Study on Watershed Analysis for Sustainable Soil Conservation and Watershed Development in GVMC Area, Visakhapatnam

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Abstract: The aim of the frame work is to create a mechanism that would allow for development while protecting soil and water resources in the region using science-based decision making. The geospatial technologies like remote sensing and GPS, GIS are useful for fast and cost-effective study of different applications with accuracy. The main focus of the study is to develop the watershed boundary and sustainable soil conservation in GVMC AREA using GIS. Different maps have been generated from satellite images and USGS EARTH EXPLORER using remote sensing and GIS. The maps are prepared by using satellite images and raw maps of GVMC toposheets generated by geological survey of India. Finally, watershed map is obtained from digital elevation model (DEM). The final output of the study gives different conservation measures for soil and water within a watershed boundary with reference to the remote sensing and GIS data.

Keywords: GIS, Landsat-8, DEM, LULC map, slope map, watershed

1. Introduction

Land and water are the most precious natural resources, the importance of which in human civilization needs no elaboration. The total available land area in the State sets the limits within which the competing human needs have to be met. The needs of agricultural, industrial, domestic and others often result in diversion from one use to the other. Diversion of land from agriculture to non-agriculture uses adversely affects the growth in agriculture sector. Even the available land is subjected to soil-erosion of varying degrees and degradation problems of different magnitudes. Water supports all forms of life on this mother earth. It plays a vital role in agricultural and industrial development and sustaining human life. Rainfall is the only source of water. The water is confined as i) soil moisture, ii) stored water in surface storage like reservoirs, tanks, ponds, temple tanks, and in open wells etc., iii) groundwater in sub surface, iv) sea water and v) waste water like sewage and effluent. Depending upon the rainfall, its intensities, and frequencies, an area becomes drought or flood affected.On the other hand, the land is subjected to soil erosion and land degradation problem due to rain or wind action and faulty cultivation practices resulting in loss of topsoil, which is the place where all nutrients are available. This leads to poor yields, uneconomic returns, reservoir sedimentation, and reduction in storage capacity,

Study area Location

The study area the Greater Visakhapatnam Municipal Corporation (GVMC) is located between 1703213011 - 1705213011 northern latitude and 8300413011 - 8302413011 eastern longitude. The urban area of GVMC is divided into six zones. These six zones are further divided into 72 municipal wards covering a total area of 545km2. The city is bounded by Bay of Bengal on eastern side, Duvvada hills, (Adavivaram hills) on the western side, Yarada konda on the southern side and Madhurawada dome on the north side. The location map of study area is given in (fig. 1).

Description

The study area is one of the major municipal corporations in the state of Andhra Pradesh. The area is famous for industries and tourism; often it is called as industrial city or city of destiny. The area has the reserved forests within the jurisdiction of GVMC. Due to recent developments such as IT Park and other constructions have come up in thick vegetated hilly area resulted in reduction of reduced forest cover. The area is well connected by rail, road, air and water (sea). According to 2011 census, the area has 1.7million population. High density population is located in the vicinity of GVMC area. The fringe area has very low density population where as areas like chinthala, Agraharam, Adavivaram, Gambhiram appears to be rural. Extensive agriculture is the major land use in these villages.

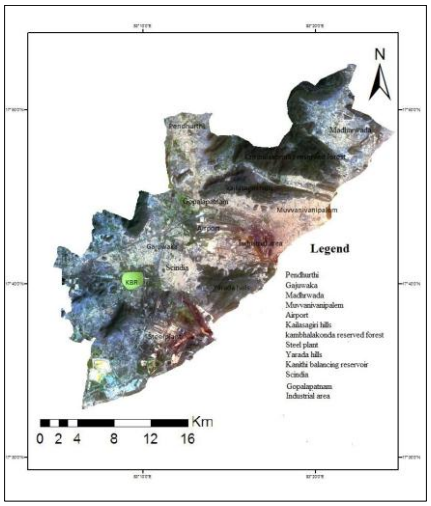

fig.1 Location map of study area

2. Methodology

Water Shed Delineation

All watershed delineation means is that you're drawing lines on a map to identify a watershed's boundaries. These are typically drawn on topographic maps using information from contour lines.

A common task in hydrology is to delineate a watershed from a topographic map

Topographic Maps are fundamental source of data for delineating and studying watersheds, Scale varies. These maps -wealth of information -topographic contour lines, locations of cities, buildings, roads, road types, railroads, gyp pipelines, water bodies, forested land, stream networks, and stream gauging stations and benchmarks.

Watershed Delineation By Using Arc Gis

ArcMap contains the Arc Tool box, which has all the tools required for modifying, reading, determining and viewing maps

Shape files (.shp) are the files that can be created in ArcCatalog and edited in ArcMap. The map we provide acts as a background for creating the shape files.For watershed delineation, the contours are to be digitized from the scanned toposheet.

Major steps involved in delineating a watershed using ARC GIS

Watershed using ARC GIS are

- Geo-registering the scanned toposheets
- Creating shapefiles Creating shapefiles
- Contour digitization
- Preparation of DEM
- Filling of DEM
- Flow Direction Raster generation
- Flow Accumulation Raster
- Determining Pour Points
- Watershed Delineation

3 Developed maps of study area

3.1 Land Use /Land Cover Studies

Land Use / Land Cover information is the basic requisite for land, water and vegetation resources utilization, conservation and measurement. Land use describes how a piece of land is used, such as for agriculture or industry, whereas land cover describes the materials, such as vegetation, rocks or buildings that are present on the surface. Land use / land cover features to some extent reflect the geological / geomorphological controls.Interpretation of satellite imagery (GOOGLE EARTH and LANDSAT-8-OLI, path 141 and row 48 dated 13th March, 2017), coupled with thematic maps has helped in mapping the various land use / land cover features in the (GVMC). A review of the major land use / land cover features of the city area is described below in (fig.3.1).

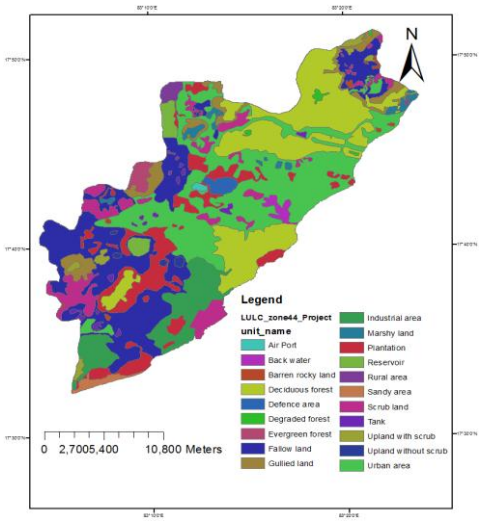

Fig.3.1. LULC map of study area

3.2 Slope Map

Slope map shows the elevation of the particular area. The steepness value is bounded between maximum and minimum values. The slope of elevation can be depicted in two ways one is in degree and another in percent wise. The generation of slope map includes the following procedure. The generated slope map is given below in (fig.3.2)

- Open Arc GIS.
- Click on the Arc toolbox.
- Click on the spatial analyst tools.
- Click on surface
- Select slope Toolbox > Spatial analyst tools > surface > slope
- Give the DEM image as input to get the slope map as output
- Slope map is generated. The generated slope ranges from 0% to 40% as low and high values respectively.

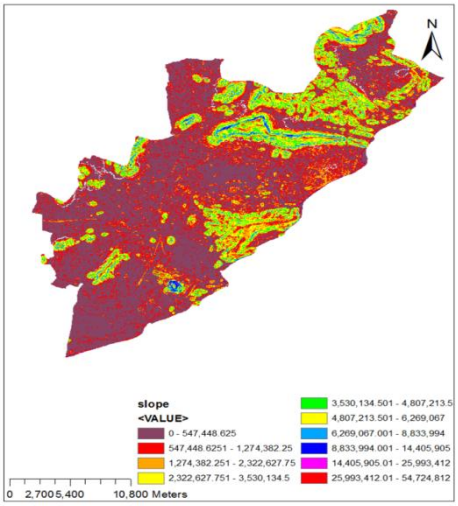

Fig 3.2 Slope map of study area

3.3 Soil Map

Soil map of GVMC area consists of different soils namely Brown clay soil, Brown gravel clay soil, Brown gravel loamy soil, Clay soil, Red clay soil, Red coastal clay soil, Red loamy soil and Sandy soil.

Selection of soil type is based on the type of harvesting structure technique is taken. Brown clay soil is covered in mostly Visakhapatnam rural Mandal areas like Madhurwada, Kommadhi and some part in Peddha gantyada Mandal. Similarly, Brown gravel clay soils is covered areas like NAD, Narava, Steel Plant and some places in Peddha gantyada Mandal. Brown gravel loamy soil is covered only besides the Meghadrigedda. Clay soil is covering areas of Gopalapatnam, NAD, Sheelanagar. Red loamy soil is covering industrial area and sandy soil is present near Meghadrigedda and some places in Peddha gantyada Mandal and Gajuwaka Mandal.

The availability of different soils are given below in fig.3.3.

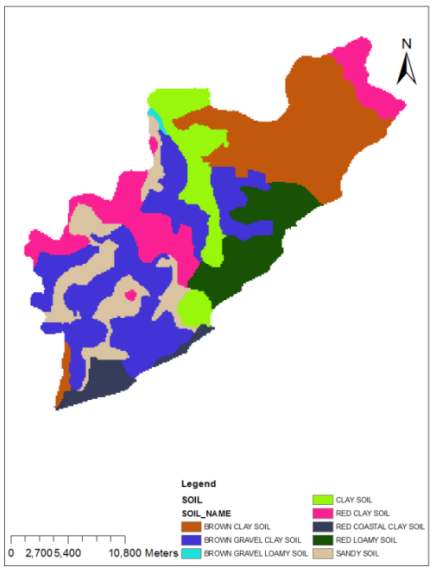

Fig 3.3 Soil map of study area

3.4.Watershed Map

The Watershed tool only supports a D8 input flow direction raster. D8 flow directions can be created using the Flow Direction tool, run with default flow direction type D8. Better results will be obtained if the Snap Pour Point tool is used beforehand to help locate the pour points to cells of high accumulated flow.When specifying the input pour point locations as feature data, the default field will be the first available valid field.

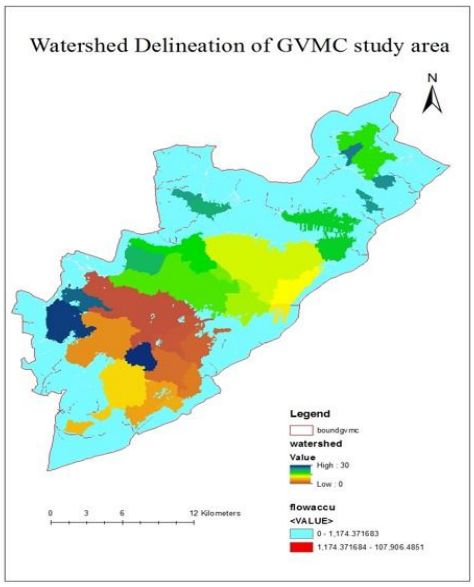

Fig.3.4 Watershed map of study area

4. Results and discussion:

The site for harvesting structures and soil conservation measures also be identified by visual interpretation of different maps like soil map, LULC map, slope map, DEM. The overlapping of different raster measures, supervised classification and slope give us suitable site for harvesting structures and conservation measures.

4.1 Afforestation:

Afforestation is the transformation of wasteland into the forest or the woodland. Forests are fundamentally essential in water harvesting. These thick forest areas being encroached by natural establishments as Yarada hill ranges, parks and other human encroachments leading to severe deforestation threatening to animal life. Government should not permit for any construction either on hill tops or on foot hills. The afforestation details are represented in fig.4.1 and table 4.1.1

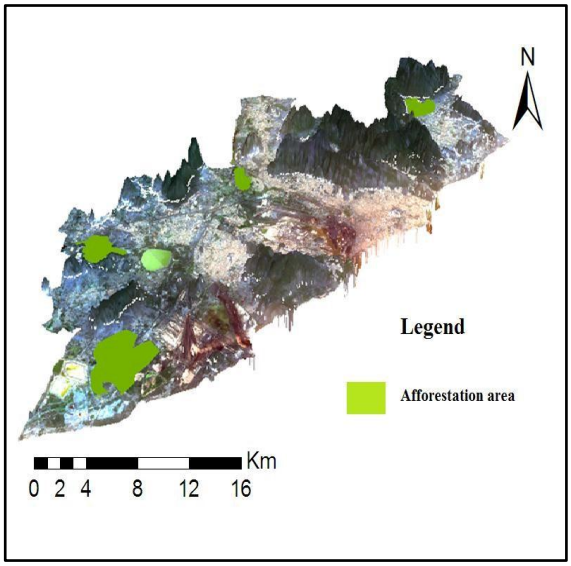

Fig 4.1 Afforestation map of GVMC

Table no. 4.1.1.Site of afforestation

S. no	Land use/land cover	Type of soil
1	Fallow land and Plantation	Brown gravel clay and sandy soils
2	Fallow and Gullied land	Brown gravel clay, sandy soil and red clay soils
3	Fallow land and Plantation	Clay and brown gravel clay soils
4	Fallow and scrub land	Brown clay soil

4.2 Check dams & Percolation tank: The quantity of water, if it is used for irrigation, is sufficient to irrigate 4-6hectares of irrigated dry crops (maize, cotton, pulse, etc.) and 2-3 hectares of paddy crop. Location of check dams and percolation tanks are given in tables (4.2.1) and (4.2.3) and represented in fig.4.2.3.

Table 4.2.1: The table shows the location of Check dams

S. no	Land use/land cover	Name of the village
1	Fallow land	Kommadhi
2	Plantation	Narava
3	Plantation	Kunmannapalem
4	Gullied land	Vennela palem

Table 4.2.2: The table shows the location of Percolation ponds

S. no	Land use/ land cover	Name of the village
1	Fallow land	Islampet
2	Gullied land	Steel Plant

Four check dams are suggested and these are located at Chaithanya College of Engineering, Kommadi, near Kanithi Balancing Reservoir, Narava and Vennela palem.

Percolation ponds are suggested at Yatapalem and other at the Narava.

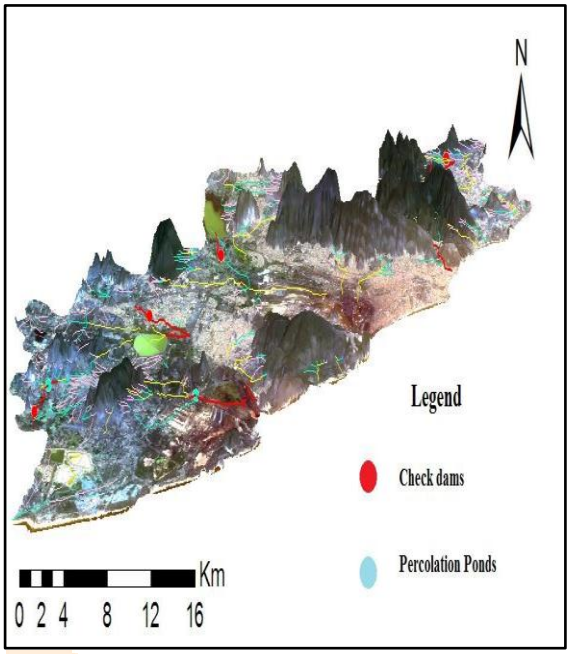

Fig 4.2.3 Map for check dams and percolation tanks of GVMC

4.3 Infiltration well:

Infiltration wells are also called as the interception wells, these are shallow wells which draw water into subsurface. The location of infiltration wells are given in table 4.3 and represented in fig.4.3.1

Table 4.3 : The table shows the location of infiltration wells

S.no	Land use/land cover	Name of the village
1	Fallow land	Madhurawada
2	Degraded forest	Radar observation centre
3	Built-up	Muvvani vani palem
4	Vacant land	Andhra university
5	Gullied land	Simhapuri colony
6	Plantation	Puttambotlapalem
7	Fallow land	Donkada
8	Upland with scrub	Islampet
9	Fallow land	Vedulla narava
10	Plantation	Vedulla narava

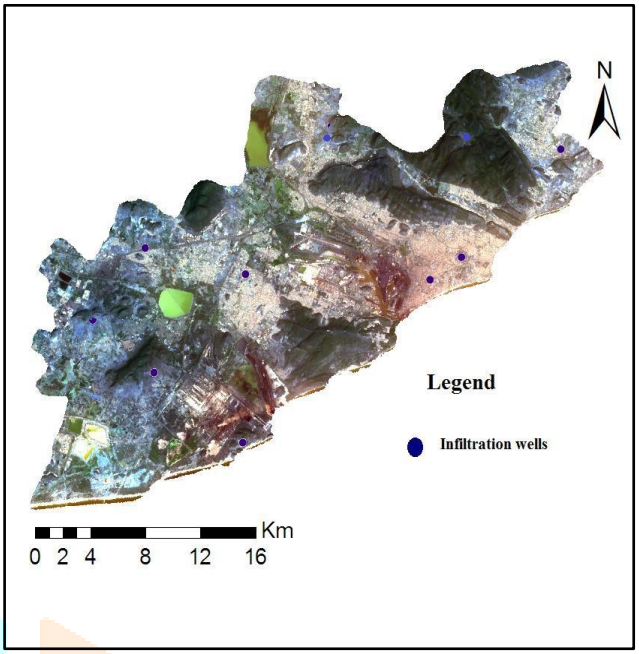

Fig 4.3.1 Map for infiltration wells of GVMC

The infiltration wells are suggested at the Srinivasa nagar near Madhurwada, RADAR observation centre, Simhapuri colony, MVP, Andhra University, Puttambotlapalem, Donkada, Islampet near Nadupuru Reserve forest and two infiltration wells at Vedulla narava .

5. Conclusion

It is concluded that different harvesting structures and conservation measures are suggested in the study area. Four check dams are suggested and these are located at Chaitanya college of Engineering, Kommadi, near Kanithi Balancing Reservoir, Narava and Vennelapalem. Percolation ponds are suggested at Yatapalem and other at the Narava. The infiltration wells are suggested at the Srinivasa nagar near Madhurwada, RADAR observation centre, Simhapuri colony, MVP, Andhra University, Puttambotlapalem, Donkada, Islampet near Nadupuru Reserve forest and two infiltration wells at Vedulla narava. Afforestation in suggested in some areas of study area and the total area suggested for afforestation is 2479.88ha

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