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Landuse and Landcover analysis using Remote Sensing and GIS: A case study in and around Rajampet, Kadapa District, Andhra Pradesh, India

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Abstract
Land use/ land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to monitor and detect the changes to maintain a sustainable environment. Land use/ land cover change study is very important aspect of the natural resources data base study. The knowledge of land use and land cover is important for many planning and management activities as it is considered as an essential element for modeling and understanding the earth's features. The present study aims to find out the land use/land cover features of in and around Rajampet of Kadapa District, Andhra Pradesh, India. The total area of the region is 316.88 sq.km. The study has made use of high resolution IRS LISS III satellite imagery for identifying the land use/land cover classes. ERDAS and ArcGIS software were used to demarcate the land use/land cover features of study area. Remote sensing and GIS provide consistent and accurate base line information than many of the conventional surveys employed for such a task. The land use and land cover analysis in and around Rajampeta area has been attempted based on thematic mapping of the area consisting of built-up land, agriculture land, water bodies, forest and waste land using the satellite image. The research concludes that there is a rapid expansion of built-up area. In the study area the major part is occupied by the cultivated land. Land use and land cover information, when used along with information on other natural resources, like water, soil, hydro-geomorphology, etc. will help in the optimal land use planning at the macro and micro level.

Keywords: Land use and Land cover, Remote Sensing and GIS Techniques, Rajampet, Satellite images.

1. Introduction
Studies have shown that there remain only few landscapes on the Earth that is still in their natural state. Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and man's presence on the Earth and his use of land has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use/land cover over time. Land use/ land cover studies have got a renewed emphasis as the process of agricultural use of land has been in a flux in the wake of fast changing national economy under the new global order. Land use refers the purpose of the land serves, for example, recreation, wild life habitat, agriculture. Land use is a product of interaction between a society's cultural background, state and its physical needs on the one hand and the natural potential of land on the other hand (Baalak Ram and Kolarkar, 1993). According to Longley (2001), "land cover refer to the physical materials on the surface of a given parcel of land, while land use refer to the human activities that takes place on or make use of land e.g. residential, commercial, industrial etc." An urban centre is a collection of houses of non-agricultural people where various uses of land are found on account of the forces of attraction and integration, the forces of dispersion and disintegration and the forces of spatial differentiation (Dickinson, 1964). Urban land use deals with the problem emerging in urban centres in the process of selecting and translating into action, the optimum utilization of limited land between shopping centres and residential areas (ManDul, 2000). Long term understanding on land use and land cover need to propose a more dynamic framework that explicitly links what is often divided into separate natural and human systems into a more integrated model Land use and land cover change have been recognized as important drivers of global environment change. Land use is influenced by economic, cultural, political, historical and land-tenure factors at multiple scales. Land cover, on the other hand, is one of the many biophysical attributes of the land that affect how ecosystems function. Knowledge of the nature of land use and land cover change and their configuration across spatial and temporal scales is consequently indispensable for sustainable environmental management and development (Turner *et al* 1995).

Urban landscapes are exemplified by the large concentration of population and fast expansion of urban zones which lead to alteration in the land use and land cover configuration that consequently impacts the landscape environment (Long *et al.*, 2008). Land transformation is one of the most important fields of human induced envir. In developing countries like India, scenario are likely land use and land cover are often semantically Land use and land cover is dynamic in nature and is an important factor for the comprehension of the interaction and relationship of anthropogenic activities with the environment. onmental transformations, with an extensive history dating back to antiquity. Alteration is nearly inseparable from human occupation and use, and the goal is to encourage degradation. The degradation of water bodies are largely attributed to extensive agricultural reclamation, resulting in negative ecological consequences such as frequent floods, a decline in biodiversity and the extinction of a number of endemic species.

The land use/land cover pattern of a region is an outcome of natural and socio – economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/ land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population.

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use land cover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources has become an important priority.

Viewing the Earth from space is now crucial to the understanding of the influence of man's activities on his natural resource base over time. In situations of rapid and often unrecorded land use change, observations of the earth from space provide objective information of human utilization of the landscape. Over the past years, data from Earth sensing satellites has become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change.

Studies have utilized remote sensed data to examine urban land changes in modern times with conclusions showing varying degree of different patterns of urban expansion and development in which could be associated with specific environmental factors (Long *et al.*, 2008). Land use planning is basically concerned with the location, intensity and amount of land development required for various uses of space, functioning of the city, e.g., industry, wholesaling, business, housing, recreation, education, religious, and cultural activities of the people (Chapin, 1957, XIV). Land use applications involve both baseline mapping and subsequent monitoring. Since, the timely information is required to know the current quantity of land which is in use and to identify the land changes from year to year (Kumaraswamy and Narayanakumar, 2005). Detection of long term changes in land cover may reveal an idea for the shift in local or regional climatic conditions and analyzing the basis of terrestrial global monitoring (Navalgund, R.R., *et al*., 2007). Land use and land cover mapping serves as a basic inventory of land resource for all levels of government, environmental agencies and private industries throughout the world (Vijith and Satheesh, 2007). Change detection in land use and land cover can be performed on a temporal scale such as a decade to access landscape change caused due to anthropogenic activities on the land (Gibson and Power, 2000). Change detection in the land use/ land cover involves use of at least two period data sets (Jenson, 1986). Change detected by post classification comparison is the most commonly used quantitative methods.

Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity.

The present study describes the various land use/land cover changes and categories of the study area. The present study has been taken up in order to understand the changes that have taken place in land use/land cover in southern parts of Kadapa district. This area is known for extensive agricultural activity in recent times. It is believed that this aggressive human activity might have influenced on the land use/land cover patterns resulting in a possible impact on the environment. This work is taken up to better understand this aspect.

1.1 Objectives:

- To prepare thematic maps using satellite imageries.
- To interpret various features on the study area.
- To extract the land use/land cover changes and categories of the study area.

1.2 Study Area:

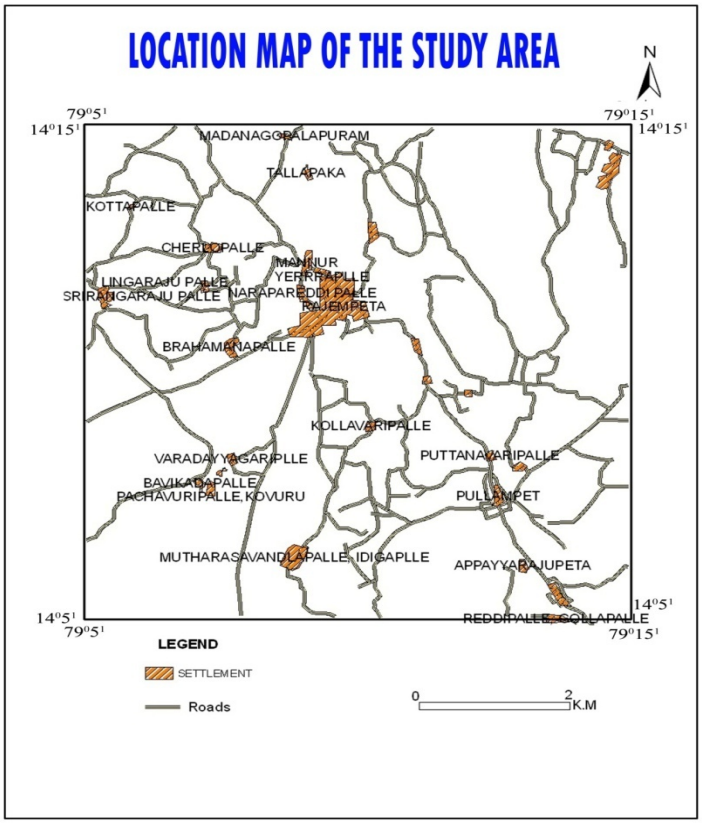

Fig 1: Location map of the study area

The study area lies between parallels of $79^0$05' to $79^0$15'E longitude and 14^0 05' to $14^0$15'N latitude with intended boundary falling in Survey of India toposheet No.57N04. The total area covered is approximately 316 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 ^{0}C ranges during April-May. There are extensive outcrops of shales, limestones, Dolomites, Granite and Quartzites in major parts of the area, which could be utilised as building material. The major minerals in the study area are white clay and iron ore. Rajampeta, Pullampeta, Obulavaripalli and Nandaluru are the mandal headquarters and Tallapaka, Hastavaram, Reddipalli, Poli, Anantasamudram, Cherlopalli, Hatyarala, Utukuru, Brahmanapalli, Varadaayagaripalli, Bavikadapalli, Mutharasaavandalapalli, Idigapalli, Appayarajupeta, Kovvuru, Kothapalli and Madaanagopalapuram are the important villages in the study area.

2. Materials and methods

For the purpose of study of land use/land cover ARC GIS 9.2 and ERDAS IMAGINE 9.1 are powerful tools for extracting the land use, land cover layers, from SOI toposheets and satellite imageries. The land use/land cover classes include agriculture land, aquaculture tanks, settlements, rivers, drains, mangroves, mud flats etc. This classification and methodology is performed based on the standard methodology. Later Change Detection methodology was done for the images to find out the changes that have taken place in the study area using ERDAS IMAGINE 9.1. The feature classes were identified based on the visual interpretation of the satellite imagery coupled with filed checks. These datasets were digitized and analyzed to obtain land use/land cover statistics for the areas under each of these categories.

The study has made use of various primary and secondary data. These include Survey of India (SOI) topographic sheets of 57N04 of 1:50,000 scale and satellite image IRS LISS III geocoded data of 1:50,000 scale for the year 2005. 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 Arc GIS software was used for processing, analysis and integration of spatial data to reach the objectives of the study. 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.

3. Results & Discussion

3.1 Analysis of Landuse / Landcover by using Remote Sensing data

Change detection is an important application of Remote Sensing technology. This gives us the changes of specific features within a certain time interval. For a given research purpose, when the remotely sensed data and study areas are indentified, selection of an appropriate change detection method has considerable significance in producing a high-quality change detection product.

The land use/land cover categories of the study area were mapped using IRS 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, Forest land, built-up land, uncultivated land, cultivated land, rivers, water bodies.

Table 1: Land use land cover classification system

S. No.	LU/LC Category	Area in sq. km	Percentage Of the area (%)
1.	Built-up land	10.91	3.1
2.	Cultivated land	90.11	25.6
3.	Forest land	84.38	23.9
4.	Water bodies	13.38	3.8
5.	Uncultivated land	59.23	16.83
6.	Rivers	4.56	1.26

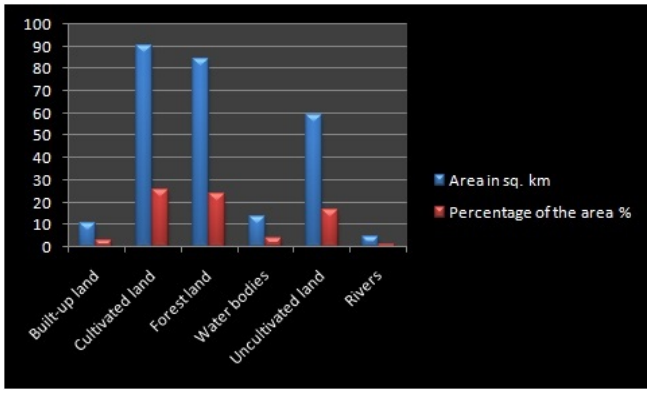

Fig 2: Land use land cover categories

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

3.2 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 south west and north east parts of the study area. The total area under this category is about 84.38 sq. km (23.9 percent). 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 green tone with smooth texture. The forest areas are Seshachalam Extension Reserved forest, Chitveli Extension Reserved forest, Venkatampalle Reserved forest, Vattaluru Reserved forest, etc.

3.3 Land with Scrub

These lands are subject to degradation, erosion or thorny bushes. Such areas are identified from their yellowish tone and their association with uplands, and their irregular shapes. Land with scrub found in the western part of the study area.

3.4 Built up Land

Built up land is composed of areas of intensive with much of the land covered by structures and it covers an area of 10.91 sq. km (3.1 per cent). Included in this category are cities, towns, villages, industrial and commercial complexes and institutions. In the study area major towns or villages are Rajampeta, Mannuru, Yerrapalle, HastavaramTallapaka, Chakrampeta, Utukuru, Pullampeta, Reddipalli, Poli, Kovvuru, Ramapuram, Venkatampalli etc. The transportation facilities in the study area are roads and railway line. The highway roads are present in the area are routes between, Tirupati- Kadapa, Rajampeta- Rayachoti. The railway line is present between Kadapa- Tirupati. The industrial mining of clay, Iran ore and some other building stones is carried out at some places in the study area

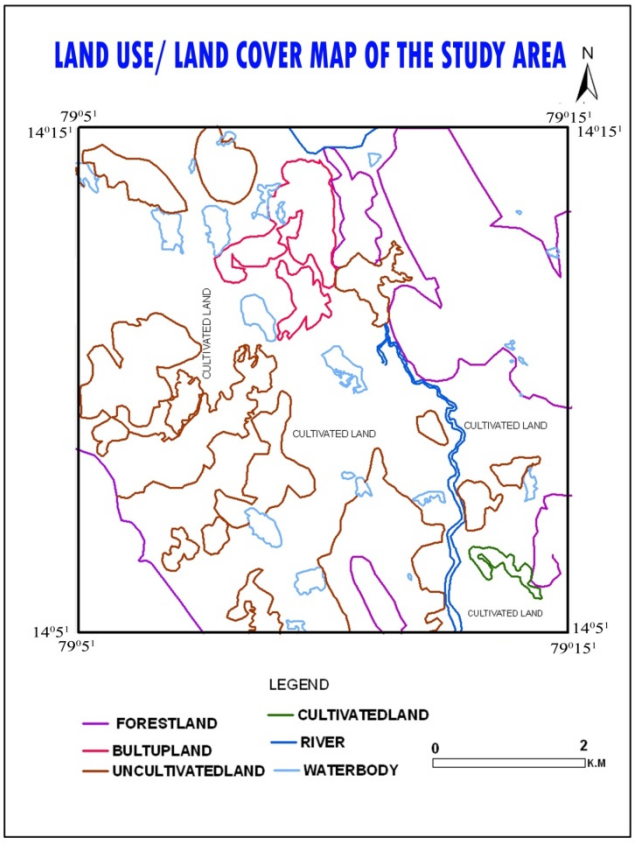

Fig 3: Land use/ Land cover map of the study area

3.5 Uncultivated Land

Land, which does not support any vegetation are known as uncultivated lands or waste lands. 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. It occupies an area of 59.23 sq. km (16.83 per cent) in the study area and is present in the south west part.

3.6 Cultivated Land

All the cultivated land with or without crops orchards and plantations are considered in this class. Total cultivated land in the study area occupies 90.11 sq. km (25.6 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 such as Rice, paddy, wheat, etc. were present in Rajampeta, Tallapaka, Veddepalli, Kovvuru, Pullampeta, Venkatarayunipeta, Brahmanapalli. Dry cultivation includes trees orchards, groundnut, etc and the areas which have this type of cultivation is noticed at Appayarajupeta, Kottalapalli, Lakshmipalle, Bavikadapalli, Balreddipalli etc.

Fallow lands refer to all land which was taken up for cultivation but is temporarily out of cultivation for a particular period. The study area have more fallow lands and are surrounded by the villages of Tangedupalli, Giddankipalli, Alavallapadu, Busireddipalli, Nandimandalam, Etc.

3.7 Water bodies

The water bodies include both natural and man-made water features namely Streams, lakes, canals, tanks and reservoirs. The water features appear black in tone in the satellite image. The shallow water and deep water features appear in light blue to dark blue in color. Tanks with plantation are identified by the square/rectangle shape and red color tone. Tanks without plantation are recognized by the shape and light blue to dark blue tone. Embankments are noticed in Poli, Yellareddi palli, Cherlopalli, Choppavaripalli, Pullareddipalli, Thimmareddipalli, Thummala Agraharam, Chinna Vengannagaripalli, etc. Small canals are noticed in the vegetation area. Tanks are mostly concentrated in the middle part of the study area with few dry tanks scattered around in the northern parts.

3.8 Drainage System

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 treelike 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.

Table 2: Stream orders and Number of streams

S. No.	Stream orders	Stream number
1	First order	343
2	Second order	66
3	Third order	9
4	Fourth order	5

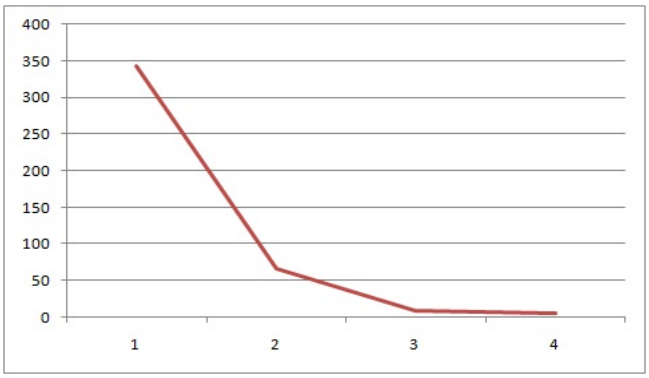

Fig 4: Graphical representation of stream order

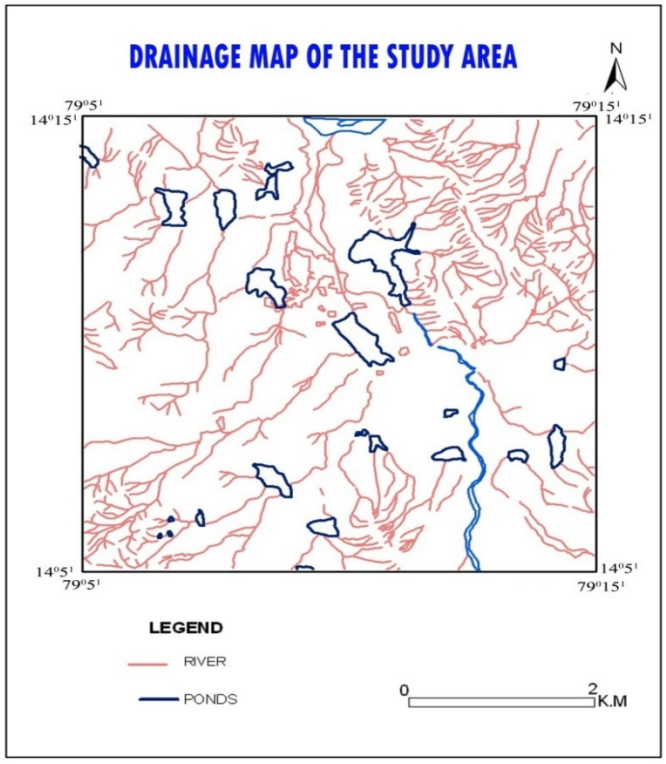

Fig 5: Drainage map of the study area

3.9 Stream Order (U)

Stream order is a method for classifying the relative location of a reach (a stream segment) within the river basin. The applied method followed the procedure that modified by Stahler [12]. 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 4-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.

3.10 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 343 first order streams, 66 second order streams, 9 third order streams and 5 fourth order streams were calculated.

4. Conclusions

Satellite Remote Sensing has proved to be a vital tool for continuous observation and quantification of environmental phenomena across varied spatial and temporal scales which are otherwise not possible to attempt through conventional mapping techniques. Analysis of the maps reveals that there is a fast shrinkage of water bodies and marshy areas and the town is witnessing rapid transformation of land from agriculture to residential, water bodies into marshy and marshy into either residential or agriculture. Urbanization may affect the local climate through its influence on the surface roughness. It may also create a local climate substantially warmer than the surrounding area by the heat released by densely populated human settlements, by change in evaporation characteristics and by modifying the outgoing long wave radiation. The influence on regional climate may be noticeable but small. It may however have a significant influence on long instrumental temperature records from stations affected by expanding urbanization.

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 forest land, built-up land, uncultivated land, cultivated land, rivers and water bodies. Satellite images in combination with predated topographic sheet of Survey of India were used for analyzing land use and land cover change detection. 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 cultivated lands are well distributed throughout the study area and it covers 90.11 sq. km (25.60 per cent). Forest occupies 84.38 sq. km and sharing about 23.90 per cent of the total land use land cover of the study area. Uncultivated land occupies 59.23 sq. km (16.83 per cent). A water bodies occupy 13.38 sq. km (3.80 per cent). The built-up land occupies 10.91 sq. km (3.10 per cent) and there was a rapid expansion of built-up lands. Rivers occupies 4.56 sq. km (1.29 per cent) but well developed dendritic drainage pattern is there in the study area

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