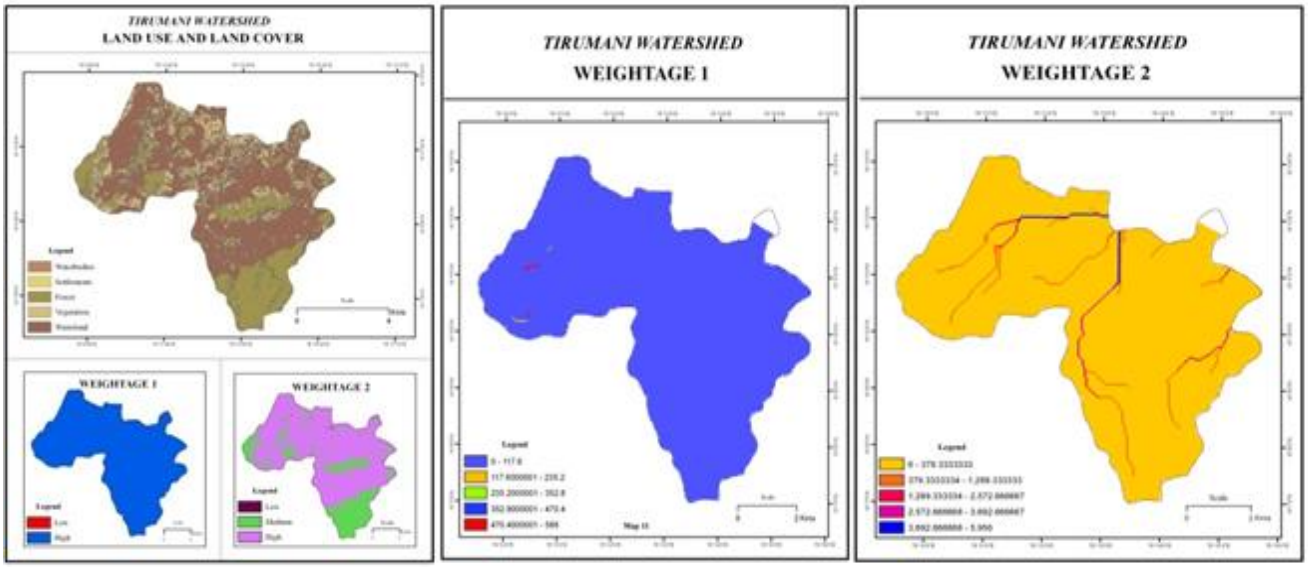
Raster calculator provides you a powerful tool for performing multiple tasks. It can perform mathematical calculation using operators and functions, set up selection queries, or type in map algebra syntax. Inputs can be raster Layers, coverage shape file, tables, constants and numbers**.**

Weightage 1

The outcome of the Weightage 1 (Map 11) is used for identifying the appropriate location of water harvesting structure. The western part of the watershed is suitable for water harvesting structures.

Weightage 2

Map12 explains the weightage 2 output. The northern part of the watershed is best suited for water harvesting structures



Findings and Conclusion

The outcome of the study has identified the appropriate locations of water harvesting structures. It can be used to avoid the run off rain water. It can also be used for decision making. This will also increase the ground water level besides providing supplementary irrigation during summer season.

References

1. N.D.Mani., Watershed Management: Principles, Parameters and Programmes, Dominant Publishers and Distributors, New Delhi, 2005 p.24.
2. N.D.Mani., Watershed Management: Principles, Parameters and Programmes, Dominant Publishers and Distributors, New Delhi, 2005 p.29.
3. Water resource conservation and development action plan for Theni Municipality region using remote sensing and GIS" is presented in National Water Seminar held at CARI, Port Blair, Andaman Nicobar Islands on Jan, 29 -30, 2009.
4. P.Rajesh Prasanna et.al, "Watershed Modeling for Kundapallam Watershed using Remote Sensing and GIS" http://www.gisdevelopment.net/application/nrm/water/watershed/mi0841.htm reffered on 18/09/2010.
5. Patrick L. Lawrence et.al, "Geographic Information System and Remote Sensing Geospatial online Data Management project for the Maumee Watershed, OHIO", http;//www.aprs.org/publications/proceedings/Portand 08/0047.pdf reffered on 23/09/2010.
6. Nithyapriya.j, a project on "Use of GIS in watershed management", March 2008.
7. Jenith Christoper.J, a project on "Comprehensive Watershed Development and Planning using GIS", April 2010.
8. Mathan Kumar.M, a project on "Micro Watershed Analysis for Sustainable Development Using Remote Sensing and GIS in Walajapet Block, Vellore District-Tamil Nadu", April 2010.
9. Shanti Karanjit, "Remote Sensing and GIS in Watershed Area Management", http://www.a-a-r-s.org/acrs/proceeding/ACRS 2002/papers/memo02-3.pdf. reffered on 20/10/2010