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# Land use and land cover analysis using remote sensing and GIS: A case study in Kunavaram Mandal east Godavari district Andhra Pradesh

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**Abstract**
Digital change detection techniques based on multi-temporal and multispectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics- detect, identify, map and monitor differences in land use and land cover patterns over period of time, irrespective of the causal factors (Jensen, J.R. 1996). Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past. GIS has enormous possible as an environment for the conception of dynamic models of physical environmental processes. Identifying the land use land cover classification of the Kunavaram watershed has be done through the remote sensing data, with the help of GIS software. Final output maps of the cropping pattern and crop concentration was done through the GIS. The present look at illustrates the dynamics of Land use/cover of Kunavaram Mandal, East godavari District, Andhra Pradesh India. IRS - 1C PAN and LISS III merged data) of 2005 and 2012have been obtained via Global Land Cover Facility Site (GLCF) and earth explorer website and quantify the changes in the years 2005-2006 to 20011-12 over a length of 8 years. Supervised type method has been employed using most chance techniques in ERDAS imagine. The images of the area have been categorized into five exceptional classes, specifically Agriculture Cropland, Wastelands, Forest, built-up and Water bodies. The outcomes indicate that over the past 8 years, Forest Land have been changed by -0.29% while agriculture, water body, built-up, Wastelands have decreased by 0.24%, 0.017% and 0.025%0.003 % respectively.

**Keywords:** LU/LC, remote sensing, GIS techniques, ERDAS, change detection

## Introduction
Land use/land cover is one of a kind technology which might be regularly used interchangeably (J.S Rawat *et al*., 2015). Land cover refers to the physical characterstics of the Earth's surface, captured the distribution of plant life, water, soil and other physical features of the land, along with the ones created merely via human sports e.g., settlements. While land-use refers to the way in which land has been utilized by human beings and their habitat, usually with the accessory on the useful function of the land for economic activities. The landuse/cover sample of a vicinity is a final results of natural and socio-economic factors and their utilization by means of man in time and area. Land use/cover ensuing the needs of growing urbanization and consequences to increasing of population in present years. Changes in land cover by land use do not always imply degradation of the land. Land use/cover change detection is very essential for better understanding of landscape dynamic during a known period of time having sustainable management. Land use/cover changes is a widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities, which in turn drive changes that would impact natural ecosystems (Ruiz-Luna *et al*, 2003; Turner and Ruscher, 2004) [5, 6] Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement. Today, earth resource satellite data are very applicable and useful for land use/cover change detection studies (Yuan *et al*., 2005; Brondizio *et al*., 1994) [7, 4]. Remote Sensing (RS) and GIS techniques are being widely used to assess natural resources and monitor environmental changes. It is possible to analyse land use/land cover change dynamics using remotely sensed data and linking it with socio-economic or bio-physical data using GIS. The incorporation of RS can help analyzing this kind of research in variety of ways like land cover mapping, detecting and monitoring land cover change over time, identifying land use attributes and land cover change hot spots etc. (Lambin. E.F 2001). With the advancement of technology, reduction in data cost, availability of historic spatio-temporal data and high resolution satellite images, RS techniques are now very useful for conducting researches like land cover change detection analysis (Das. T. 2009).

## Study Area
Kunavaram is located in East Godavari District of Andhra Pradesh. The Kunavaram watershed is situated it lies between 17°35'21.12° and 17°33'38.67°N latitude and 81°16'7.95° and 81°14'20.48°E longitude and the total Study area is 6133.35 ha.

**Location map of study area**

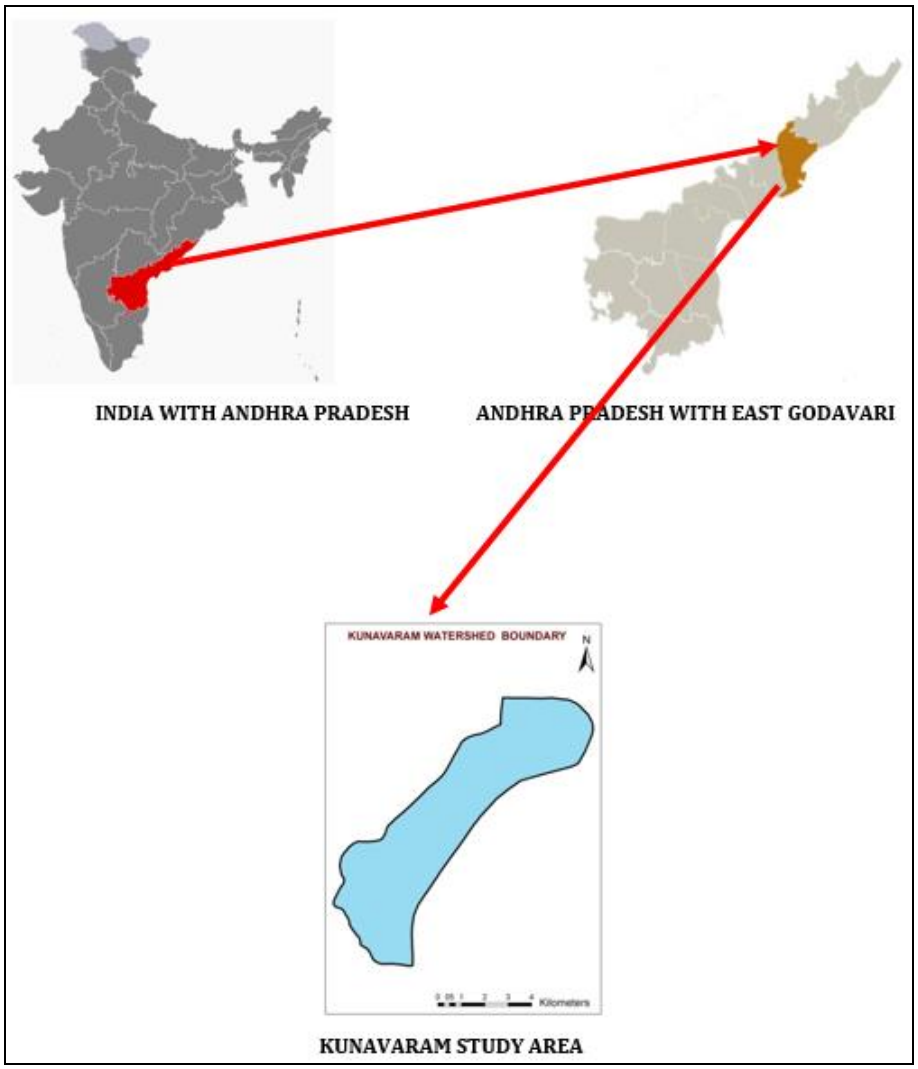


**Fig 1**

**Data source and methodology**

The Kunavaram Watershed study area data source of Telangana State Remote sensing Application Centre (TRAC) Hyderabad telangana. The present framework of land use/land cover classification system has been primarily developed for use with remote sensing data to meet the basic information need on land use for agricultural planning. The land use/land cover classification system amenable for use with remote sensing data developed by the National Remote Sensing Centre (NRSC) and modified on the suggestions made by the planning commission of India has been adopted in the present study. The present classification system is carried out with the help of IRS-1C PAN and LISS-III merged data integrated with Survey of India top sheets on 1:50,000 scale using ERDAS-9.3 version software package for interpretation of various land use/land cover classes. Survey of India (SOI) topographical sheets and normal false colour composites (FCC) of IRS-1C PAN and LISS-III merged data dated 2005-06 and 2011-12 were used for the study. Preliminary information about the geology of this area was collected, through literature review which served the basis for carrying out pre field interpretation and post field interpretation. The satellite data was visually interpreted using the elements like shape, size, pattern, tone/colour, texture, association etc., and terrain elements like topography, drainage, vegetation and land use pattern etc., created in using Arc GIS 10.2 version package.

**Land use/land cover change detection and analysis**

The land use/cover classification, supervised classification method with maximum likelihood algorithm was applied in the ERDAS Imagine Software. Supervised classification methods used with remote sensing image data. This method is based on the prospect that a pixel belongs to a particular class. The basic theory assumes that these probabilities are equivalent for all classes and that the input bands have normal distributions. However, this method needs long time of computation, relies heavily on a usual distribution of the data in each input band and tends to classify signatures. Based on the signature classification five land use/cover types are identified in the study area viz., (i) Agricultural land (ii) Built-up land (iii) Wastelands (iv) Water bodies (v) Forest.

For performing land use/cover change detection, a post-

classification detection method was employed. A pixel-based comparison was used to produce change information on pixel basis and thus, interpret the changes more efficiently taking the advantage of from, to information. Classified image pairs of one different decade data were compared using cross-tabulation in order to determine qualitative and quantitative aspects of the changes for the periods from 2005 to 2012. A change matrix (Weng, 2001) was produced with the help of ERDAS Imagine software. Quantitative areal data of the overall land use/cover changes as well as gains and losses in each category between 2005 and 2012 were then compiled.

**Analysis of land use/land cover by using remote sensing data**

Change detection is an important application of remote sensing technology. This gives us the changes of detailed features within a certain time gap. For a given research purpose, when the remotely sensed data and study areas are recognized, the 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-1C PAN and LISS-III at a resolution of 23.6m of 2005 and 2012 were used for land use/cover classification. The satellite data was visually interpreted and after making a thorough field check, the map was finalized. The various land use and land cover classes interpreted in the study area include agriculture land, built-up land, waste land, Forest and water bodies. The change detection of the study area diagrammatically illustrated in Figs: 2& 3 and data are registered in Table-1.

**Agriculture Land**

The several components of Cropland now used for agricultural statistics include: cropland harvested, including bush fruits, cultivated summer fallow and idle cropland; land on which crop failure occurs; cropland in soil- improvement grasses and legumes; cropland used only for pasture in rotation with crops; and more or less permanently used for that purpose (Hardy, Belcher and Phillips, 1971). In the year 2005-2006 The total extent of agricultural lands occupies an area of 3721.05 hectares in Kunavaram watershed. Crop land is the major Land use/Land cover category which is sparsely distributed in the villages of watershed. The percentage of lands occupied by crop lands accounts for 60.6 percent to the total geographical area of watershed. Where as in the year 2011-2012, crop land is 3705.9 hectare. The percentage of lands occupied by crop lands accounts for 60.4 percent to the total geographical area of Kunavaram watershed. In the year of 2011-12 the agricultural crop land is decreased 0.02 percent when compare to 2005-06 in the study area.

**Wastelands**

Waste lands are described as "degraded lands which can be brought under vegetative cover with reasonable effort, and which are currently underutilized. These are the lands deteriorating due to lack of appropriate water and soil management or on account of natural causes. Waste lands can result from inherent/imposed disabilities such as by location, environment, chemical and physical properties of the soil or financial or management constraints (NRSC, 1997). Waste lands spread in a large area in the Kunavaram watershed. In the year 2005-2006 the total extent of waste lands occupy 661.14hectares which accounts for 10.7 percent to the total geographical area of watershed where as in the year 2011-2012 waste land is 660.9 hectare. The percentage of lands occupied by waste lands accounts for 10.8 percent to the total geographical area of watershed. In the year of 2011-12 the forest land is decreased 0.003 percent when compare to 2005-06 in the study area.

**Built up Land**

Kunavaram watershed is accessible by nearest Rail, Road and Air. The nearest railway station to Kunavaram is Bhadrachalam Road which is located in and around 39.6 kilometer distance. Kunavaram nearest airport is Rajahmundry Airport situated at 79.3 K.m distance. The nearest district headquarters is eluru situated at 96.3K.m distance from Kunavaram. Kunavaram nearest town is Bhadrachalam located at the distance of 38.9 Km. Surrounding towns from Kunavaram are Serapaka, Ramachandrapuram and Rampacodavaram. The Built-up lands found in the Kunavaram watershed are settlements and transportation lines are roads. All the settlement in Kunavaram watershed are Tribal settlements in the year 2005-2006 The total extent of Built-up land occupied in the area is 102.28 hectares which accounts for 1.7 percent to the total geographical area of the watershed. Where as in the year 2011-2012 Built-up land is 100.7 hectare. The percentage of lands occupied by Built-up lands accounts for 1.6 percent to the total geographical area of Built-up land. In the year of 2011-12 the Built-up land is decreased 0.02 percent when compare to 2005-06 in the study area.

**Water Bodies**

The water bodies contain both natural and artificial water features, namely streams, lakes, canals, tanks and reservoirs. The water features show black in tone in the satellite image. The shallow water and deep water features show in light blue to dark blue in color. Tanks with plantation are recognized by the square/rectangle shape and blue color tone. Small canals are identified in the vegetation area. In the year 2005-2006 the total extent of water bodies occupied in the area is 235.06 hectares which accounts for 3.8 percent to the total geographical area of the watershed. Where as in the year 2011-2012 waste land is 234 hectare. The percentage of lands occupied by waste lands accounts for 3.8 percent to the total geographical area of water bodies. In the year of 2011-12 the water bodies land is decreased 0.01 percent when compare to 2005-06 in the study area.

**Forest Lands**

A forest is referred to as a wood or the woods, is an area with a high density of trees. As with cities, depending on various cultural definitions, what is considered a forest may vary significantly in size and have different classifications according to how and of what the forest is composed (Lund, H. Gyde coord 2006). In Level II classification, Forest Land is divided into three categories: Deciduous, Evergreen and Mixed. To differentiate these three categories effectively, sequential data or at least data acquired during the period

when deciduous trees are bare. In this land use land cover study is concentrate only on level I classification, the study area is partly covered by the Kunvaram watershed Forest area is known as Rapaka R.F, Sitaramapuram R.F. The forest lands identified from the satellite data are categorized into degraded forests and scrub forests as shown in figure 6.3. The forest lands occupy a large area because of the Manchalamma gutta ranges present in the western margin of Kunavaram watershed. In the year 2005-2006 the total extent of forest lands occupy 1413.86 hectares which accounts for 23.05 percent to the total geographical area of watershed where as in the year 2011-2012 forest land is 1431.86 hectares. The percentage of lands occupied by forest lands accounts for 23.3 percent to the total geographical area of watershed. In the year of 2011-12 the forest land is Increased 0.29 percent when compare to 2005-06 in the study area.

**Table 1:** land use/land cover change detection analysis-2005-06 to 2011-2012

| S. No. | Description | Area (2005-06) (%) | Area (2011-12) (%) | Area in Changes (%) |
|---|---|---|---|---|
| 1 | Crop Land | 60.66848 | 60.42167 | 0.246811 |
| 2 | Built-up | 1.667604 | 1.642418 | 0.025186 |
| 3 | Wastelands | 10.77943 | 10.77543 | 0.003994 |
| 4 | Water bodies | 3.83249 | 3.815178 | 0.017311 |
| 5 | Forest | 23.052 | 23.3453 | -0.2933 |
| Total | | 100 | 100 | 0.02 |

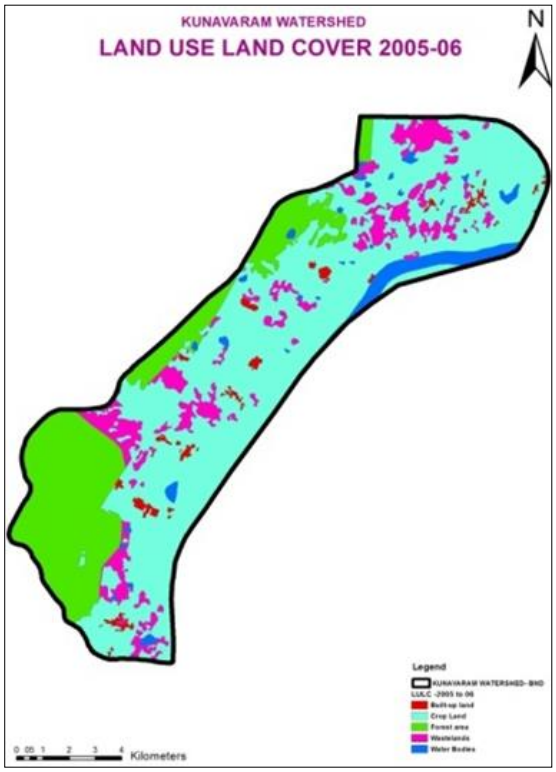


**Fig 2:** Land use land cover 2005-2006

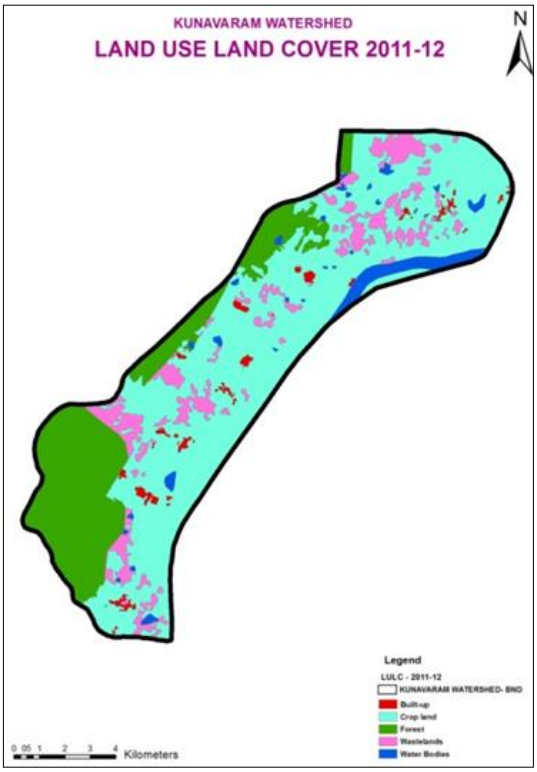


**Fig 3:** Land use land cover 2011-2012

## Conclusions

The change detection of the study advocates that multi temporal satellite imagery plays an important function in quantifying spatial and temporal phenomena which is in any other case now not possible to try through conventional mapping. Study reveals that the major land use in the study area is barren/waste land. The area under barren/waste land has increased by 8.00% (31.5 sq.km) due to deforestation work during 2000 to 2010. The second major category of land in the study area is agriculture which was decreased by 6.4% (25.5 sq.km) due to adaptation in vegetation, barren land and built-up land. The third major category of land in the study area is water bodies have also decreasing. During the study period (i.e., 2000-2010), built-up land has been increased by 3.5% (13.8 sq.km) due to alteration into urbanization and industrial areas. Thus, the present study illustrates that remote sensing and GIS are important technologies for analysis and quantification of spatial phenomenon which is otherwise not possible to attempt through conventional mapping techniques. Change detection is made possible by these technologies in less time, at low cost and with higher accuracy.

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