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IDENTIFICATION OF SITES AND STRUCTURE FOR WATER HARVESTING USING GIS

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Abstract - *Water is the most precious resource on Earth which is essential for existence of life. Though Kerala is blessed with two prominent monsoons with an average rainfall of around 3000m, it experiences water scarcity in off monsoon seasons. Palakkad is a semi-arid region that contributes to major part of cultivation. Peculiarities such as steep slopes and undulating terrain accelerate surface flow. Water harvesting is the best technique to trap unused runoff effectively and thereby improve ground water recharge. This study proposes an approach to identify suitable sites/zones for rainwater harvesting and recharge structures. It is done by suitability criteria and using GIS. GIS is used for spatial analysis and site is located by overlaying thematic maps such as land use, soil, slope, geomorphology and drainage map. The suitability sites of check dam, farm pond, percolation tank and subsurface dykes were identified. The best suited structure and its sites were determined.*

Key Words: **GIS, Rainwater Harvesting Structures, Remote Sensing, Weighted Overlay**

1. INTRODUCTION

Water, which is one of the most essential resources is depleting faster due to increase in agricultural and domestic demands. Hence water harvesting structures are extremely important for the conservation of both soil and water. The various rainwater harvesting (RWH) structures such as check dam, percolation tank, subsurface dyke, farm pond was considered for evaluation. These structures differ depending upon parameters such as location, slope, soil type, geomorphology, land cover, etc. Remote sensing and Geographic Information System (GIS) proved to be an effective tool in planning. The main objective of our work was to identify the most suitable site and RWH structure for the study area using GIS.

2. STUDY AREA AND DATA USED

Koppam is a panchayat situated in Palakkad district, Kerala. The panchayat belongs to Pattambi Taluk. It covers an area of 25.9 Sq. Km. The panchayat is stretched between $10^0$53' N & $76^0$11' E. It is situated at an elevation of 21 meters from mean sea level. The place receives an average annual rainfall of 1350mm. The panchayat is located in a district which is reeling under drought. With dams and water bodies including Bharatapuzha and Bhavani drying up, people are facing severe shortage of drinking water. The major portion of Koppam panchayat covers agricultural land. The scarcity of water affects irrigation. The studies conducted by Central Ground Water Board; Palakkad marked this panchayat as a water scarce area.

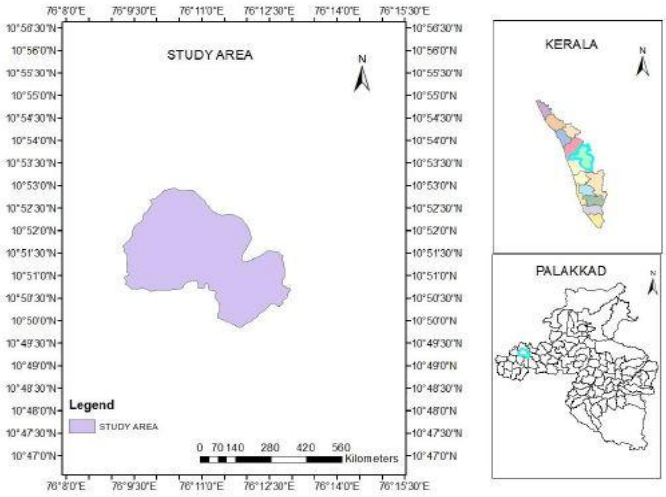


Fig-1: Study area map

Table -1: Details of Data Collected

Sl. No	Description of Data	Source
1	Aster DEM	www.bhuvan.nrsc.gov.in
2	Land use map	www.earthexplorer.usgs.gov
3	Drainage map	www.bhuvan.nrsc.gov.in
4	Soil map	Soil grid- FAO/UNESCO
5	Geomorphology map	www.bhuvan.nrsc.gov.in
6	Koppam panchayat boundary	Projects.datameet.org

- **Aster DEM** - It is a 3D representation of terrain surface. The Digital Elevation Model (DEM) was obtained from bhuvan site by entering latitude and longitude of the place.
- **Slope Map** – Slope map was prepared from DEM using Surface tool from Spatial Analyst Tools. The map was classified into 7 categories
- **Land use Map** –Land use is one of the main constraints as the built-up area is not favorable. The land use map obtained from earthexplorer site represented 5 classes of land use. It was converted into raster.
- **Drainage Map –** Drainage map showed drainage order of 1,2 and 3. It shows spatial relation of individual streams and the overall flow pattern
- **Soil Map –** The soil map was obtained from soilgrid site. The soil group obtained were gravelly sandy clay loam & silty loam to sandy clay loam.
- **Geomorphology Map –** The geomorphology feature identified was Denudational origin. It includes denudational hills, piedmont zone and intermontane valley. It is as a good recharge zone

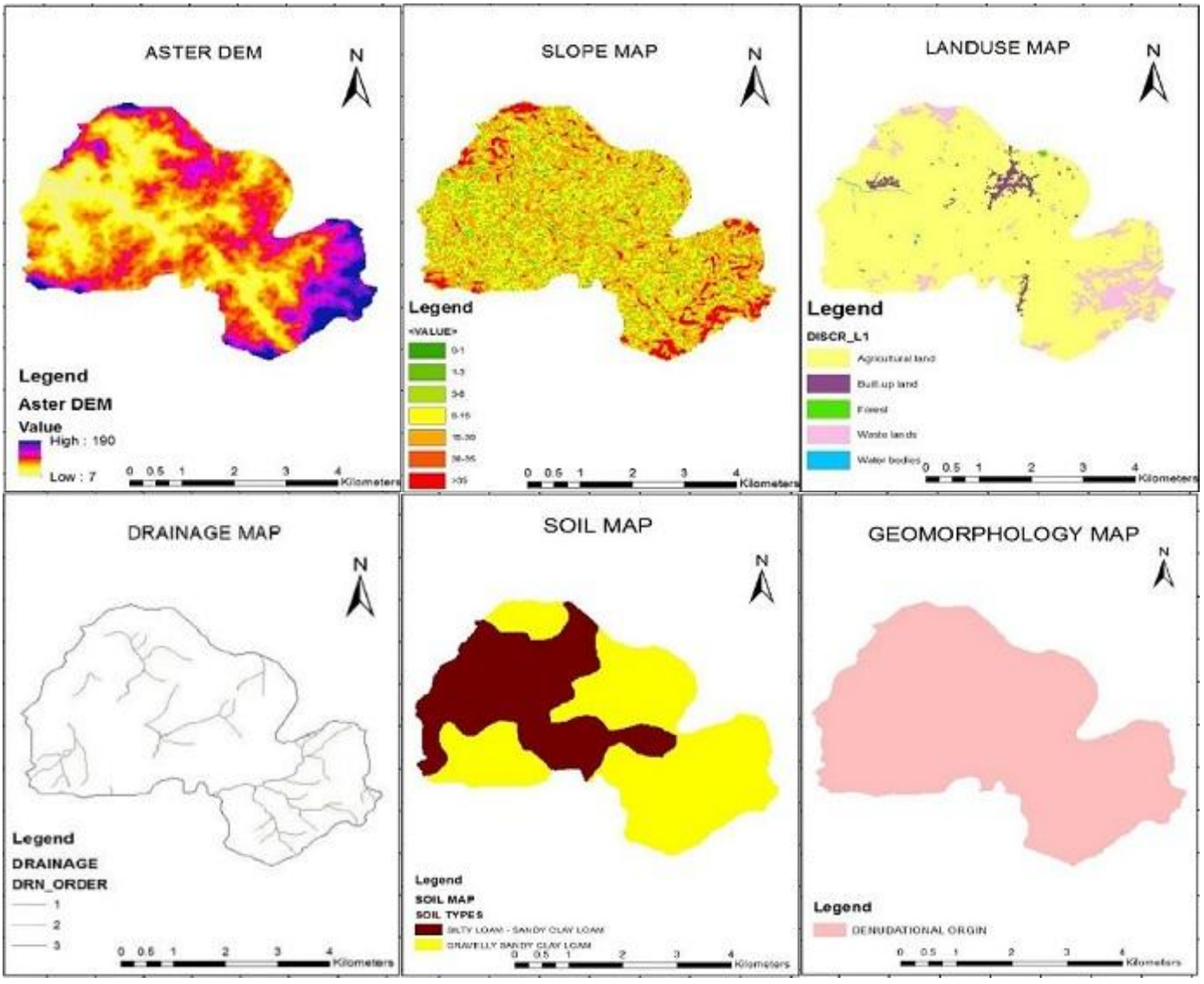


Fig -2: All thematic maps

3. METHODOLOGY

The methodology primarily involved selection of study area which suffers from water shortage. Then the Digital Elevation Model (DEM) and thematic maps were prepared. The RWH structures and their criteria for reclassification were obtained from the suggestions by the Integrated Mission for Sustainable Development (IMSD) guidelines. The maps were interpreted and analyzed using GIS software. Reclassified maps for each structure was created

and overlaid using weighted overlay method. The final model of the most suitable structure and its sites is prepared.

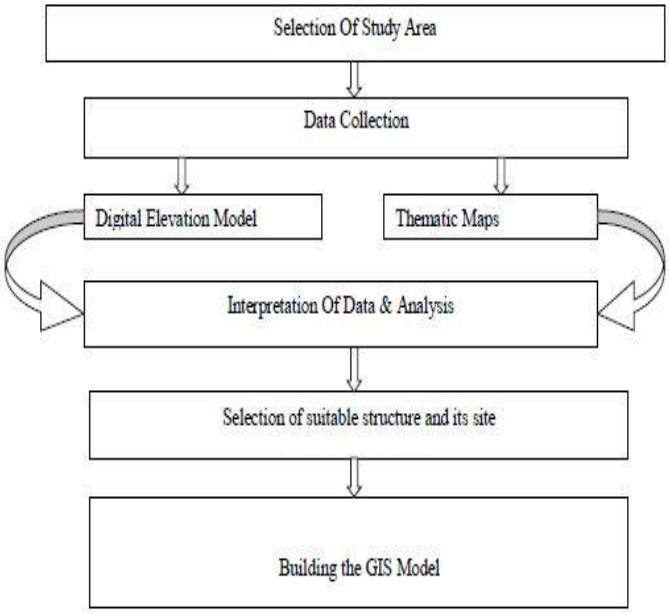


Fig-3: Schematic representation of methodology

3.1 Software Package & Activities Performed

The software used for the work is ArcGIS 10.3.1. ArcGIS is a geographic information system for working with maps and capture, store, analyze, manipulate and present all types of geospatial data. It supports both vector and raster layers.

The activities performed using GIS are:

- Georeferencing- Georeferencing of scanned maps were carried out using already established control points
- Digitization- Map was digitized using GIS and editing was done to remove errors.
- Clip- The georeferenced and digitized maps were clipped using boundary shape file of study area.
- Reclassification- All 5 thematic maps were reclassified for each structure based on criteria by IMSD into 1 & 0.

3.2 IMSD Guidelines

Suitable water harvesting structures and their criteria were identified using the guidelines by Integrated Mission for Sustainable Development (IMSD).

Table-2: IMSD Guidelines

Structure	Slope (%)	Soil Type	Land Use	Drainage Order
Check dam	<15	Silty loam to sandy clay loam	Agricultural land, waste land, water bodies	1-3
Farm pond	<5	Silty loam to sandy clay loam	Agricultural land, waste land	1
Percolation tank	<10	Gravelly sandy clay loam	Agricultural land, waste land, forest	2 &3
Subsurface dykes	<3	Gravelly sandy clay loam	Agricultural land, waste land	>4

4. RESULTS

Identification of the most suited sites for the water harvesting structures is crucial for maximizing recharge and conservation of water. We considered 5 thematic layers for the reclassification purpose- Slope, Land use, Drainage, Soil and Geomorphology. All the 5 georeferenced and digitized maps were reclassified for each RWH structure using the Reclass tool in Spatial Analyst Tools. The reclassification was done as per the criteria by IMSD guidelines (Table-2). The maps were reclassified into 1 & 0, with 1 being the favorable locations. Thus, 20 reclassified maps were obtained as shown in figures below (Fig- 4, 5, 6, 7 & 8). The reclassified maps for each structure was then overlaid. Overlay is the technique of applying a common scale of values of distinct inputs for integrated analysis. Weighted sum overlay is done by Overlay tool in Spatial Analyst tools. Weighted sum overlay raster, multiply each by their given weights and sums them together. Weighted sum overlay was done separately for all the 4 structures namely check dam, farm pond, percolation tank and subsurface dyke. For each structure the 5 layers namely slope, drainage, soil, land use and geomorphology were overlaid to obtain the suitability map. The overlaid maps have pixel values from 1 to 5 in which 5 being the most favorable site. Similarly, pixels with values were allocated as 4-suitable, 3-moderately suitable, 2-little suitable and1-very little suitable. The overlaid maps obtained as suitability maps for each structure is shown in Figure-9.

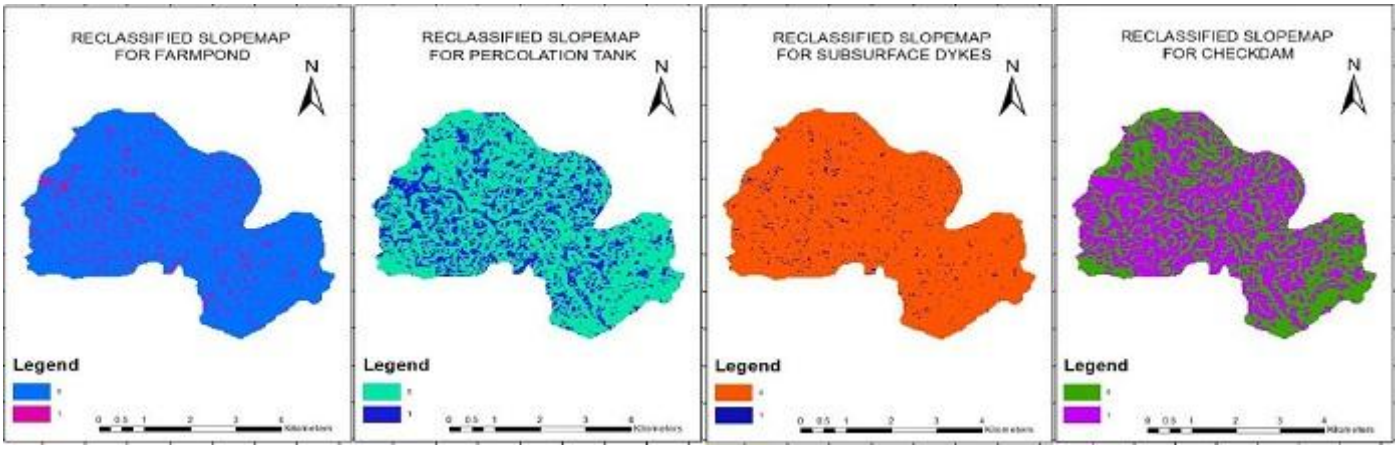


Fig-4: Reclassified slope maps for all structures

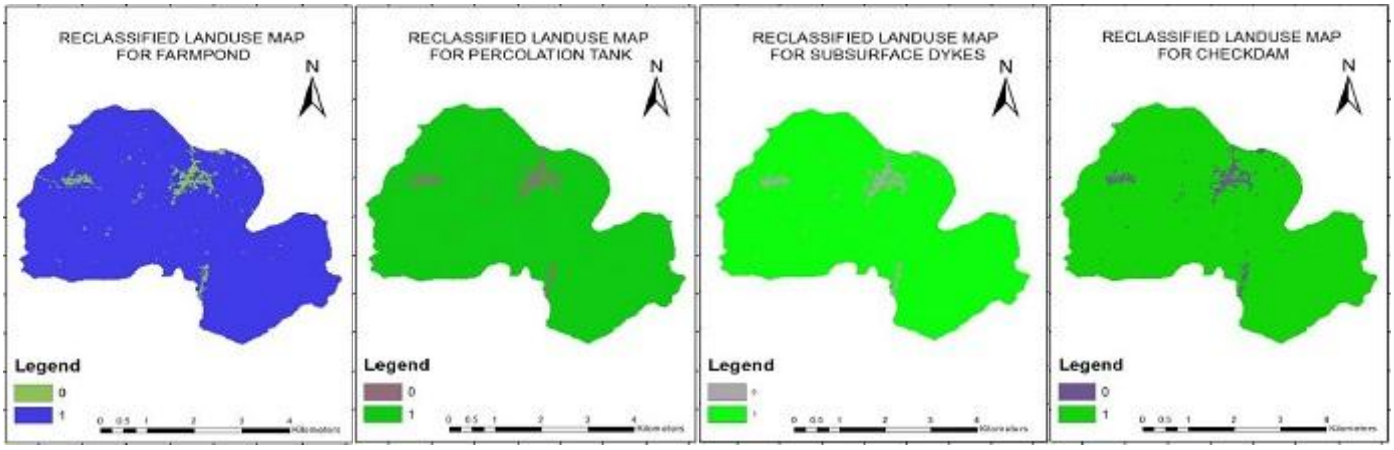
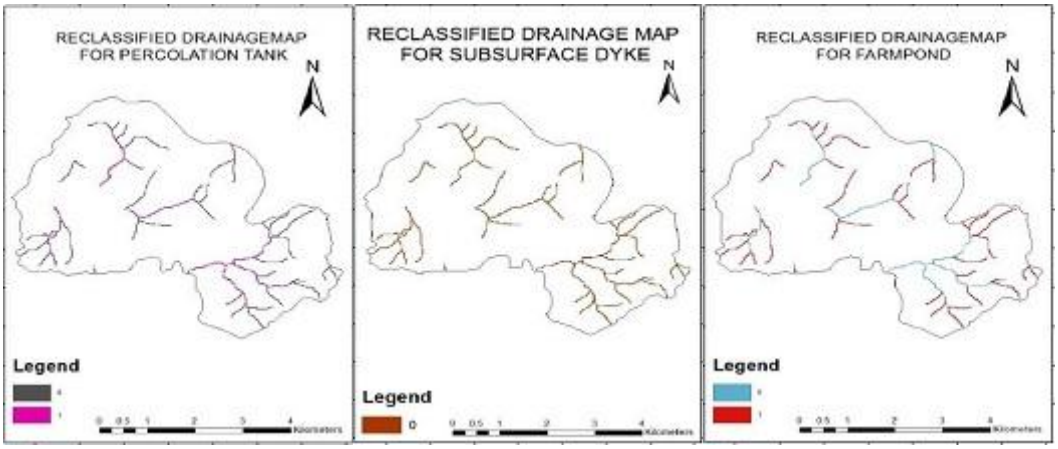


Fig-5: Reclassified land use maps for all structures



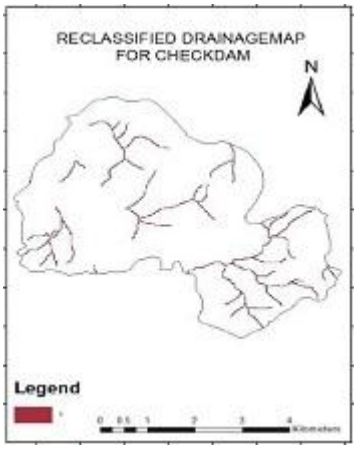


Fig-6: Reclassified drainage maps for all structures

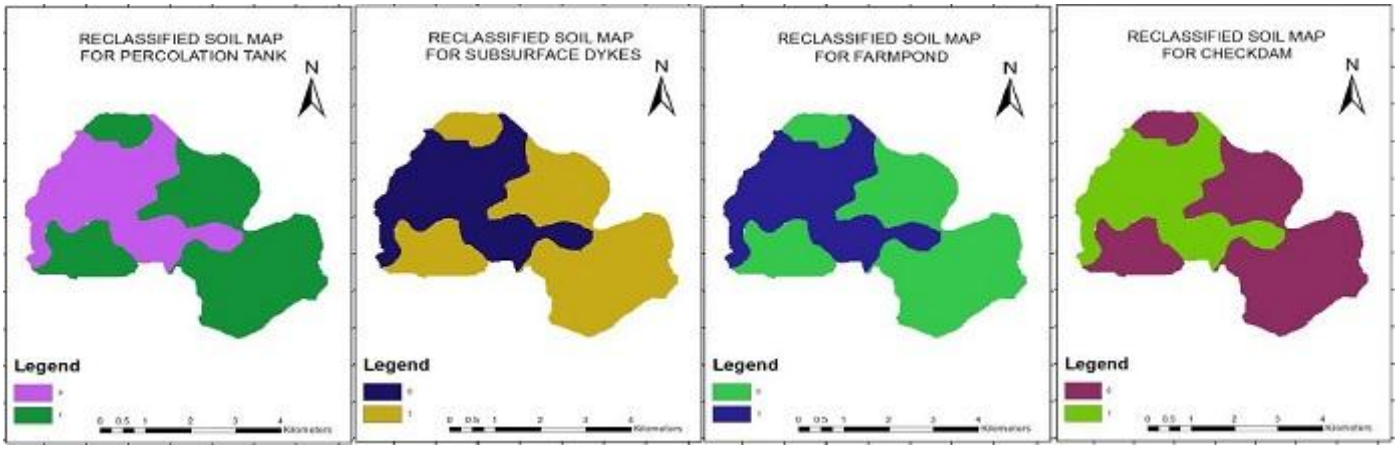


Fig-7: Reclassified soil maps for all structures

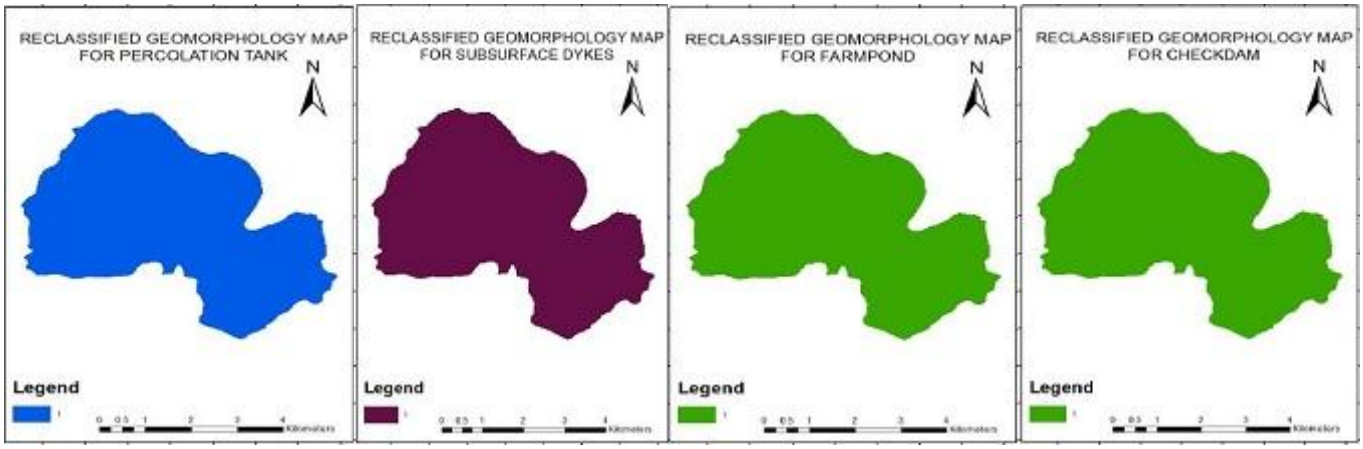


Fig-8: Reclassified geomorphology maps for all structures

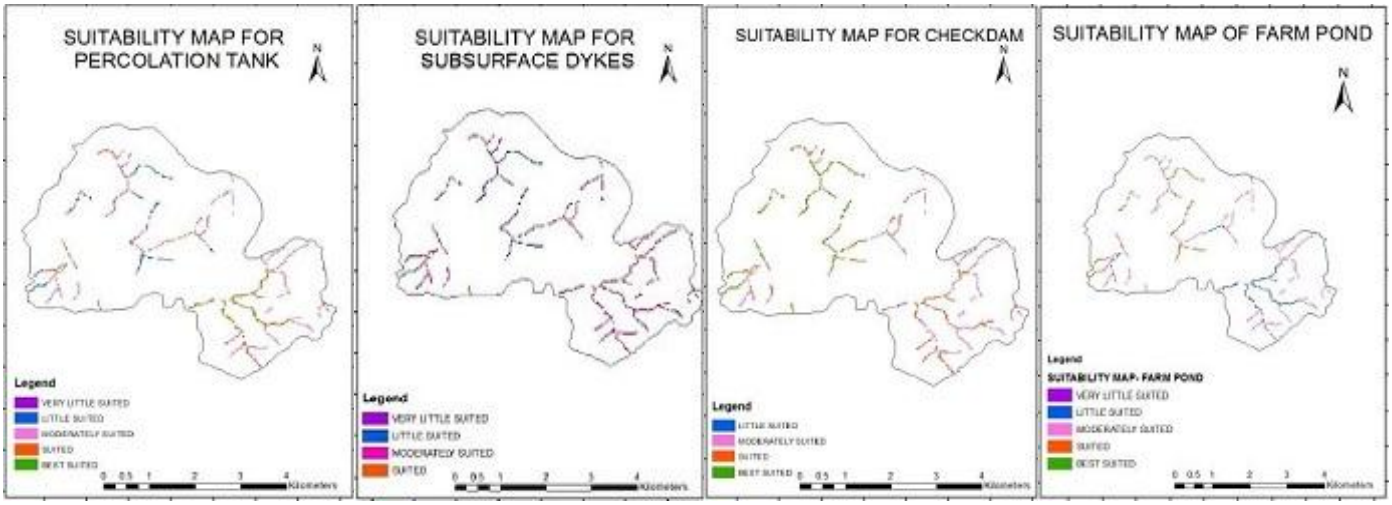


Fig-9: Suitability maps for all the structures (Obtained by overlay)

According to the work done by M. Girish Kumar, A.K. Agarwal and Rameswar Babu in 2008, a check dam is suitable in a site with the following characteristics:

(1) The check dam is essentially on the drainage course that may be situated on either first or second order of drainage; (2) The preference for this structure is given where drainage is narrow and straight; (3) The structure of check dam should be made so as to regulate water during monsoon and non - monsoon period; (4) the selected site may be located in the vicinity of habitation and its water storage away from surrounding lands of irrigation potential (as much as possible); (5) The structure of check dam is proposed at hydro geomorphic unit of buried pediplain medium (BPP - M), buried pediplain deep (BPP - D) and valley fills (VF) near lineaments.

The study area confirms to the above characters. Hence a check dam is preferred over the other structures. The coordinates of best suited locations of check dam was overlaid with Google Earth to obtain the places. For this, the weighted overlay result was converted to KML format and imposed to Google Earth. The best suited sites for check dam are shown in Figure-10.

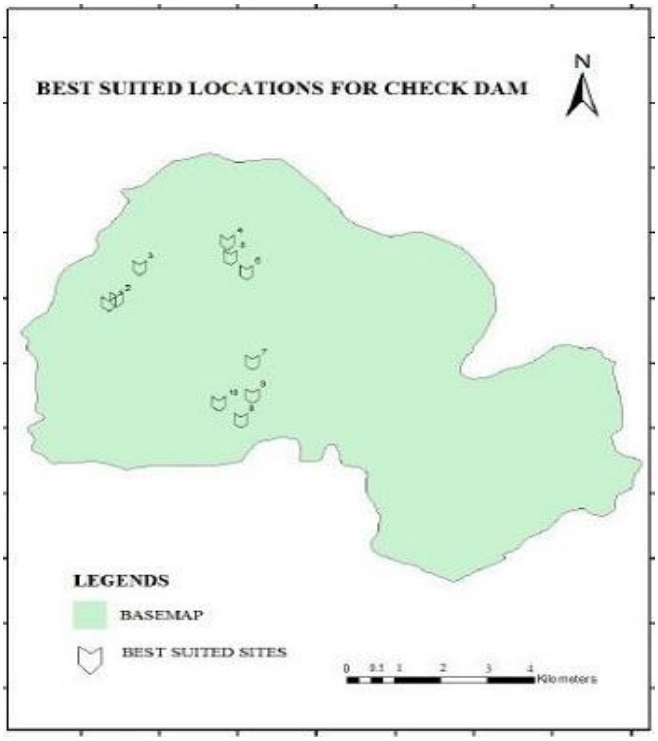


Fig-10: Most suitable sites for check dam

5. CONCLUSION

The suitable sites and structure for the study area Koppam panchayat was done using GIS. The most suitable sites for the structures check dam, farm pond, percolation tank and subsurface dyke was obtained. Check dam is the most feasible RWH structure for the area This work will help future surveyors to locate the feasible sites. Also, these maps cut down the time and fund required by conventional survey methods. By overlaying coordinates of check dam with google earth, places that are found to be suited for constructing check dams are Melmuri, Palakavu, Kolothody, Kalady, Thrithala and Pullasery.

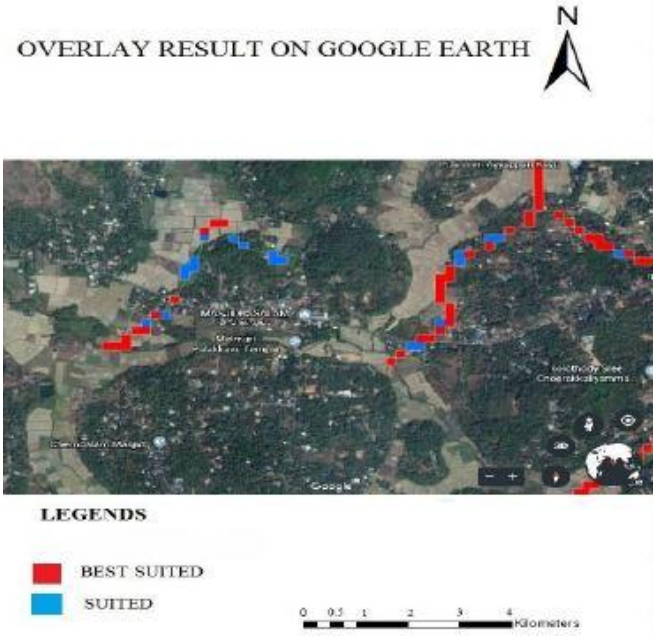


Fig-11: Overlay result on Google Earth

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