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Thematic Integration Approach for Watershed and Land Management

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Abstract

The present study is to integrate thematic layers like land use / land cover, soil map, hydrogeomorphology, slope map, by remote sensing techniques (Arc-GIS and ERDAS software). The study area includes Edulabad Cheruvu Watershed, Ranga Reddy district comprises parts of Ghatkesar, Keesara, Shamirpet, Malkajigiri, and Uppal mandals in Andhra Pradesh, India. The extent of the watershed stretches from between 17^0 25'06" and $17^0$34'26" North Latitude, $78^0$31'20" and $78^0$43'14" East Longitude and covers an area of 204 Sq km. The dominant soils found are red soils followed by black soils. The land capability classes of the study area are II, III, IV, VI, VII and the land irrigability of the study area are 2,3,4,6 only. The analysis of slope map indicates that the study area covers all types slope classes 1,2,3,4,5,6,7, while very gentle slope covered above 80% of the area. Afforestation is proposed in the forest blanks/open forest areas to increase the density of vegetation. Some of the barren rocky areas are identified for quarrying provided suitable environmental production measures are followed. This would generate employment and income to the local people.

Keywords: Conservation, Drainage, Land Capability, Thematic Integration, Watershed.

1. Introduction

Watershed is an ideal unit and accepted for planning, development and management of land and water resources. Watershed is also very useful for soil conservation, and development of forest/vegetation [3]. The main scope of the study is to identify the natural resources and their development using remote sensing and GIS. Using these techniques have prepared, hydrogeomorphology, land use / land cover, soil and slope maps of the Edulabad Cheruvu watershed, using high resolution satellite data LISS III [1]. The present study suggests integrated land and water resource development, adopting various water harvesting plan and soil conservation measures, using Remote Sensing and GIS techniques [4] for Edulabad Cheruvu watershed.

2. The Study Area

Edulabad Cheruvu Watershed, Ranga Reddy district, comprises parts of, Ghatkesar, Keesara, Shamirpet, Malkajigiri, and Uppal mandals in Andhra Pradesh, India. The watershed is around 204 Sq km, Northeast of from Ranga Reddy. The extent of the watershed stretches between 17°25'06" and 17°34'26" North Latitude, 78°31'20" and 78°43'14" East Longitude. The Survey of India toposheet numbers 56 K/10 & 56 K/11 on the scale of 1:50,000 are used, depicts that the watershed covers an area of 204 Sq km, covers predominantly agricultural land. The present study area is selected for agricultural area development through the watershed management, better knowledge of various natural resources, their relations with each other and with livelihood of the stakeholders.

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3. Methodology

The study involves preparation of various thematic map by using SOI toposheets of 1:50000 scale, IRS P6 LISS III data dated 14 October 2009. ERDAS Imagine software has been used for image rectification, enhancement and classification operations. IRS P6 LISS III satellite data has been used to classify land use/land cover. On Screen interpretation has been used to extract thematic layers. Interpretation was made in conjunction with the topographical map and also supported by adequate ground actual data for accurate output. Required thematic layers - Geology, Geomorphology, Hydrology (drainage), Soils, Slope, Land use / Land cover [6] have been derived from the image. Arc GIS software has been used to integrate the individual layers to generate suitable land use models and to develop a micro level action plan. NRSC [5], methodology has been applied to classify the land use categories and recommendations were suggested appropriately.

4. Results and Discussions

4.1 Soils

Soil mapping for the Edulabad cheruvu watershed was carried out, using IRS-P6, LISS-III dated 14 October 2009 False Color Composite (FCC) Data. In the present reporting system, remote sensing data products in the form of FCC are used as the base maps. In view of this technology limitation, a special method has been devised for carrying out soil survey. Detailed Soil Survey work has been carried out in selected areas encompassing various mapping units and the associated sub units. A general rapid reconnaissance survey was conducted with random sampling techniques in the rest of the area. Particularly, while deriving the land capability and land Irrigability classes, generalization is required at the level of mapping in association of soil series. All interpretations are, thus, provided for each mapping unit.

4.1.1 Interpretation of Soils Data

The data acquired through soil survey of Edulabad cheruvu watershed, Ranga Reddy District, A.P, has been duly interpreted for land resources development. The purpose of generating soil and land data will be meaningful when the same is used to derive valid interpretations [8]. The data collected through interpretation of remote sensing data, and laboratory characterization and other studies are complied and evaluated deriving 5 land capability classes, 4 land Irrigability classes, and many other crop suitability classes. The soil map is shown in Figure 1.

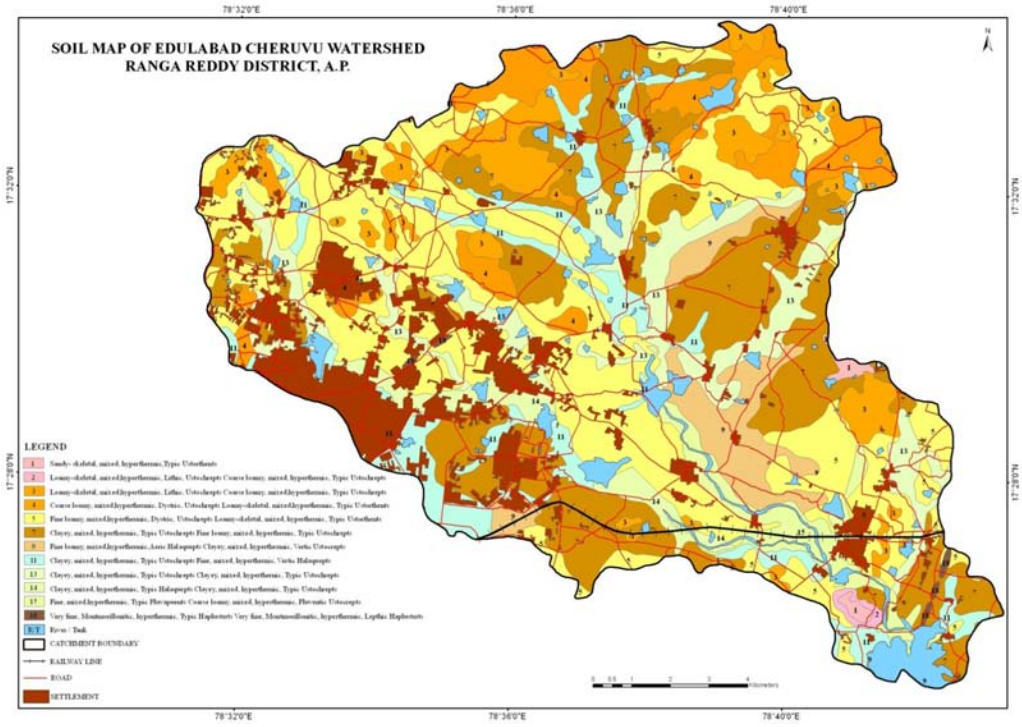

Figure 1. Soil Map.

4.2 Drainage Pattern and Slope Classification

Drainage map of the study area has been prepared from the SOI topographic maps on 1:50,000 scale and shown in Figure 2 and the drainage length and stream order is presented in Table 1. Drainage pattern of the study area is dendritic in nature with the stream order ranging from 1st to 5th order and the area consists of 72 tanks.

A topographical map on 1:50,000 scales give contours with 20 meter interval or its multiple i.e. 40m, 60m, 80m etc. Close spaced contours on the map have higher percentage slope as compared to sparse contours in the same space. Thus density of contours on the map can be used for preparing the slope map that gives various groups / categories of slopes. The slope classes of the study area are presented in Table 2.

Table 1. Drainage length and stream order

Stream order	Length (mts)
1	314231.86
2	103890.89
3	59144.89
4	25973.13
5	9877.85
Total:	513117.96

4.3 Land Classification

Basic essence of the Land Capability Classification system is to categorizing the lands into different classes based on their capability for efficient production on one hand and identifying the limitations on the other hand. Soil of the study area have been classified into five classes II, III, IV, VI & VII along with three sub classes s, es and sw and given in Table 3.

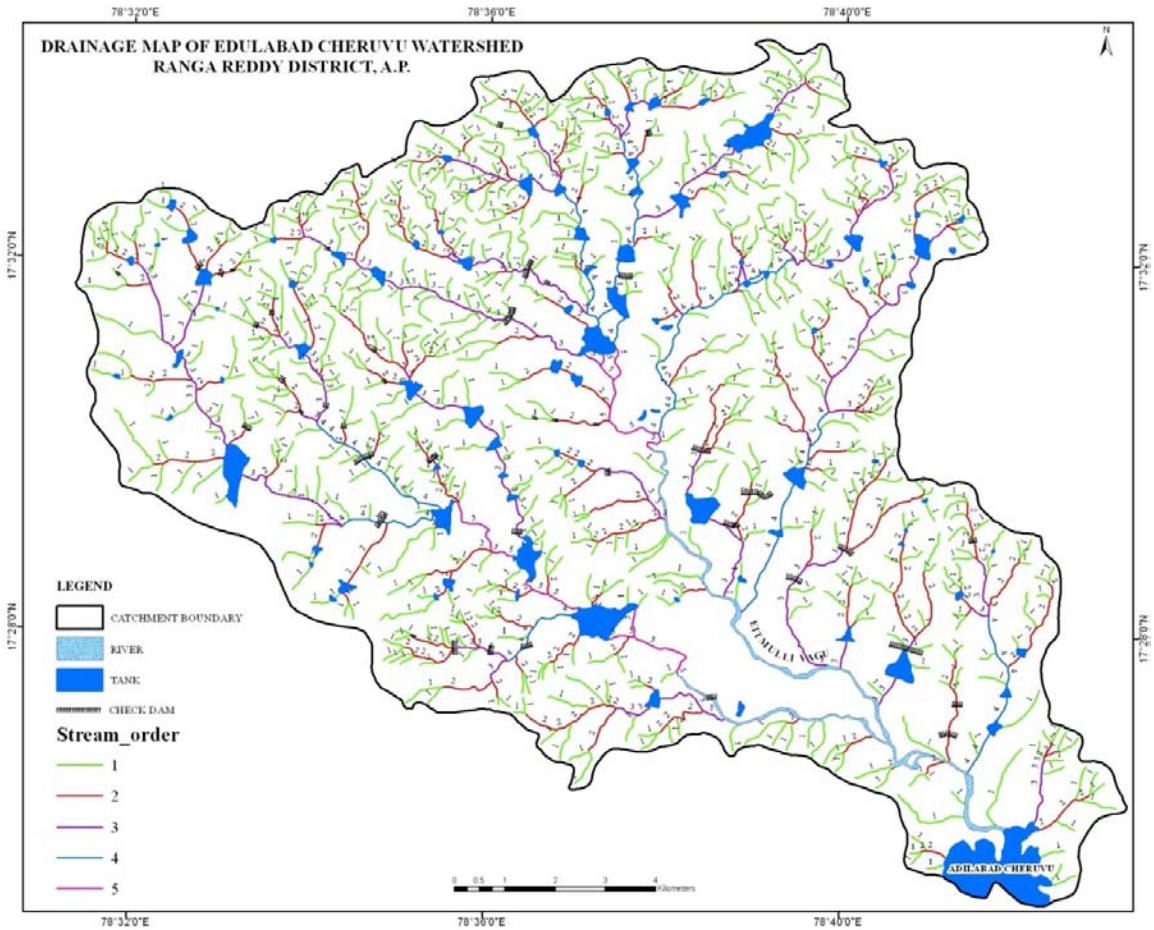

Figure 2. Drainage map of watershed.

Table 2. Slope classes of the watershed

Slope class	Slope, %	Slope category	Area (ha)	% to total area
1	0–1	Nearly level	2653.10	13.18
2	1–3	Very gently slope	16452.73	81.72
3	3–5	Gently slope	494.30	2.46
4	5–10	Moderately slope	109.24	0.54
5	10–15	Moderately steep slope	342.54	1.70
6	15–35	Steep slope	14.11	0.07
7	>35	Very steep slope	67.63	0.34

Table 3. Land capability classification

Land capability	Sub class	Suitable for (only the most intensive safe use is mentioned)	Area (ha)	Area (%)
II Good cultivated land.	II s	Good cultivable lands under irrigation, deep sandy loams to very deep sandy clay loams.	1141.16	5.80
	II sw	Good cultivable lands under irrigation, slightly wet, deep sandy clay loams.	4042.99	20.55
III Moderately good Cultivable land.	III es	Moderately good cultivable land, moderately deep clays and severely eroded .	11696.46	59.46
IV Fairly good land	IV es	Fairly good land suited for good cultivation, severely eroded, having only shallow clays .	1370.38	6.97
VI Well suitable for grazing or forestry.	VI es	Land not suitable for cultivation. Suitable for grazing, with shallow sandy loams, severely eroded.	1339.58	6.81
VII Suited only for wild life recreation and water supplies.	VII se	Land not suitable for cultivation. Suitable for grazing, forestry or both with shallow sandy loams, severely eroded.	79.87	0.41

4.4 Land Irrigability Classification

Land and soil characteristics have been carefully studied and the limitations for their conversion to irrigable lands have been inferred. Though, irrigation facilities are not available at this moment, a projection is made in this section to evaluate the qualities and problems of soils and land for development under sustained use under irrigation when facilities become available. The land irrigability classification is given in Table 4.

4.5 Integration of Land and Water Resources

Integration of land and water resources unit has been carried out digitally by using GIS software packages. The GIS technique which helps to visualize, organize, combine, analyze, predict and query the spatial data along with non spatial data. GIS is useful for combination of all the available resources together with a set of operational procedures to produce information for taking administrative and economic decisions as an aid to planning and development process related to geographical unit to meet the set objectives [2]. GIS plays a key role in achieving an integrated model of any parcel of land in the area of interest.

Table 4. Land irrigability classification

L.I.C	Details	Area (ha)	Area (%)
2d	Lands have moderate limitations for sustained use under irrigation due to drainage.	3931.64	19.95
2sd	Lands have moderate limitations for sustained use under irrigation due to soil and drainage.	961.84	4.88
3s	Lands have moderate limitations for sustained use under irrigation due to soil.	7357.29	37.33
3st	Lands have moderate limitations for sustained use under irrigation due to soil and terrain.	4338.72	22.02
4t	Lands have severe limitations for sustained use under irrigation due to soil.	1379.47	7.00
4st	Lands have severe limitations for sustained use under irrigation due to soil and terrain.	136.49	0.69
6s	Lands with severe limitations, not suitable for sustained use under irrigation due to soil.	1601.57	8.13

4.6 Thematic Integration

The thematic maps of hydro geomorphology, slope, soil, and land use/land cover maps are digitized and integrated in Arc Info GIS package and basic integrated land and water resources units are derived. Thus there are units in this catchment each of which has unique combination. In order to keep manageable of integrated units some of the thematic classes have been merged and shown in action plan map of the watershed in Figure 3.

4.7 Recommended Drought Proofing Works

According to the guide lines given by the department of Agriculture, the soil and water conservation measures have been recommended for the 'Edulabad cheruvu' watershed depending upon the land attributes. Check dams are proposed on lower order streams to control water velocity and for storage. Construction of percolation tanks at suitable distances are suggested for supplemental irrigation. The Study area is receiving rain fall with good distribution and drought proof works [7] are suggested to ensure sustainable development in the area. It is envisaged to implement drought proofing works in the watershed with people's participation. These works are spatial development strategies to combat drought on a sustainable basis.

4.8 Action Plan for Water Conservation Measures

Terracing and bonding and construction of Check dams and Percolation tanks are recommended after considering the climate, groundwater potential, surface water availability, and morphology of the area, soil characteristics, current land use practice and slope of the area. The socio-economic conditions of the particular watershed were also taken into

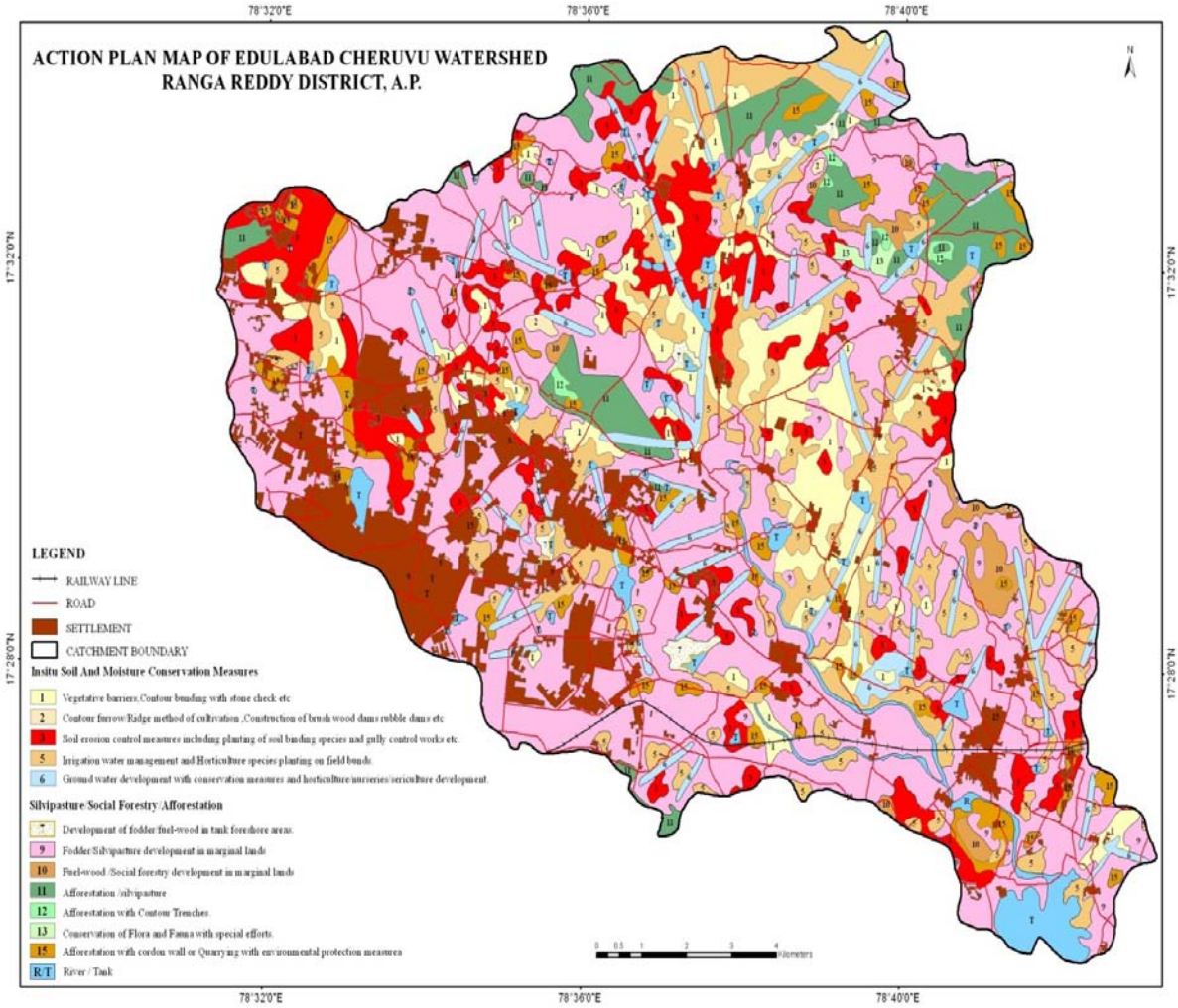

Figure 3. Action plan map.

consideration to suggest optimum utilization of land and water resources. The rain water structures like, Percolation tank, Check Dam, Farm Ponds, Diversion drains are mostly recommended and overall position is shown in the Figure 3.

4.9 Action Plan for Land Conservation Measures

Keeping in view, the need for soil and moisture conservation, development of fodder and fuel wood, social forestry, silvipasture, afforestation, the following drought proofing works are recommended for implementation in Edulabad cheruvu watershed.

1. Vegetative barriers, contour bunding with plantation, stone checks.
2. Irrigation and water management and horticulture and specific planting on field bunds.
3. Groundwater development with conservation measures and horticulture nurseries development.
4. Silvipasture/fodder/fuel wood development in marginal lands.
5. Afforestation with contour trenches.

4.10 Quarrying Area Development

Some of the barren rocky areas are identified in the study area used for quarrying, provided suitable environmental production measures are taken. This would generate employment and income to the local people. Significant area covered under this category is shown in Figure 3.

5. Conclusion

The slope of the study area covers all types slope classes 1,2,3,4,5,6,7. Very gentle slope covers more than 80% of the area. Granite Gneisses is the predominant geological formation in this watershed area. Ground water prospects in agricultural area are moderate to poor. Barren rocky areas outside notified forest area are recommended for afforestation with cordon walls or quarrying with environmental protection measures. The major development of groundwater in the study area is to be planned by tapping the potential zones of pediplain with moderately weathering of granite genesis, of basalts by executing dug-cum-bore wells or bore wells. The waste lands or land with scrub normally associated with pediplain with shallow weathering, moderately thick lateritic plateaus may be developed by tapping groundwater by sinking bore wells and growing agricultural plantations, social forestry.

6. References

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