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RESEARCH ARTICLE

ASSESSMENT OF LAND USE LAND COVER CLASS CONVERSIONS WITH IN THE FOREST ECOSYSTEM THROUGH REMOTE SENSING AND GIS TECHNOLOGY

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ABSTRACT

A land resource plays a significant role to understand the interactions between human activities and environmental sustainability. This study was investigated to assess the land use /land cover changes in Pachamalai reserved forest, a part of Eastern Ghats situated in Tamil Nadu. To solve the purpose multi-dated satellite images were used for analysis during the period of 15 years (1998–2012). Different types of thematic layers were generated using visual image interpretation techniques using ERDAS imagine and thematic maps were prepared at ArcGIS environment. Accuracy assessment was made using GPS data and ground truth verifications. Land use/land cover changes were observed that the forest area (5.56 km²) settlement (7.94 km²) and crop land (12.76 km²) increased, while area under waste land decreases by 26.26 km². Waste land has been converted into forest, settlement, crop land and was inversely proportional with other LU/LC classes. The conversion of wasteland to forest land shows the positive impact of forest management planning strategies taken up by the government and NGOs. Forest department plays a crucial role in maintaining forest ecosystem health during the past decade.

INTRODUCTION

Human-driven land cover change is considered as the single most important variable affecting ecological systems (Vitousek, 1994) and can significantly change the amount, type and successional state of forests. A major issue of global environmental change is the land use land covers pattern change. The Stockholm Conference of 1972 on the Human Environment and the 1992 United Nations Conference on Environment and Development calls for substantive study of land use changes among the scientific community. Land uses, resources, ecosystem and biophysical environment on the surface of the earth under changes over time. Land use is the reason for which human exploits the land covers (Fresco 1994). Land use change is the modification of the land which is not necessarily the only change in land cover but also the changes in intensity and management (Verburg 2000). The human induced and natural land cover/ land use changes are both critical due to their influence on global warming, biodiversity loss and impact on life of human (Sala *et al.* 2000; Geoghegan *et al*. 2001; Lopez *et al.* 2001). Change detection is a procedure of identifying and analyzing the difference of an object or a phenomenon through monitoring at different times (Singh 1989; Mouat *et al.* 1993). Recent studies and review of literature deals with the application of change analysis to various problems including land use/land cover changes, global change analysis, monitoring the impact of pressure on the environment, monitoring of agricultural production, assessing damages due to forest fire and deforestation, monitoring damages causes by natural calamities like earthquake, floods and volcanic eruption etc. (Anwar 2002). Latest information on land use change is necessary to provide update land cover maps and planning of the available resources for effective management (Alphan 2003; Muttitanon *et al.* 2005). A wide range of applications can be benefited from the study of the change process over a specified area at different times. Many researchers show that the huge population growth, unempirical agricultural methods and lack of public awareness about the significance of forests among the general and among the tribal folk are the main causes for deforestation of the forests. Geographical Information System and remote sensing techniques nowadays have been widely applied in the study of land use/land cover changes. The role of Geographical Information System (GIS) is that it provides proper display for data analysis, update and retrieval (Star *et al.* 1997; Chilar 2000). Remote sensing coupled with GIS provides an efficient method for analysis of land use issues and tools for land use planning and modeling. The data generated through remote sensing provide an enhanced source for derivations of land use due to their reproducibility, internal consistency and coverage in locations where ground-based knowledge is not accessible or less (Townshend 1992, DeFries and Townshend, 1994). Green *et al.* (1994), Wolter *et al.* (1995), Kaufman and Seto, (2001) have studied the LULC change detection analysis studies using multitemporal Landsat Thematic Mapper (TM) data. The present study examines Pachamalai reserve forest area and its influence on land use/land cover changes through remote sensing and GIS and to studies the pattern of land use

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for a period of 15 years (1998–2012). This study is essential to understand the existing situation and plan for the future conservation for sustainable development.

Study Area

Pachamalai reserve forest is located between 78°30”E and 78°45”E latitudes and 11°10”N and 11°30”N longitude under the administrative jurisdiction of Salem and Thiruchirapalli districts (Fig. 1 and 2). The total area of Pachamalai forest is 525.23 km². Out of the total 22,877 km² of forest area in Tamil Nadu, Pachamalai forest accounts for 2.29% in the state. The highest elevation is 1000 MSL. According to the Census 2011 report, the population recorded is 2, 31,497. The mean temperature is 29.1°C and annual average rainfalls are 860 mm. The mean humidity is 60%. Different types of forest types are present including the evergreen forest, semi evergreen forest, dry evergreen forest, dry mixed deciduous forest and thorn forest.

Methodology

To study the land cover changes in the study area, Indian remote sensing satellite data from IRS ID, P6 LISS III of path 101 rows 65 and 66, 30% shift in the month of May 1998, 2007 and 2012 were used in the present study. The Survey of India (SOI) toposheets 58 I/7, 11, 12 and 15 in 1:50000 scales of 1971 were used for base map preparation as referenced spatial data. An integrated technique of 3S (RS, GIS, and GPS) was employed to detect the land use/cover change in the study area. Global Positioning System was used as bases to register the images and was geometrically corrected using ArcGIS. Based on the spatial resolution of the satellite images, the images were transformed with a standard default resolution of 23.5M. Images are projected to polyconic coordinate system using nearest neighbourhood resampling method and are geometrically corrected using histogram equalization tool in ERDAS Imagine. The study area was extracted using subsets option in ERDAS Imagine and False Colour Composite (FCC) displayed with the band combination of 1, 2 and 3 as showed in (Fig. 3). Using ERDAS Imagine the different LU/LC classes namely, Forest cover, settlement, cropland, and wasteland are classified for the year 1998, 2007, and 2012.

Satellite Image Interpretation key

Visual interpretation of image elements such as colour, size, texture, pattern, association; resolution and shape was used to classify the broad forest cover area (Table 1). Utilizing visual interpretation key, change in satellite image was detection to process and identified the changes in LU/LC class based on co-register multi-dated satellite data (Shalaby and Tateishi (2007), Muchoney and Haack (1994), Singh (1989).The images were visually interpreted on screen and classified base on the interpretation key prepared during ground truth verification and attribute to the corresponding LU/LC changes.

Accuracy Assessment

The reference pixels are an important factor in determining the accuracy of the LULC classification. An equalized stratified random sampling approach was used in the present study to assess the accuracy of each land cover classification. The overall accuracy and Kappa analysis were used to perform classification accuracy assessment using random point’s tools. Kappa analysis is a discrete multivariate technique used for accuracy assessment (Hudson and Ramm 1987; Congalton and Green 1999). A number of 40 points from each class were randomly selected. The selected points were verified on the field check using hand held GPS. Accuracy of map was assesses by comparing the thematic map with ground observations point, which results in overall classification accuracy of 87%. The overall accuracy target of 85% with no class being less than 70% accuracy is acceptable for land-use land-cover mapping (Anderson *et al*. 1976, Thomlinson *et al*. 1999).

RESULTS AND DISCUSSION

Land use / Land Cover Change Assessment

Land use/land cover pattern of Pachamalai reserve forest has been altered significantly, since early 1998. It is observed that steady increase in forest cover, crop land and settlement but declining trend in waste land category were identified during the period from 1998 to 2012 as presented in Table 2, and (Fig. 4). The increasing trend in forest cover 5.56 km² is shown in the (Fig. 5). The major forest types found in the study area consist of evergreen, semi evergreen; dry every green, southern thorn and dry mixed deciduous forest. Area under settlement 7.91 km² and cropland 12.76 km² also slightly increases. The increasing trend in cropland and settlement is shown in the (Fig. 6 and 7).

Table 1 Land Use Land Cover Classes -Image Interpretation Key

Land use/ land cover classes	Tone	Shape	Texture
Forest cover	Dark red to red, brown to red	Irregular	Medium to smooth
Settlement	Bluish green, blue mixed red and white	Irregular	Coarse and fine
Cropland	Bright red, pink, brown	Irregular	Medium to smooth or fine
Wasteland	Bright white, greenish blue	Irregular	Medium to smooth

The decreasing trend in the wasteland 26.26 km² is shown in the (Fig. 8). The increase in the forest area is due to favorable climatic condition and also closely monitoring undertaken by the local conservation groups and forest official. The main crops cultivated include paddy, maize, ragi, chilly, pulses, cereals, oil seeds and mustard and cash crops including tobacco, tapioca, jackfruit, cashew nut. The increase in the cultivation of agriculture is due to the availability of water bodies located in the low lying areas, which result in increase of the total population. Due to improvement of their economic condition landless peoples are migrating nearby urban areas in search of jobs and better education for their children’s. But still they are retaining the land rights within the Pachamalai reserve forest area**.**

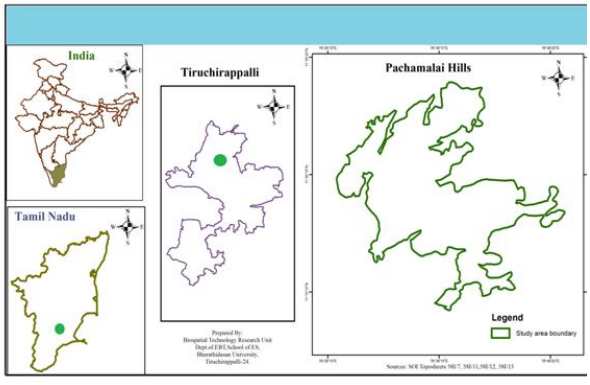

Fig.1 Location Map of the Study Area

Table 2 Land Use Land Cover Change Analysis

Category	MAY			Change during 1998-2012	
	1998	2007	2012	Changes in km²	Variation in %
Forest	384.74 (73.25%)	387.64 (73.73 %)	390.30 (74.31%)	+5.56	+1.06
Settlement	49.40 (9.40 %)	52.21 (9.75%)	57.34 (10.91 %)	+7.94	+1.51
Cropland	55.49 (10.56%)	66.23 (12.60%)	68.25 (12.99%)	+12.76	+2.43
Waste land	35.60 (6.77%)	19.15 (3.64 %)	9.34 (1.77 %)	-26.26	-5

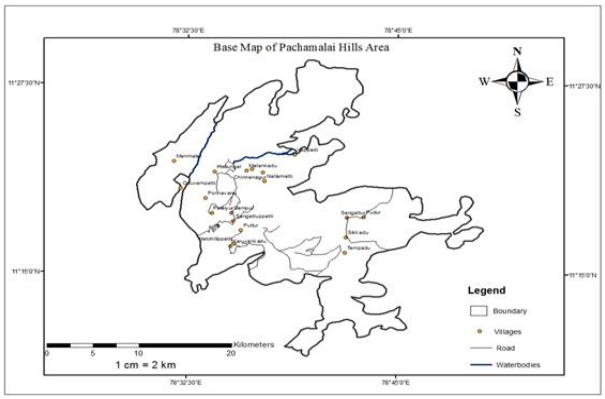

Fig.2 Base Map of the Study Area

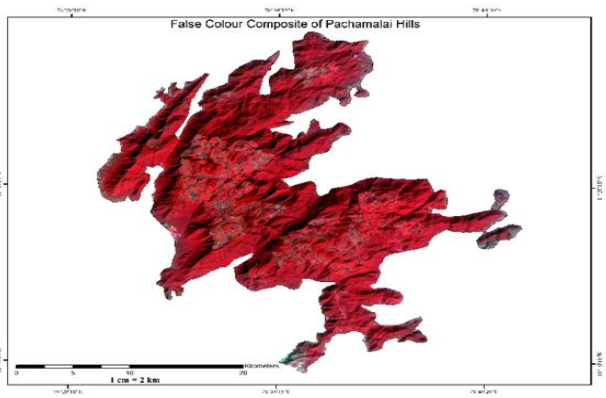

Fig.3 Satellite Imagery of the Study Area

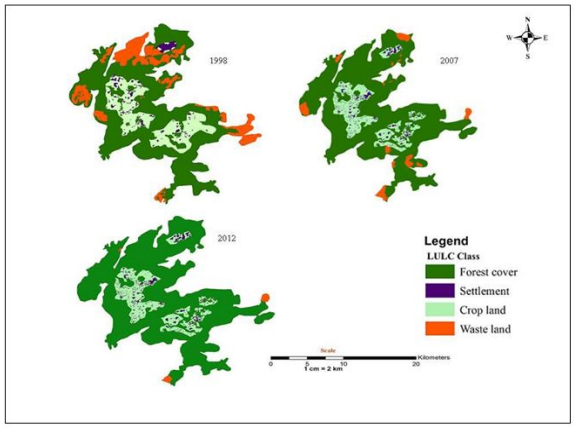

Fig.4 Land Use Land Cover Maps 1998, 2007 and 2012 of the study area

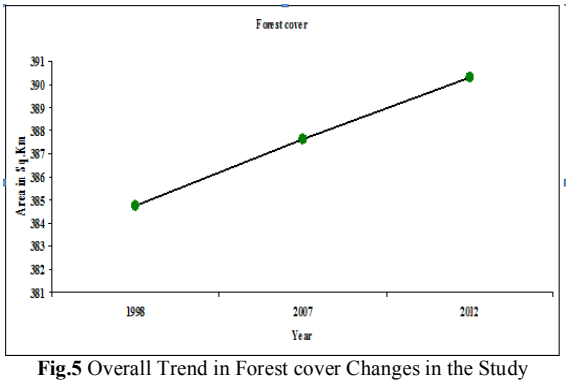

Fig.5 Overall Trend in Forest cover Changes in the Study area during 1998 to 2012

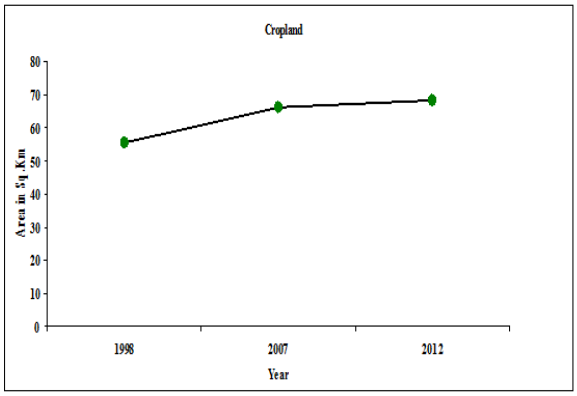

Fig. 6 Overall Trend of Change in Cropland in the Study area during 1998 to 2012

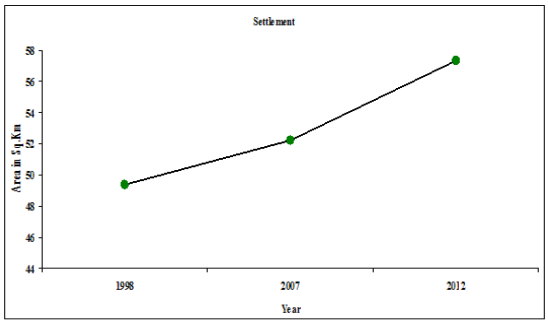

Fig.7 Overall Trend of Change in Settlement in the Study area during 1998 to 2012

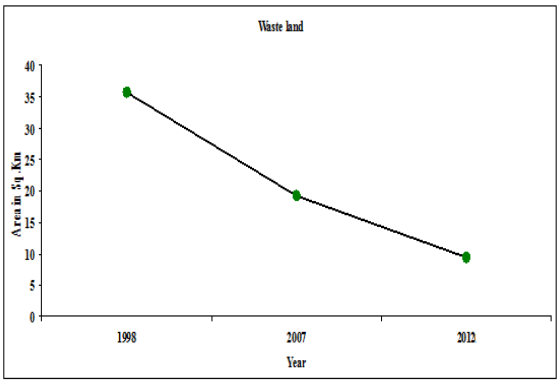

Fig.8 Overall Trend of Change in Waste land in the Study area during 1998 to 2012

CONCLUSION

The present study integrated the techniques of 3S i.e. RS, GIS, and GPS to unveil the landscape ecological alteration of the study area through land use/land cover change analysis of Pachamalai reserved forest since 1998. The study reveals there is an increase in the forest area, crop land, settlement and decrease in wasteland during the study period. This kind of study helps in identifying the biodiversity threats of endemic and endangered species within the study area. Based on these data sets monitoring and management of the forest areas can easily be done and in more scientific way. It is found that land cover pattern in the Pachamalai has experienced complex changes with the rapid social and economic progress. This increase forest cover is mainly due to social forestry, conservation of sacred grooves and preserving the original plant species, increase in population, and awareness among the indigenous people undertaken by forest department and NGOs.

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