

Land use and land cover change detection through remote sensing approach: A case study of Kodaikanal taluk, Tamil nadu

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ABSTRACT

Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Empirical observation revealed a change in land use land cover classification in Kodaikanal taluk, a part of Western Ghats located in Tamilnadu state. In this paper an attempt is made to study the changes in land use and land cover in Kodaikanal Taluk over 40 years period (1969-2008). The study has been done through remote sensing approach using SOI Taluk map of Kodaikanal (1969), and Land Sat imageries of May 2003 and April 2008. The land use land cover classification was performed based on the Survey of India Kodaikanal Taluk map and Satellite imageries. GIS software is used to prepare the thematic maps. Ground truth observations were also performed to check the accuracy of the classification. The present study has brought to light that forest area that occupied about 70 per cent of the Taluk's area in 1969 has decreased to 33 per cent in 2008. Agricultural land, Built up area, Harvested land and Waste land also have experienced change. Built-up lands (Settlement) have increased from 3 per cent to 21 per cent of the total area. Kodaikanal area is identified as one of the bio-diversity area in India. Proper land use planning is essential for a sustainable development of Kodaikanal Taluk.

Keywords:Land use, Land cover, Change Analysis

1. Introduction

Land use and land cover (LULC) change is a major issue of global environment change. Scientific research community called for substantive study of land use changes during the 1972 Stockholm Conference on the Human Environment, and again 20 years later, at the 1992 United Nations Conference on Environment and Development (UNCED). At the same time, International Geosphere and Biosphere Programme (IGBP) and International Human Dimension Programme (IHDP) co organized a working group to set up research agenda and promote research activity for LULC changes. Land use/ land cover mapping is essential component where in other parameters are integrated on the requirement basis to drive various developmental index for land and water resource. Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). Land Cover, defined as the assemblage of biotic and a biotic components on the earth's surface is one of the most crucial properties of the earth system. Land cover is that which covers the surface of the earth and land use describes how the land cover is modified. Land cover includes: water, snow, grassland, forest, and bare Soil. Land Use includes agricultural land, built up land, recreation area, wildlife management area etc.

The Land cover reflects the biophysical state of the earth's surface and immediate subsurface, thus embracing the soil material, vegetation, and water. Land use refers to man's activities on land which are directly related to the land. Land use and land cover are dynamic. Changes may involve the nature or intensity of change but may also include spatial (forest abatement at village level, or for a large-scale agro-industrial plant), and time aspects. Land use/ Land cover changes also involve the modification, either direct or indirect, of natural habitats and their impact on the ecology of the area.

Land degradation results mainly due to population pressure which leads to intense land use without proper management practices. Over population makes people move towards sensitive areas like highlands. In such areas land use without considering the slope and erodibility leads to severe erosion and related problems. The influence of road construction and other comparable disturbances of landscape on erosion and on landslides, and other mass movements on hilly area are well known.

Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Kachhwaha, 1985) in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Star et al. 1997; McCracker et al. 1998; Chilar 2000). Space-borne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking (Dong et al. 1997). Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. By understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, one is able to develop plans for multiple uses of natural resources and nature conservation. The change in any form of land use is largely related either with the external forces and the pressure built-up within the system (Bisht and Kothiyari, 2001).

Kodaikanal is one of the most popular hill stations in Tamil Nadu. 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.

2. Study Area

Kodaikanal is one of the most popular hill stations in Tamil Nadu. It is a striking hill resort on the Palani hills in the Dindigul district of TamilNadu. Located 120 Km/75 mile away from Madurai, Kodaikanal is a beautiful hill station at an altitude of about 2133 m on the southern tip of upper Palani hills in Tamil Nadu in the Western Ghats. With her wooded slopes, mighty rocks, enhancing waterfalls and a beautiful lake, Kodaikanal will mesmerize any visitor. Kodaikanal Taluk geographically located in west part of Dindigul district, it lies between $10^{\circ}6'38''\text{N}$ to $10^{\circ}26'57''\text{N}$ Latitudes and $77^{\circ}16'00''\text{E}$ to $77^{\circ}44'56''\text{E}$ longitudes, its covering 1081.33 sq.km (108133 Hectares) (Fig- 1). Kodaikanal is located in the Palani Hills which are a direct branch of the Western Ghats. Interestingly enough, the Western Ghats are considered to be the oldest mountain range in the world, composed of rock that is said to be billions of years old.

Study area administratively located in south direction of Palani Taluk, west direction of Dindigul Taluk, east direction of Udamalpet Taluk and north east part of Kerala State. The temperature of

STUDY AREA LOCATION MAP

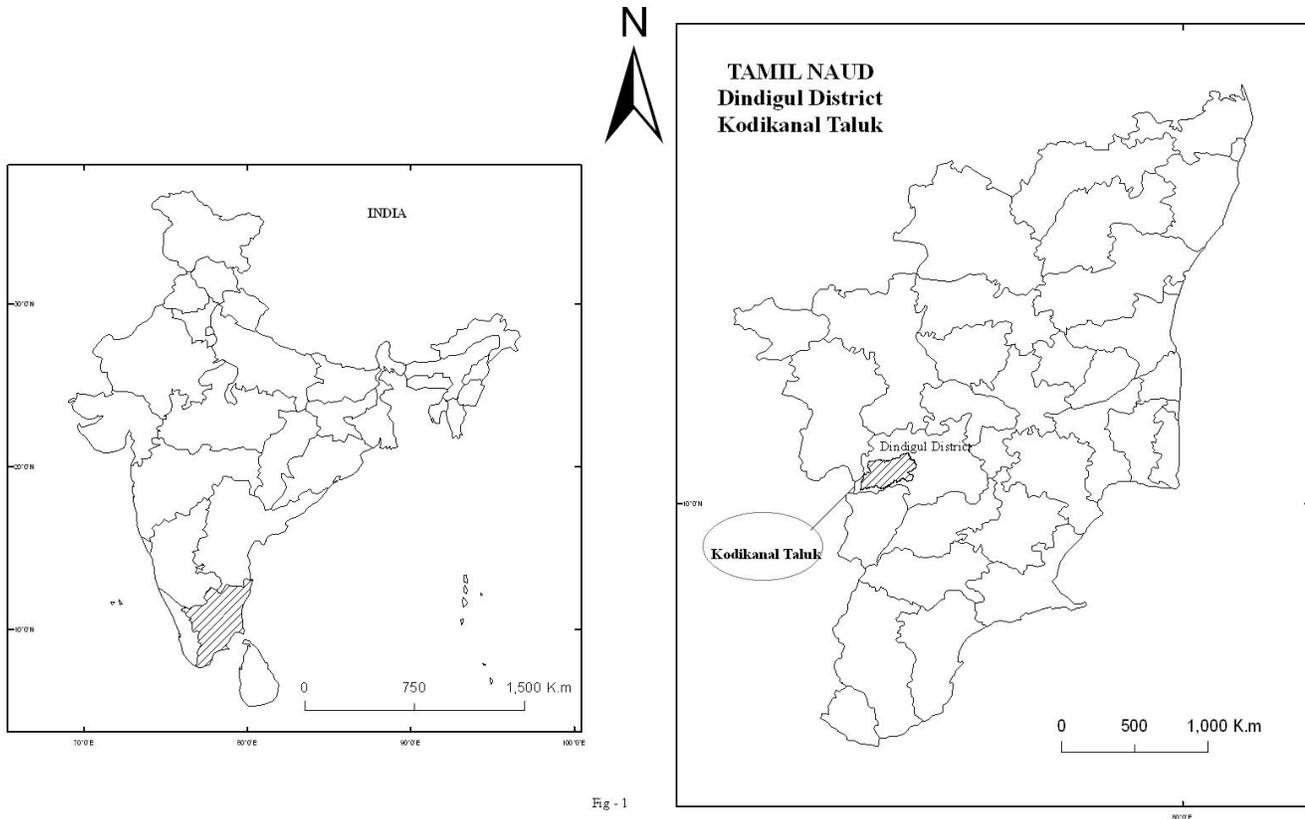


Fig - 1

Figure 1: Image showing the location of study area

Kodaikanal is quasi-temperate, with summer (April-May) temperatures touching 24°C maximum, 13°C minimum. Winter (December-January) temperatures hover between 16°C maximum and 7°C minimum. Rainfall is well distributed throughout the year, with an average precipitation of 1300 mm. annually. The climate of Kodaikanal is very unique, with a temperate fall, winter, and spring and a mild summer. Kodaikanal also receives a large amount of rainfall every year, making it an ideal environment for cultivation. Therefore, many varieties of fruits and vegetables are grown in the Kodaikanal region, many of which can only be grown here including: peaches, pears, grapes, plums, guava, jackfruit, hill-banana, passion fruit, cauliflower, potatoes, garlic, carrots, and coffee. Many other varieties of plants inhabit the area including blue gum, eucalyptus, pine, walnuts and other fruit trees which are used for cultivation. The total population of the study area is about 58203 persons consisting of 9752 males and 28451 females according to 2001 census.

3. Objectives

The main objective of the present paper is to analyse the nature and extent land use/land cover changes in Kodaikanal Taluk in the past 40 years and to identify the main forces behind the changes.

4. Methodology

Multi- temporal satellite data set observed by LANDSAT 5, Thematic Mapper (TM), LANDSAT 4, and Multi Spectral Scanner (MSS) and Survey of India Taluk map drawn on 1:63360 scale were used for the analysis (Table 1). TM and MSS are optical sensors which has 7 and 4 multi-spectral bands between visible and infrared radiations.

Table 1: Spatial data sources

Data	Month of Observation	Spatial Resolution / Scale
Land Sat – 5 (TM)	2008 – April	30m
Land Sat – 4 (MSS)	2003 – May	30m
SOI Taluk Map	1969 (Kodaikanal Taluk)	1: 63360

The resolution is 30 meters/pixel. Digital land use / land cover classification through supervised classification method, based on the field knowledge is employed to perform the classification. Arc GIS 9.2 and Erdas Imagine 9.2 are powerful tools for extracting the land use, land cover layer, from Taluk map and satellite imageries. The land use land cover classes include agriculture land, harvested land, wasteland, forest, built-up (settlement, road), water bodies and cloud cover areas. This classification is performed based on the classification scheme of National Remote Sensing Center (NRSC), Department of Space, Govt of India.

5. Result and Discussion

Kodaikanal Taluk is a hilly area with forest cover as the main natural resource. The findings of the present investigation are presented in table 2. Most of the forest lands are reserved and dense forest. But day by day forest lands are converted to built-up (settlements, road, tourists amenities) and agricultural land. According to SOI Taluk map of the year 1969 forest covered almost 70 per cent of the study area. (Table-2) This has decreased to 46 per cent in 2003 (May Land Sat (MSS) Imageries) and 33 per cent in 2008 (Land sat, TM data). It is worth observing that in the 40 years almost 50 per cent (Fig – 2, 3, 4&Table-2) of the forest lands have got transformed to Agricultural land, Harvested and Built-up land. Because of human population forest land got converted to forest Plantation, Settlement and Road.

Table 2: Kodaikanal Taluk: Area under land use and land cover

Sl. No.	Lu/Lc	1969		2003-May		2008-April	
		Hectares	%	Hectares	%	Hectares	%
1	Forest	75200.00	69.54	49700.00	45.96	35700.00	33.02
2	Agriculture	21540.00	19.92	28573.20	26.43	37905.50	35.05
3	Waste Land	5296.63	4.90	4415.00	4.08	4012.00	3.71
4	Built-up	3489.00	3.23	20302.90	18.78	23280.00	21.53

5	Harvested Land	2409.00	2.23	4782.00	4.42	7071.00	6.54
6	Water bodies	198.37	0.18	359.90	0.33	164.45	0.15
	Total	108133	100	108133	100	108133	100

Source: Computed by the author.

Agriculture land occupies sizeable area. Vegetables, cardamom, pepper, and coffee are the major agricultural crops. The cultivation of these cash crops is more profitable to farmers. Agricultural land which covered 20 per cent of the land in 1969 has increased to 26 per cent in 1969 has increased to 26 per cent in 1969 and to 35 per cent in 2008. From figure 2, 3 and 4 it could be observed that forest lands got converted to Agricultural land Wattle plantation. Cardamom plantation, mixed plantation, Pepper Cardamom and coffee mixed plantation are the major type of use in agricultural land. Wattle plantation covered Arankulai Malai, Chendanur Malai, Pukadu Malai, Periya Malai and Manarattan Kanal. Coffee cultivation is seen in Periyur, Pachalur, Vilpatti, Kamankova Malai, Ganguranadai, Kamanur and Pannaikkadu. Thandigudi and Mangalamkombu have cardamom cultivation. Cardamom and coffee intercropping is noticed in Periar.

Built-up land includes settlements, roads and tourist places. Kodaikanal is a famous tourist place in south India. Due to tourist activities land under hotels, lodges, gardens and waste dumping places have increased. In the year 1969 built-up land covered 3.23 per cent of the total area; this has increased to 18.78 per cent in 2003 and to 21.53 per cent in 2008. Here forest lands are converted to built-up land. In few areas agricultural land also got transformed to built-up area. Harvested land covered 2.23 percent of land in 1969, increased to 4.42 per cent in 2003 and to 6.54 per cent land in 2008 (Fig – 2, 3, 4 & Table-2). This gradual increasing of Harvested land may be attributed to the procedure of leaving the land without cultivation for some time. As the observation period is namely April and May the post harvest season the extent of Waste land might have increased. Waste lands are not suitable for agriculture and other human activities. These lands have very steep slope and areas susceptible to land slide. Waste lands covered 4.9 per cent in 1969, 4.08 per cent in 2008 and 3.7 per cent in 2008. (Fig-2, 3, 4 & Table-2)

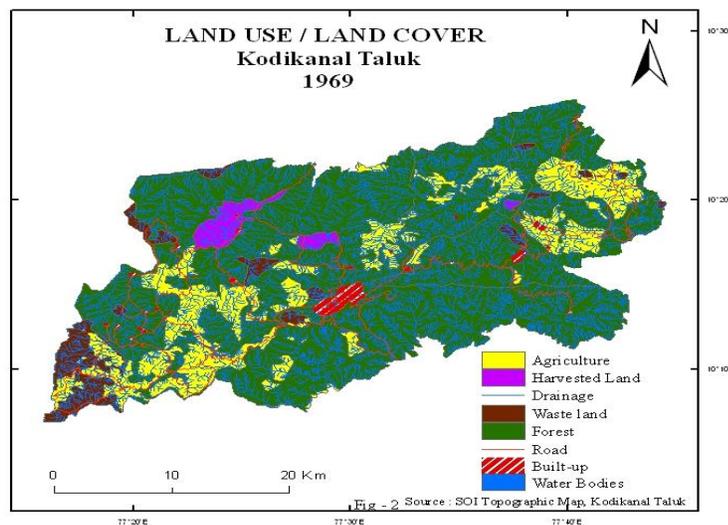


Figure 2: Land use land cover map of Kodaikanal- 1969

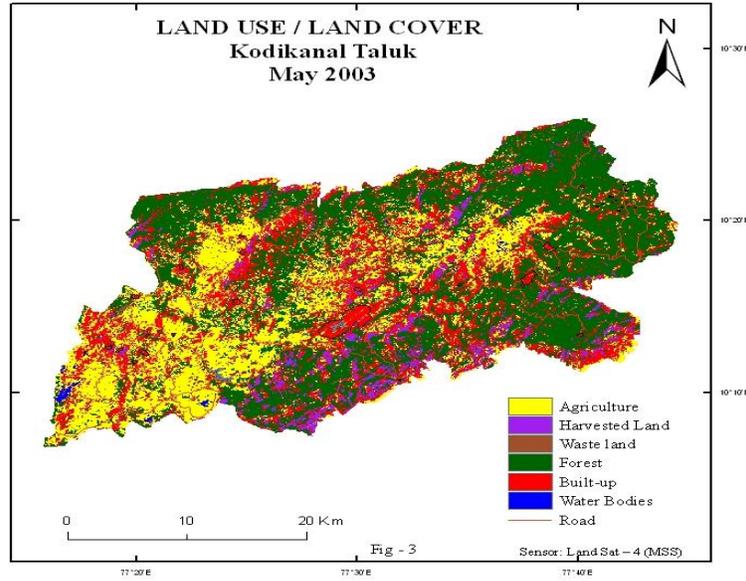


Figure 3: Land use land cover map of Kodaikanal -2003

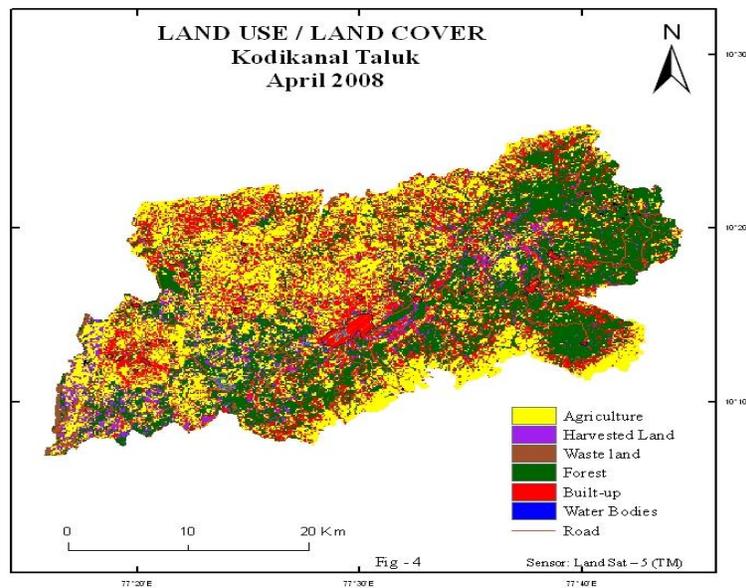


Figure 2: Land use land cover map of Kodaikanal -2008

Water Bodies included lakes, reservoirs, ponds, rivers and streams. Water bodies covered only 0.18 per cent of the study area land in 1969 and increased to 0.33 per cent in 2003 but decreased to 0.15 per cent in 2008 (Fig-2,3,4 & Table-2). This fluctuation may be due to the rain fall in the month of May even water logged areas in the south west part of study area might have got classified under water bodies. Kodaikanal Taluk a hilly area is also the catchments of the rivers and odais. Major water bodies include Kodaikanal Lake, Berijam Lake, Kudiraiyar, Kumbur, Porandalar, Kallar, Tevankara, Talaryar, Manjalar, Vattar, Selambar, Ohtnnapiar and Unvanapi Rivers, Vannatti Odai, and Shurpan Odais. Figure 5 represents the distribution of land use land cover distribution during the three periods in the study area.

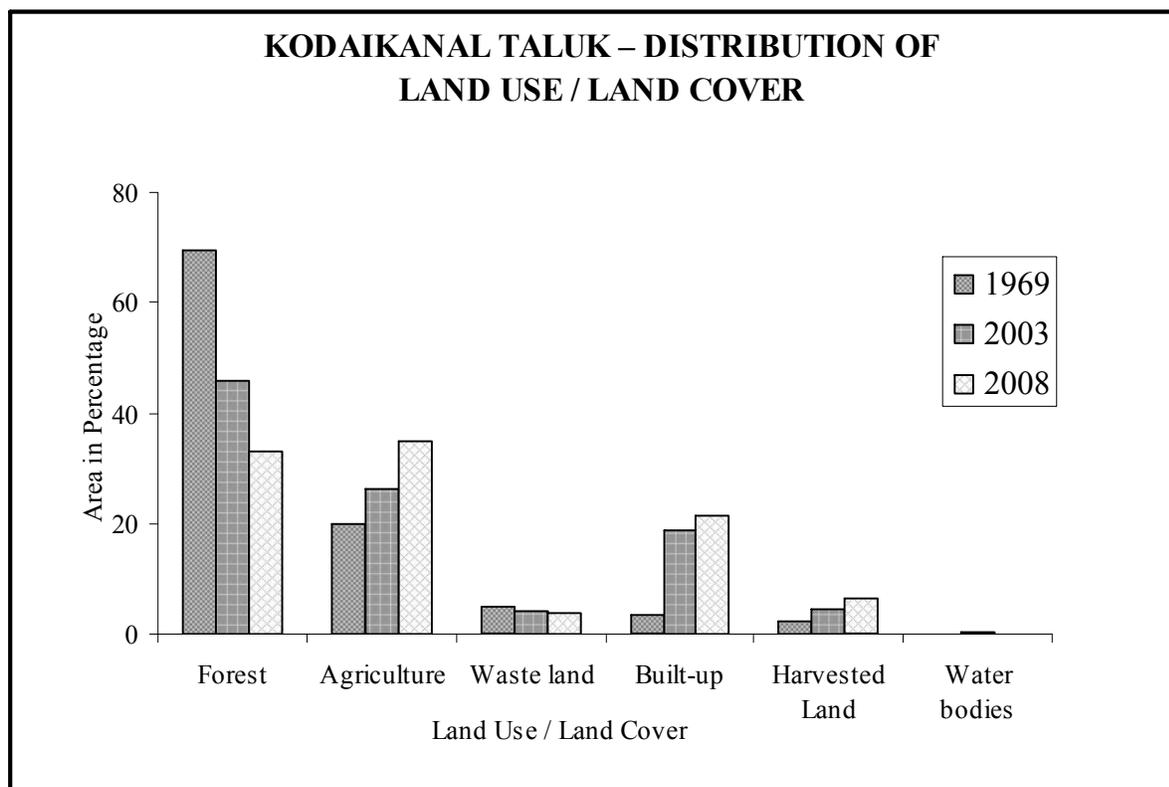


Figure 5: Distribution of land use land cover distribution during the three periods in the study area.

6. Conclusion

Kodaikanal is a famous hill station in south India the major source of income is through tourism. The major land use in Kodaikanal Taluk is forests. But the land under forest cover has experienced a declining trend in the past forty years. Here forest land converted to Agricultural land, Built-up, and Harvested land due to this changes we loss our natural ecosystem and biodiversity also. The increase in agricultural land is a welcoming trend. But empirical observation reveals that due to increase in cost of cultivation, problems due to shortage of labor,

supply of low quality adulterated fertilizers and price fluctuation in the market the farmers prefer to sell their land to property promoters. Hence there is a risk of decline in the extent of land under agriculture in the near future. The increase in the area under built up lands may lead to a lot of environmental and ecological problems.

To sum up it could be stated that Kodaikanal Taluk one of the major bio-diversity zones of the country is a under the threat of environmental and ecological problems due to improper management of land, the free gift of nature. Hence government should come forward to take effective measures to protect the land under forest and agriculture in Kodaikanal Taluk. Here proper land use planning is needed other wise we loss our natural resources ie forest, water bodies.

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