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RESEARCH ARTICLE

GEOSPATIAL ANALYSIS USING REMOTE SENSING AND GIS; A CASE STUDY IN AND AROUND RAYACHOTY, KADAPA DISTRICT, ANDHRA PRADESH, INDIA

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ABSTRACT

Geospatial analysis is used in a wide range of disciplines as a research tool, a decision-making tool, data analysis tool, and/or as a planning tool. Remote Sensing and Geographic Information Systems are used to predict, manage and learn about all kinds of phenomena affecting the earth, its systems and inhabitants. Land use/land cover (LULC) changes play a major role in the study of global change. In this study, Landuse/ Landcover changes are investigated by using of Remote Sensing and Geographical Information System (GIS) in and around Rayachoty, Kadapa District, Andhra Pradesh, India by using satellite image IRS- P6, LISS-III data. Under this study three thematic maps such as location map, drainage map and landuse/ landcover maps were prepared. The land use and land cover analysis on the study area has been attempted based on thematic mapping of the area consisting of built-up land, cultivated land, water bodies, forest land, barren land and uncultivated land using the satellite image. The result shows that the cultivated lands are well distributed throughout the study area and it covers 253.18 sq. km (35.61 per cent). Forest occupies 105.44 sq. km and sharing about 14.83 per cent of the total land use land cover of the study area. The built-up land occupies 3.98 sq. km (0.56 per cent) and there was a rapid expansion of built-up lands. Barren land occupies 156.13 sq. km (21.96 per cent). Water bodies and uncultivated lands occupy 5.19 sq. km (0.73 per cent) and 186.92 sq. km (26.29 per cent) respectively. About the annual rainfall data of six years from 2007 to 2013 shows that the significant decreases tend was observed graphically. Well developed dendritic drainage pattern is there in the study area. The spatial information of the surface will help in the optimal land use planning at the macro and micro level.

INTRODUCTION

Geospatial analysis originated in Canada for cataloging natural resources in the 1960s, using the first Geographical Information System (GIS). Geographic Information Systems are used to predict, manage and learn about all kinds of phenomena affecting the earth, its systems and inhabitants. Moreover, land use/ land cover inventories are assuming increasing importance in various resource sectors like agricultural planning, settlement surveys, environmental studies and operational planning (Kotoky, 2012). The modern technology of Remote Sensing includes both aerial as well as satellite based systems which collects physical data on repetitive basis with speed along with GIS helps us to analyze the data spatially generating various modeling, thereby optimizing the whole planning process. To make planning process effective and meaningful, these information systems offer interpretation of physical data with other socio-economic data (Ratanopad, 2006). Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Prakasam 2010 and Ruchar, 2011). Therefore, it is essential to know about the characteristics and capabilities of these Remote Sensing data products available to urban and regional planners (Kamal Kumar 20014). Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use/ land cover changes over large areas (Selcuk Reis, 2008). GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection (Wu, 2006). The Remote Sensing and Geospatial Analysis (RSGA) Section provides a variety of products and services using the tools and methodologies of digital image analysis (Remote Sensing) and Geographic Information Systems (GIS). The program includes operational agricultural and environmental applications, custom mapping, and satellite image analysis and geomatics services. These Remote Sensing and geostatistical products and services are available on a cost-recovery or fee-for-services basis. Landuse is influenced by economic, cultural, political, and historical and land – tenure factors at multiple scales. Land use referred to as man's activities and the various uses which are carried on land. Landcover is referred to as natural vegetation, water bodies, rock/soil, artificial cover and

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others resulting due to land transformation (Yadav, 2012). Since both landuse/ landcover are closely related and are not mutually exclusive they are interchange able as the former is inferred based on the land cover and on their contextual evidence (Manonmani, 2010 and Prakasam, 2010). Land-use and land-cover changes are local and place specific, occurring incrementally in ways that often escape our attention. Yet, collectively, they add up to one of the most important facets of global environmental change. This thematic guide provides an introduction to these changes, and walks the readers through important topics in land use and land cover change research: deforestation, desertification, biodiversity loss, land cover and the water cycle, land cover and the carbon cycle, and urbanization.

A total of three thematic maps such as location, drainage and land use and land cover maps were prepared based on image interpretation studies with limited checks. The land use-land cover pattern falls under the broad categories of built-up land, cultivated land, forest land, water bodies and uncultivated lands (Sreenivasulu, 2013). In this study area major natural resource is forest. Because of human activities the extent of the land under forest is getting reduced. In the same way land used for cultivation is also decreasing. But at the same time land under built up area is increasing. Recently the functioning of the real estates people and property promoters are bringing a serious disaster to forest area and agricultural land. This is an unhealthy situation of land management. In this context studies on land use land cover change detection are essential to understand the existing situation and plan for the future.

Study area

The study area lies between parallels of 78^0 35' to $78^0$50' E longitude and 14^0 to $14^0$15'N latitude with intended boundary falling in Survey of India toposheet no.57J12 and 57J16. The total area covered is approximately 711 square kilometers. The climatic conditions of this area as its minimum temperature in November-January at about 28-30^0 C. The hottest temperature ranges between the 40-45^0C ranges during April-May. There are extensive outcrops of limestones, Dolomites, Granite and Quartzites in major parts of the area, which could be utilised as building material. Rayachoty, Lakkireddipalli and Ramapuram are the mandal head quarters and Nallaguttapalli, Obulreddi palli, Konampeta, Saraswathi palli, Budidhakuntapalli, Chitluru, Reddivaripalli, Guntimadugu, Odividu, Sibyala, Eguvagottividu and Gannikuntla are the important villages in the study area

MATERIALS AND METHODS

The study has made use of various primary and secondary data. These includes Survey of India (SOI) topographic maps (57J12 and 57J16 of 1:50,000 scale) (Balachandar *et al.,* 2011) and IRS LISS – III geocoded data of 1: 50,000 imageries were subjected to a classification zones (Rahdary 2008 and Santhiya, 2010). The Indian Remote Sensing Satellite (IRS) data was visually and digitally interpreted by using the image interpretation elements (such as tone, texture, shape, pattern, association etc.) and ArcGIS software was used for processing, analysis and integration of spatial data to reach the objectives of the study. Visual image interpretation was utilized to classify the images to different land use categories (Yagoub, 2006). In order to classify the rectified images, six classes were delineated in the images namely, Cultivated/ Agricultural lands, Builtup lands, wetlands/ water bodies, uncultivated lands, Barren lands and Forest lands. The land use/ land cover map prepared for the study area. (Jayaraju, 2011 and Sreenivasulu, 2014). Adequate field checks were made before finalization of the thematic maps. The main goal of this study is to extract the land use/land cover changes and categories of the study area.

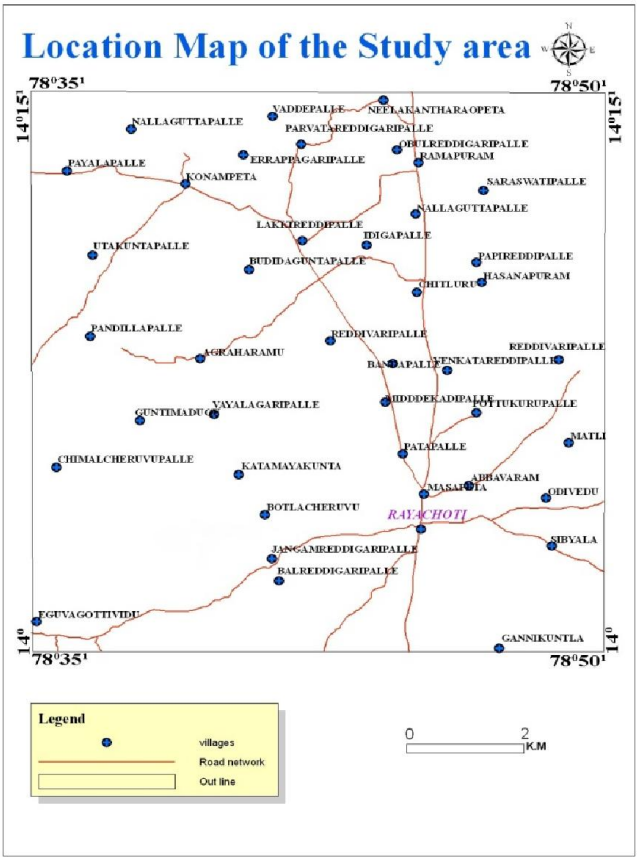

Figure 1. Location Map of the study area

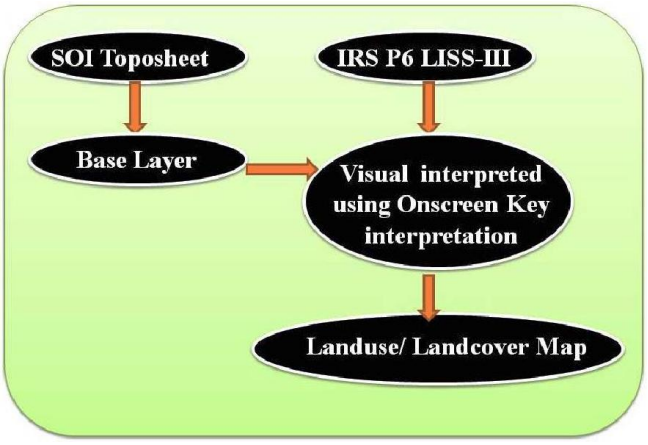

Figure 2. Cartographic Model of Methodology

RESULTS AND DISCUSSION

This section presents the results of the data analysis by first providing a brief synthesis of the descriptive statistics and geospatial analysis (GIS and Remote Sensing analysis) of the assessment.

1). Analysis of Landuse/ Landcover by using Remote Sensing Data

The land use/land cover categories of the study area were mapped using IRS P6, LISS-III data of 1:50,000 scale. The satellite data was visually interpreted and after making thorough field check, the map was finalized. The various land use and land cover classes interpreted in the study area include, built-up land, cultivated land, forest land, uncultivated lands, barren land and water bodies.

Detailed accounts of these land use /land cover classes of the study area are described in the following section.

Table 1. Land use Land Cover Classification of study area

S. No.	LU/ LC Category	Area in Sq. Km	Percentage (%)
1	Built-up land	3.98	0.56
2	Water bodies	5.19	0.73
3	Cultivated land	253.18	35.61
4	Barren land	156.13	21.96
5	Uncultivated land	186.92	26.29
6	Forest land	105.44	14.83

1.1). Builtup Land

The built-up land occupies 3.98 sq. km (0.56 per cent) and there was a rapid expansion of built-up lands. Built up land is composed of areas of intensive with much of the land covered by structures. Included in this category are cities, towns, villages, industrial and commercial complexes and institutions. In the study area major towns or villages are Rayachoti, Ramapuram, Lakkireddypalli, Odivedu etc. The transportation facilities in the study area are roads. The highway roads are present in the area are routes between, Rayachoti- Kadapa, Vempalli- Rayachoti, Kadapa- Banglore.

1.2). Water bodies

Both man-made and natural water features are included in this category; they are rivers, streams, lakes, tanks and reservoirs. The deep water features appear in black tone in the satellite imagery. The shallow water and deep water feature appear in light blue to dark blue in colour. The numerous major and minor tanks, lakes and canals are identified. The lakes and tanks were found in the eastern part of the study area such as Banaganapalli, Reddivaripalli, Hasanapuram, Masapet and Idigapalle blocks. The water bodies share about 5.19 sq.km (0.73 per cent) of the total study area.

1.3). Cultivated land

All the cultivated land with or without crops orchards and plantations are considered in this class. These lands are well distributed throughout the study area and it covers 253.18 sq. km (35.61 per cent). This land use class is further subdivided into two sub-classes they are wet land (crop land) and dry land (fallow land). Crop lands are the agricultural lands under crop. In the study area the crop lands have wet cultivation and dry cultivation. Wet cultivation includes food crops were noticed in Patapalli, Matli, Gannikuntla and Neelakantarau pet. Dry cultivation includes trees orchards, groundnut, etc and the areas which have this type of cultivation is noticed at Lakkireddy palli. Obulreddy gari palli, Reddivari palle, Patapalle, Rayachoti, Sibyala, Papireddipalli, Nallaguttapalli..etc.

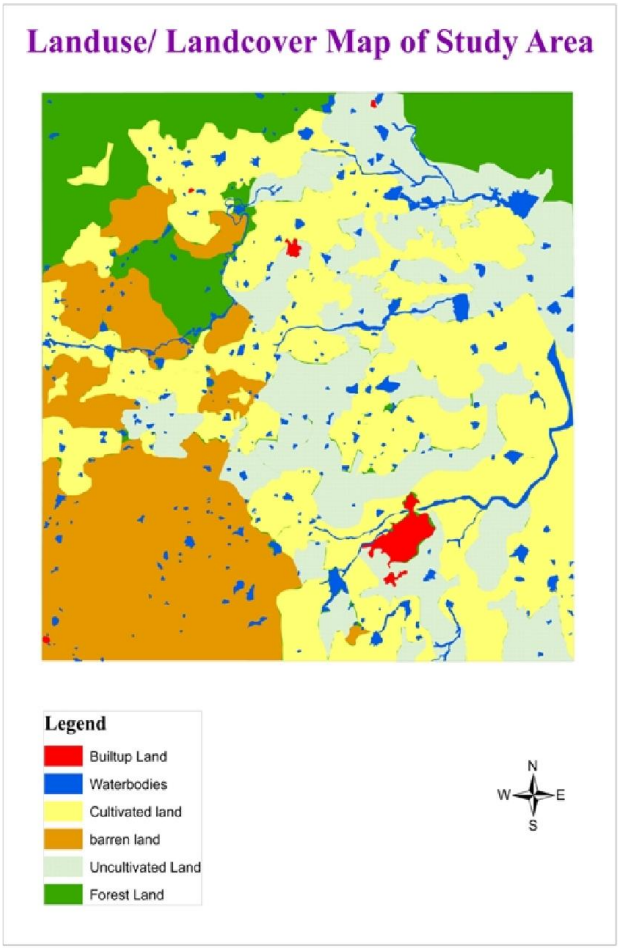

Figure 3. Landuse and Land cover map of the study area

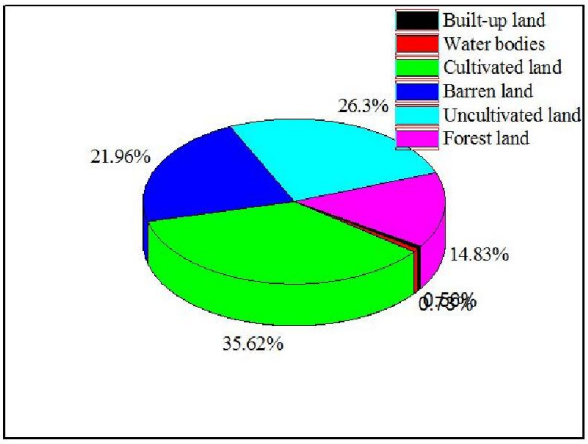

Figure 4. Pie diagram of Landuse Land cover

Table 2. Mandal wise Annual rain fall data of study area

Year	Mandals					
	Rayachoty		Lakkireddipalli		Ramapuram	
	Normal	Actual	Normal	Actual	Normal	Actual
2007-08	605.0	1162.2	660.0	807.5	606.0	756
2008-09	605.0	780.4	660.0	611.4	606.0	444.7
2009-10	605.0	669.8	660.0	703.6	606.0	563.2
2010-11	607	908.2	660	905	606	863.4
2011-12	591	496.8	660	507	706	673.4
2012-13	600.1	667.2	656.3	526	586.2	538.2

1.4). Barren Land

Barren land occupies 156.13 sq. km (21.96 per cent). It covers all lands which are uncultivable like mountains, deserts, bare exposed rock, strip mines, gravel pits and quarries. The areas which comprise barren lands are surrounded by villages Katimayakunta, Guntimadugu, Botla cheruvu, Balreddygari palli and Eguvagottividu in the South Western part of the study area.

1.5). Uncultivated Land

Land, which does not support any vegetation are known as uncultivated lands or waste lands. Uncultivated land occupies 186.92 sq. km and sharing about 26.29 per cent of the total land use land cover of the study area. Barren rocky, salt affected land, land with and without scrub, sandy area, sheet rocks and stony regions include in this category. Such lands are formed due to the chemical and physical properties of soil, temperature, rainfall and local environmental conditions. In the study area uncultivated lands are present in the south east part.

1.6). Forest Land

Forest, comprises of thick and dense canopy of trees. These lands are identified by their red to dark red tone and varying in size. They are irregular in shape with smooth texture. The forests are found on the North Western part of the study area. The study area covers mostly the dense and scrub forest. The relative concentration of scrubs, bushes and smaller trees are predominant in this category. In the satellite image such forest are identified by yellow tone with smooth texture. Forest occupies 105.44 sq. km and sharing about 14.83 per cent of the total land use land cover of the study area.

2). Annual Rainfall Analysis

Annual rainfall data of six years shows that the actual rainfall was greater than the normal in the year of 2010-11 and it was the highest record of the annual rain fall in the study area of three mandals. In 2007-08 1162.2 mm (Normal: 605.0 mm) was recorded in Rayachoti mandal it was the highest rain fall record in this study. 507 mm (Normal: 660 mm) was the lowest rain fall record at Lakkireddipalli Mandal in the year of 2011-12. Significant decrease trend was observed graphically in the rainfall from the year 2007-2013.

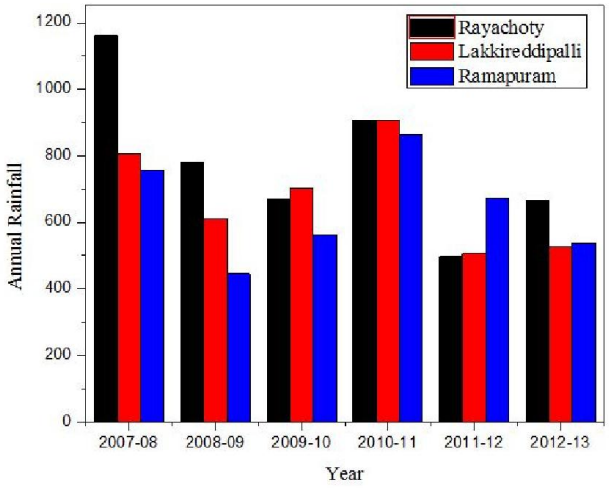

Figure 5. Graphical Representation of Annual rainfall

3). Drainage Analysis

The arrangement of streams in a drainage system constitutes the drainage pattern, which in turn reflects mainly structural/ or lithologic controls of the underlying rocks. The area of study encompasses a miscellany of drainage patterns; however, dendritic drainage pattern is the most dominant type and occupies more than 95% of the area. Even though, difference in stream lengths and angle of connection, yet they are in general characterized by a tree like branching system, which is a dendritic drainage pattern that indicates homogenous and uniform soil and rocks. Radial drainage patterns also exist in the study area. They appear either as one-set or two-sets of Radial drainage patterns are develop surrounding areas of high topography where elevation drops from a central high area to surrounding low areas.

3.1). Stream order (U)

Stream order is a method for classifying the relative location of a reach (a stream segment) within the river basin. Stream order 1 has one connected edge, and then at the confluence of two1st -order streams assigns the downstream reach of order 2, and so on for the rest orders. In the study area has 5-stream orders, and thus a map was obtained using GIS system. In addition, the used GIS system enabled calculating the number of reaches in each order.

Table 3. Stream orders and number of streams

S.No.	Stream orders	Stream number
1	First order	763
2	Second order	355
3	Third order	152
4	Fourth order	52
5	Fifth Order	12

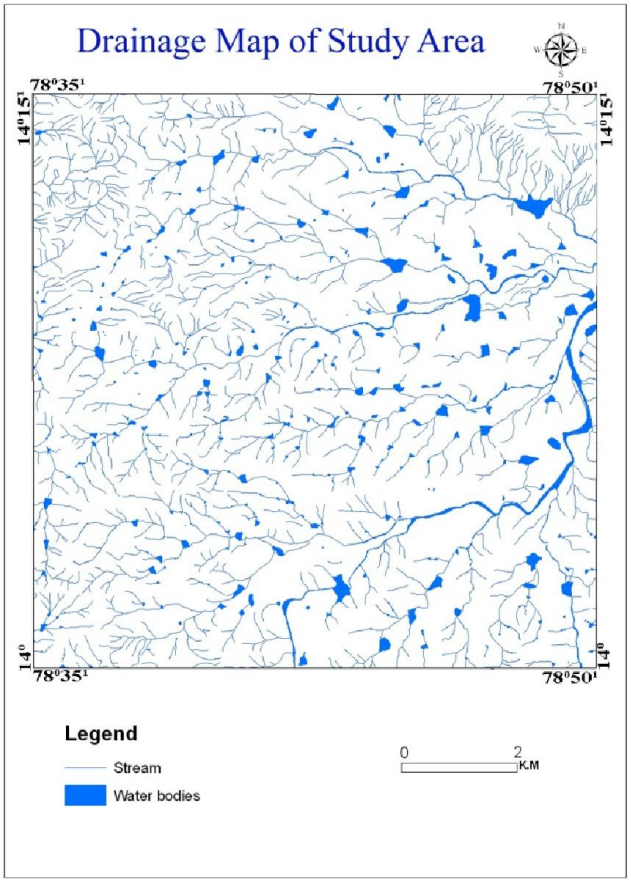

Figure 6. Drainage map of the study area

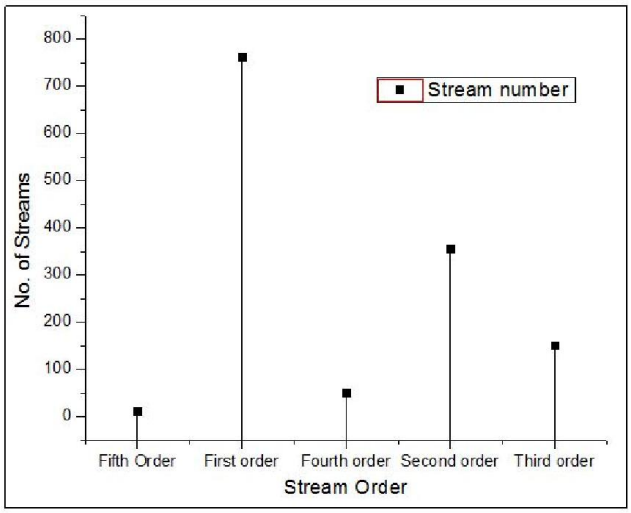

Figure 7. Graphical representation of stream orders

3.2). Stream Number (NU)

The count of stream channel in its order is known as stream number. The number of streams decreases as the demarcated watershed has the following stream orders and stream number. In the study area four stream orders have been calculated. In the study area 763 first order streams, 355 second order streams, 152 third order streams, 52 fourth order streams and 12 fifth order streams were calculated.

Conclusion

The study has classified as per the major land use/land cover types**.** The Indian Remote Sensing Satellite (IRS) data, image processing and Geographical Information System techniques were used to identify the land use categories such as built-up lands, cultivated lands, forest lands, water bodies, Barren lands and uncultivated lands. Satellite images in combination with predated topographic sheet of Survey of India were used for analyzing land use and land cover analysis. It is helpful for further macro and micro level planning. With the help of Geographic Information System the various land use and land cover zones are mapped, which in turn helps for decision maker for planning purpose. The result shows that the cultivated lands are well distributed throughout the study area and it covers 253.18 sq. km (35.61 per cent). Forest occupies 105.44 sq. km and sharing about 14.83 per cent of the total land use land cover of the study area. The built-up land occupies 3.98 sq. km (0.56 per cent) and there was a rapid expansion of built-up lands. Barren land occupies 156.13 sq. km (21.96 per cent). Water bodies and uncultivated lands occupy 5.19 sq. km (0.73 per cent) and 186.92 sq. km (26.29 per cent) respectively. About the annual rainfall data of six years from 2007 to 2013 shows that the significant decreases tend was observed graphically. Well developed dendritic drainage pattern is there in the study area. The spatial information of the surface will help in the optimal land use planning at the macro and micro level.

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