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A geographical analysis of land use in Ariyalur district using remote sensing data and GIS

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Abstract
Land use is used to describe human uses of the land, or immediate actions modifying or converting land cover. It includes broad categories such as human settlements, protected areas and agriculture. Within those broad categories are more refined categories, such as urban and rural settlement, irrigated and rained fields, national parks and forest reserves, and transportation and other infrastructure. Land cover refers to the natural vegetative cover types that characterize a particular area. These are generally a reflection of the local climate and landforms, though they too can be altered by human actions. Ariyalur District was bifurcated from Perambalur district for the administrative purpose which has many natural calcite mines in and around the study area. After bifurcation it is necessary to demarcate different land use and land cover classifications using the satellite optical remote sensing methods. The maps prepared for different land use and land cover classifications as per the United States Geological Survey (USGS) different classes have been derived using ENVI digital image analysis methods.

Keywords: Calcite mines, bifurcation, USGS, digital image analysis, land use and land cover

Introduction
"Land" is the most significant resource of mankind in a 'finite' area. However, population growth is very rapid. Since man is a terrestrial animal, this increase is exerting a greater pressure on land. Land surface characteristics differ from one region to the other. This results in varied environments. The land must be utilized on a rational basis so that the available resource of land, water and livestock are developed to the maximum potential and the population is assured a decent living. There exists a state of balance between rainfall, soils, crops, trees, animals and man. The potential may include both qualitative terms as degree of suitability and quantitative terms as crop/cash outputs. The study of land use is necessary for proper utilization of land resources of a region.

Role of remote sensing in Land use / land cover studies
Remote sensing data are used for various studies and development, repetitive scanning of an area at affixed interval of time through satellite based sensor as provided invaluable information for updating the natural resources. The land use/land cover can be identified in the remotely sensed image using digital analysis techniques. The USGS has derived the Land use/land Cover system for use with remote sensing data for built up, agricultural land, waste land, forest land water wet land barren land, water bodies etc., The land use classification has totally seven stages:

- Large area coverage at a single time, and identification of large feature.
- Data acquisition over in accessible area.
- The data can be obtained in different scale and with different resolution.
- Temporal changes can be identified.
- Data can be obtained in any weather condition.
- The data may be obtained in softcopy as well as hardcopy.
- The data comparisons can be easily done.

Earlier Empirical Investigations
In the last three decades, the technologies and methods of remote sensing have evolved dramatically to include a suite of sensors operating at a wide range of imaging scales with

potential interest and importance to planners and land managers. Coupled with the ready availability of historical remote sensing data, the reduction in data cost and increased resolution from satellite platforms, remote sensing technology appears poised to make an even greater impact on planning agencies and land management initiatives involved in monitoring land-cover and land-use change at a variety of spatial scales. Current remote sensing technology offers collection and analysis of data from ground-based, atmospheric, and Earth-orbiting platforms, with linkages to GPS data, GIS data layers and functions, and emerging modeling capabilities (Franklin, 2001) [6]. This has made remote sensing a valuable source of land-cover and land-use information. As the demand for increased amounts and quality of information rises, and technology continues to improve, remote sensing will become increasingly critical in the future. Therefore, the focus of this chapter is on the issues and challenges associated with monitoring land-cover and land-use change.

Planning and land management agencies have numerous and varied responsibilities and tasks (Jensen and Cowen, 1999) [7]. Further, their ability to complete these tasks is hampered by the paucity of comprehensive information on the types and rates of land-cover and land-use change, and even less systematic evidence on the causes, distributions, rates, and consequences of those changes (Loveland *et al*., 2002) [8]. For example, at the rural–urban fringe, large tracts of undeveloped rural land are rapidly converted to urban land use. This land-use dynamic makes it difficult for planners to obtain or maintain up-to-date land-cover and land-use information, where typical updating processes are on an interval scale of 5 years (Chen *et al*., 2001) [3]. Although the full potential of remote sensing technology for change detection applications has yet to be completely realized, planning agencies at local, regional and international levels now recognize the need for remote sensing information to help formulate policy and provide insight into future change patterns and trends (Jensen and Cowen, 1999) [7].

Remote sensing information, in concert with available enabling technologies such as

GPS and GIS, can form the information base upon which sound planning decisions can be made, while remaining cost-effective. Clearly, however, the fast-paced developmental nature of remote sensing technology often overlooks the needs of end-users as it '…continues to outpace the accumulation of experience and understanding' (Franklin, 2001: 137) [6]. As a result, effective real-world operational examples of land-cover and land-use change remain relatively rare (Loveland *et al*. 2002; Rogan *et al*., 2003) [8, 11].

Study Area

Ariyalur is an administrative district in the state of Tamil Nadu in India which occupies an area of 2,034 km² and has a population of 754,894 (as of 2011) with an administrative head, being Ariyalur. It was carved out from Perambalur district on January 1, 2001. But, it was again merged with the Perambalur district by the subsequent in March 31, 2002 on economic grounds. Ariyalur district reformed on Friday November 23, 2007. The district is bordered by the districts of Cuddalore in the north, Perambalur and Tiruchirapalli in the west, Thanjavur and Tiruvarur in the south and Nagapattinam in the east. Ariyalur district will comprise three taluks - Ariyalur, Udayarpalayam and Sendurai and three Assembly segments - Ariyalur, Andimadam and Jayankondam. The new district will have an area of 2,034 km² and will have a population of 6.96 lakh. The new district had a total of 16 police stations (Figure – 1)

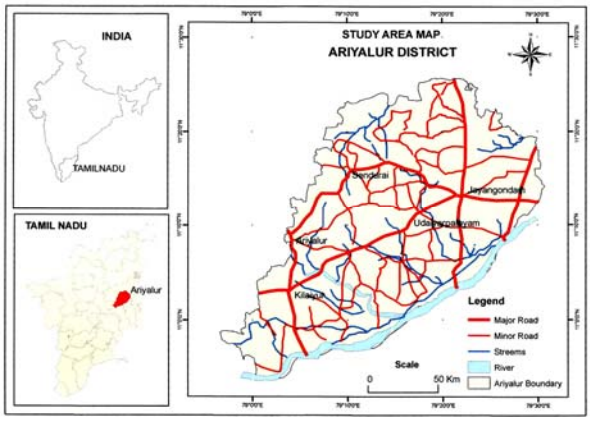

Fig 1

It is famous for its cement industries in the district and nearby. This is possible due to its immense limestone potential raw material, which is required for cement industries. In particular the Arasu cements, the Birla cements, the Sakthi cements, the Dalmia cements, the Tamil Nadu cements, etc. are situated in Ariyalur and hence makes the district as one of the busiest transport towns. It is also culturally familiar for the Kaliyaperumal Temple situated at 5 km from Ariyalur.

Objectives

a) To study the geographical factors of the present study area after bifurcation/ newly formed district,
b) To evaluate the present land use/land cover and prepare a general land use map using the IRS 1D digital data.

Methodology

For the geographical analysis of land use and land cover, basic data in the form of secondary information have been collected from the District Statistical office at Ariyalur. Soil classification and distribution data have been collected from the Public Works Department, Ariyalur. Population and other details have been taken from Census of India Volumes for 2011. The Physiography of the study area was collected from the Soil Atlas. In the present investigation both statistical and cartographic techniques have been applied. The satellite IRS 1D digital data have been used to demarcate various land use categories based on the digital image processing techniques using ENVI, and finally analysis of data is done and suitable tables and maps/ diagrams have been prepared using Arc GIS software.

Implied Data Products

The multi temporal data of IRS 1D imagery is used Satellite Digital data acquired on May, 2012 is used as primary data for this study. The earth observing instrument onboard this spacecraft is Enhanced IRS 1D Image with Four bands such as visible, near-IR, spectral regions at a spatial resolution of 23.5m. (Figure -2)

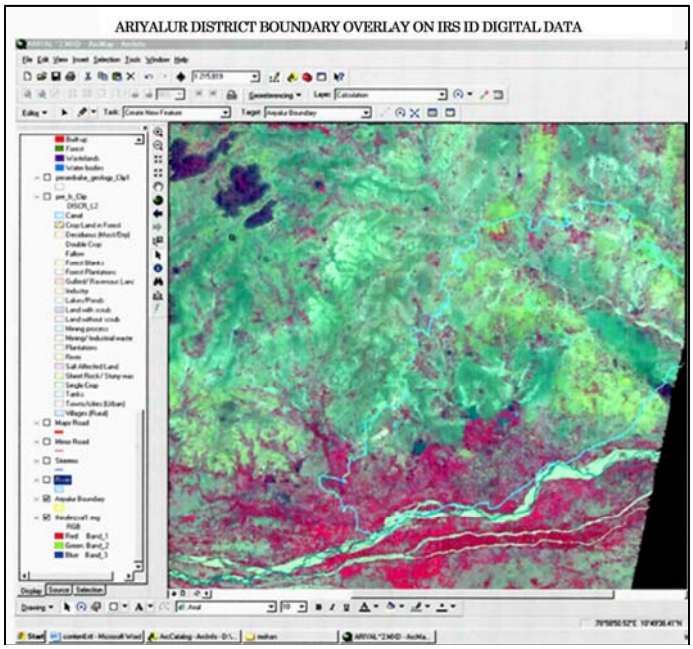

Fig 2

Landuse/Landcover Classification

The term land use refers to 'how' the land is being used by human beings. Land cover defined as the biophysical materials found on the land. The best way to insure land utility information derived from remote sensor data is useful in many applications to organize it according to a standard land use/ land cover classification system especially "Modified United States Geological Survey (USGS) land use/ land cover classification system", proposed by Geological Survey Department, USA. The knowledge of land use and land cover is important for many planning and management activities concerned with the surface of the earth.

Table 1: Landuse/Landcover Classification scheme for the present study

Level - I	Level – Ii	Level - Iii
1. Built up	1.1 Built up land	
	Transport 1.2 Roadways	1.2.1 Major roads 1.2.2 Other Roads
2. Water bodies	2.1 River 2.2 Tank 2.3 Canal	2.2.1 Tank with water 2.2.2 Tank bed vegetation 2.2.3 Dry tank bed
3.Agricultural land	3.1 Crop land 3.2 Fallow land 3.3 Plantation	
4.Natural Vegetation	4.1 Open Scrub	
5.Waste land	5.1 Relief 5.2 Structural Hill	

Land use/ land cover defined as the presence of surface features in parcel of land in an area. This study area physical resource like relief, geomorphology, soil and minerals are described with corresponding thematic maps and its attribute data base. Land use / Land cover include both natural and cultural features. These are delineated by modified USGS classification system. A multi-level system as being designed to untainted different degrees of information on resources up to level III for each land parcels from IRS 1D imagery. The level I and II classifications are specifically interest to express resource information on national wide and state wide basics. It is indented that level III and IV are focused more details for local or village wide basis.

In this study area, each resource is mapped at level III with the help of substantial amount of supplemental information extracted from high resolution, medium scale satellite image in addition , details from topo sheets, statistical department data and by field verification(GTV).

Distribution of Soil Categories

Soil is an important factor for agriculture production. The internal soil characteristics and external land features in combination with environmental factors are the determinants of land use. Figure -3 shows the soil distribution in Ariyalur district. Ariyalur series; Gray to dark gray, very deep calcareous, colluvial soil, fine textural, moderately slow permeability and moderately drained, soils occur in almost level lands. Other types of soils where found in Ariyalur district the most predominant soil in angular soil, muthukulam soil, palamedu soil kalathur soil etc.,

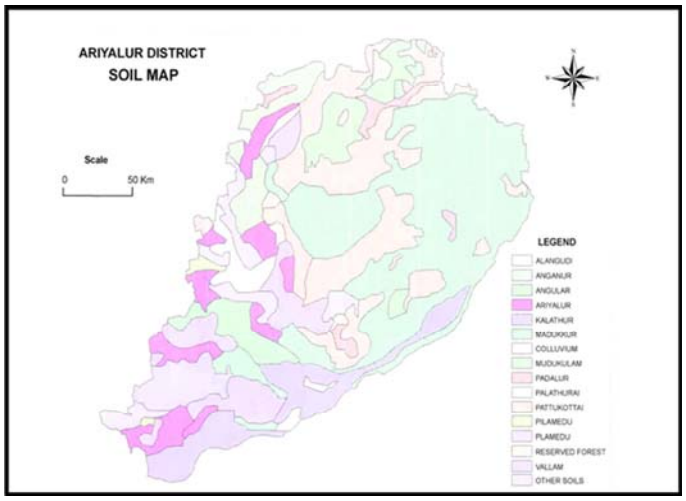

Fig 3: Geologic Structure

The cretaceous rocks are represented by limestone with marl and clay of Maruvathur formation of Uttattur Group, clays with lenses of limestone and sandstone, shale and limestone of Kullallalnattam formation of Trichinopoly Group and sandstone of Illakudi formation of Ariyalur Group. Thin patches of upper gondwana sandstone and shale are exposed near the fringes of the cretaceous rocks. Cretaceous rocks are exposed on the eastern side of Tiruchirapalli, Perambalur road around Maruvathur, Kalpadi, Kariterani, Kulakkalnattam and Anaipadi. Along the margins of cretaceous rocks a few thin patches of shales and sandstone of upper Gondwana age are exposed. The marine sediments of cretaceous rock are rich in fossils depicting in particular evolution of the fossil species of brachiopod and cephalopod. Ariyalur is very famous for its marine fossils store house. Apart from the marine fossils, trunks as well as broken pieces of fossil wood are seen in several places especially near Sathanur and south east of Garudamangalam indicating the shallow coastal character of the beds.

The rock formation around Ariyalur, forms parts of the well-known cretaceous formations of Tiruchirappalli and they are all sedimentary rocks. These formations were deposited under marine conditions, and their geological age is about 80 million years. These formations have been studied in detail during the post several decades by various organizations in view of their geological and paleontological interest. Limestone is the main raw material for making cement and it is available in abundance around ariyalur district. The limestone formations form part of Ariyalur stage (Maastrichtian age) of upper cretaceous, which contain both mega, and microfossils of different species. Main fossils found in Ariyalur stage are Turritella, Trionarca,, Fluvial, Fluvio- Marine, Aeolian and marine sediment, pink migmatite, granitoid gneiss, Sand stone and clay, sand stone with lime stone and clay, Alectryonia, Gryphaea, Nautilus and Stygmatophygus. (Figure – 4)

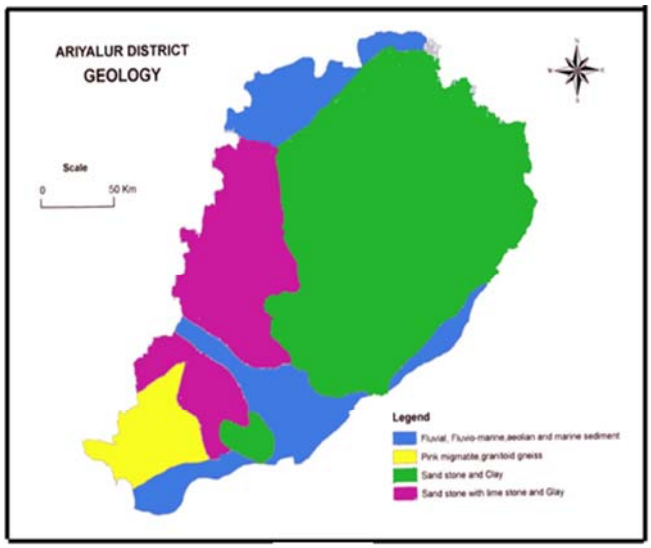

Fig 4

The cretaceous formation of Ariyalur area was explored in detail by various organizations like a Geological Survey of India, state department of Geology, Mining, Tamil Nadu Cement Corporation Limited and Oil and Natural Gas Commission. The ONGC initiated detailed exploration of the Cauvery basin with a view to assess it Geological structures. ONGC have indicated in their during the Ariyalur period there was continuous regression of the due

to the continued uplift of the basin in the northern area and corresponding transgression of the sea due to subsidence of the basin in the central pare the Ariyalur area during deposition of the sediments.

General Land use

In the northern side Ariyalur district most of the area found in agriculture region this area agriculture was distributed on 267 sq.km area and also southern side agriculture was sparsely distributed. In major built up area is located on northern and middle area of Ariyalur district and also the built up area was distributed on sparsely, in Ariyalur district. Figure -5 and table -2 shows the main built up area is 8 sq.km. Most of the forest region distributed on northern and middle area of Ariyalur district. Area covered by 9.15 sq.km, waste land of this district 8.27 sq.km.

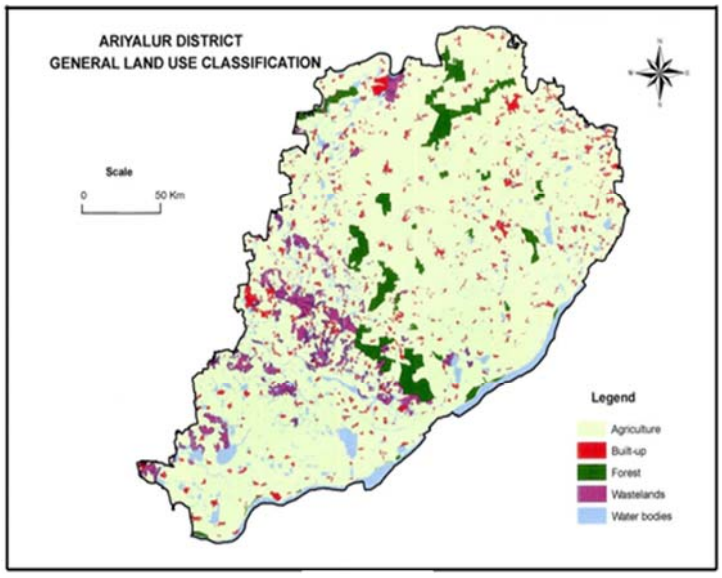

Fig 5

Table 2: Ariyalur District: General Land use

Sl.no	Landuse	Area in Sq. Km
1.	Agriculture	267.05
2.	Built up	8.04
3.	Forest	9.15
4.	Waste land	8.27
5.	Water bodies	42.90

Source: Data derived using ENVI digital image analysis methods

The major waste land was found in the southern side water bodies was found in boundary of Ariyalur district and this water bodies covered area is 42.90 sq.km. The main river is kollidam and it distributaries where flows in Ariyalur district.

Agriculture and Forest

The Table 3 and Figure – 6 shows the distribution of the Agricultural landuse and the Forest landuse in Ariyalur district. The cropping land in forest covered area is found in centre parts of the Ariyalur district and the deciduous land use where spared in the overall all of the district.

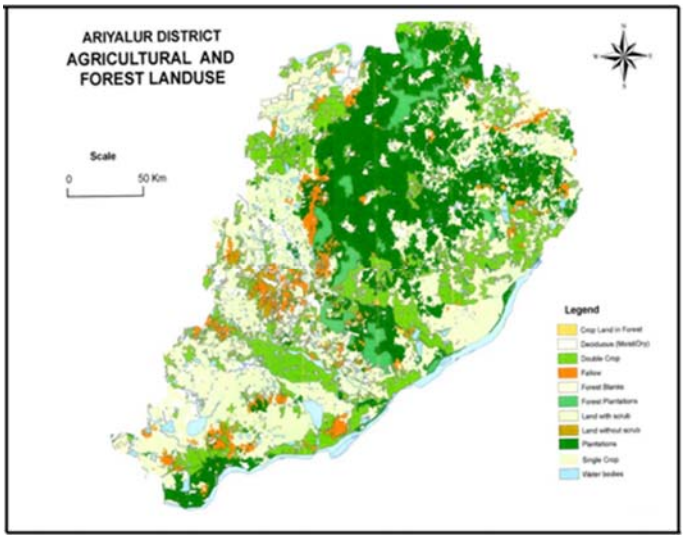

Fig 6

Table 3: Agricultural and Forest Landuse

Sl.no	Landuse	Area in Sq.Km
1.	Crop Land in Forest	0.10
2.	Deciduous (Moist/Dry)	0.89
3.	Double Crop	46.07
4.	Fallow	8.89
5.	Forest Blanks	0.33
6.	Forest Plantations	7.82
7.	Land with scrub	3.04
8.	Land without scrub	1.46
9.	Plantations	55.94
10.	Single crop	156.13
11.	Water bodies	42.90

Source: Data derived using ENVI digital image analysis methods

The cropped areas where found in the northern parts of the district and the Kollidam and its distributors where the crop cultivation and the seasonal crops flows in this region so also cultivated in this region. Some of the areas where lies interior of the district and the rain fall is low and the irrigation where less in the middle parts and the near of ariyalur Town. The plantation crops were randomly seen; in the figure and the some of the river where filled with water during this seasons. Due to the mining activities, the abounded ponds where filled with water and the area where more polluted due to the industrial activities in Ariyalur district.

Settlements and Industrial land use categories

The table -4 and Figure – 7 shows the distribution of the settlements and industrial land use pattern in Ariyalur District. The most of the area distributed in village

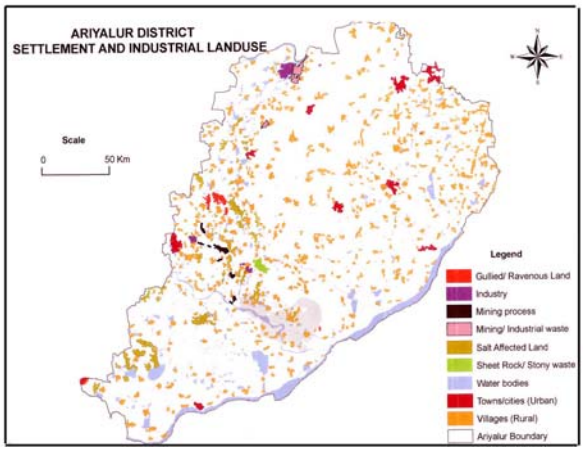

Fig 7

Table 4: Settlement and Industrial Landuse

Sl.no	Landuse	Area in Sq. Km
1.	Gullied/ Ravenous Land	0.29
2.	Industry	0.41
3.	Mining process	0.28
4.	Mining/ Industrial waste	0.37
5.	Salt Affected Land	2.58
6.	Sheet Rock/ Stony waste	0.22
7.	Water bodies	42.90
8.	Towns/cities (Urban)	1.23
9.	Villages (Rural)	6.40

Source: Data derived using ENVI digital image analysis methods

Particularly northern side and western side accumulated in several villages in 6.40 per sq.km, water bodies found in the southern parts and eastern parts and also distributed in all places. Major towns in Thonur, Vilagam Ariyalur, Sendurai and Udayarpalayam in 1.23 sq.km. Salt affected land category in western part of the Ariyalur district in 2.58 sq.km, sheet rock lies in the western parts, Cement Industries and mining activities are found near Ariyalur town.

Conclusion

The Land use analysis has been studied and the changes in land use/land cover have been vividly studied. The agricultural areas need more and immediate attention since 70 per cent of the countries population depends upon agriculture for its living. The waste area requires attention to take suitable measures for afforestation activities; this will prevent soil erosion and helps the rain water to percolate in the soil there by increasing the ground water. Remote sensing provides modern and scientific techniques.

Suggestions

The agricultural cropped areas where found in the northern parts of the district and the Kollidam and its distributors where the crop cultivation and the seasonal crops flow in this region so also cultivated in this region. Some of the areas where lies interior of the district and the rain fall is low and the irrigation where less in the middle parts and the near of ariyalur Town.

Particularly northern side and western side accumulated in several villages in 6.40 per sq.km. Water bodies found in the southern parts and eastern parts and also distributed in all places. Major towns in Thonur, Vilagam Ariyalur, Sendurai and Udayarpalayam in 1.23 sq.km. Salt affected land occur in western part of the ariyalur district in 2.58 sq.km.

Government can conduct awareness programs with the help of NGO to the local villagers in order to develop the waste land into use agricultural lands. Not only for agriculture but these areas can be developed into settlements by constructing colony houses or housing board colonies. The lime stone regions the industries and mining activates where make more air pollution due to the cement industries and the explosion of the rock in the mining area and the abounded mining regions where act as the stagnant water area is act as the vector disease.

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