Identification of Land use and Land cover Changes using Remote Sensing and GIS

N. Nagarajan and. S. Poongothai

***Abstract* — This study reveals to identify the changes of land use/land cover of rural agricultural watershed of Tamilnadu. The relationship between Land Use and Land Cover Changes (LULCC) has identified using IRS IC LISS III and PAN merged data. Further, the preparation of LULC map using Survey of India (SOI) Toposheet for the year 1972 contain come up to in multipurpose to know the land use pattern. In the same way, the various LULC image classified which has collected from Institute of Remote Sensing (IRS), scanned and digitized using Arc GIS software. The agricultural practices under agriculture land and cropland has most important crash over the hydrological processes of the watershed. Thus, the change detection obtained from LULC serve in most favorable solutions for the selection, planning, implementation and monitoring of development schemes to meet the increasing demands of human needs has lead to land management. The Remote Sensing techniques also cost effective to detect the change in LULC over a large area due to natural and human activities. This study shall be very useful for further development planning.**

Index Terms—Identification of Land use and Land cover change, Land management, Remote sensing techniques and GIS.

I. Introduction

Knowledge of land use and land cover is important for many planning and management activities and considered as essential element for modeling and understanding the earth as a system. Land cover maps have presently developed from local to national to global scales. The use of panchromatic, medium-scale aerial photographs to map land use has been as accepted practice since the 1940s. More recently, small-scale aerial photographs and satellite images have utilized for land use/land cover mapping [1]. Hydrologic modeling to estimate surface roughness or friction values, since it affects the velocity of the overland flow of water. Land-use information, coupled with the hydrologic characteristics of soils on the land surface, can also provide measures of expected percolation and water-holding capacity.

The amount of expected runoff from vegetated land-use types, such as forest, which are not affected by the surface and soil physical properties, but by the uptake capacity of the vegetation present [2]. Thus, the knowledge of both land use and land cover can be important for land planning and land management activities. The USGS devised a land use and land cover classification system for use with remote sensor data in the mid-1970s [3]. The basic concepts and structure of this system are still valid today.

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Land use and land cover change (LULCC), associated with climate changes have became a focus of the study on the interactions between human activities and natural environment. Land cover changes can observe as one of the most sensitive indicators that come back these interactions [4]. Remote sensing can be a good tool for getting wide impression on land cover change. Change detection on land cover focuses mainly on four aspects, (1) detecting if a change has occurred, (2) identifying the nature of the change, (3) measuring the area extent of the change, and (4) assessing the spatial pattern of the change [5]. Since spatial pattern of the land use changes regarded as a good indicator of the impact by the other three aspects, its research has become quite active in change detection study [6]. Many remote sensing change detection methods has been developed to monitor land cover change and to build spatio-temporal patterns of change, in order to derive better understanding of causes and consequences of the change, and to model the tendency of the change. In general, remote sensing change detection method can be dividing into two broad classes, termed as bi-temporal change detection and temporal trajectory analysis [7]. The former has based on the comparison between two dates, and the latter analyzes the tendency of change in a multiple period or a continuous time scale.

Techniques have developed to support these two categories of change detection methods. With the accumulation of remotely sensed images over the past decades, it is now possible to analyze the spatial pattern of land cover change over a long period using images with a higher spatial resolution and multi-temporal coverage. A time series analysis of multi-temporal images will be helpful to understand the sequence patterns of land cover change during the long period and to forecast the trend of changes in future [8],[9]. However, to understand causes of land cover change, study often focuses on the metrics [10], [11] of land cover types that form a part of input parameters together with other environmental or human factors.

This growth, however, has fundamentally based on the large consumption of natural resources such as land and water, which in turn created great impact on the arid environment where the ecosystem is fragile and vulnerable due to the harsh natural conditions. In order to find the balance of economic growth and environmental conservation to achieve sustainable regional development, this research is in need to investigate on what happened in the past and the trend of change in the near future.

The impact of changing land uses relies on the prevailing surface and subsurface hydrologic conditions. Within a basin, the dynamics of hydrologic processes governed partially by the temporal and spatial characteristics of inputs and outputs and the land use conditions [12]. Often it is forests, which are at risk in the process of LULCC [13].

The synoptic view of the area allows better monitoring capability, especially when the coverage is repetitive, interval is short, and resolution of the image is high. Techniques and methods of using satellite imageries as data sources have been developed and successfully applied for land use classification and change detection in various environments including rural, urban and urban fringe areas [14-17].

II. Objectives

The present study includes preparation of LULCC during the last few decades, understanding the influences of human interventions in the basin and formulating comprehensive and effective mitigation strategies for land conservation in the study area using Remote Sensing and GIS.

The objectives are:

- To identify the nature and extent of Land Use/Land Cover Changes for the past 25 years,
- To identify the major components that promotes in land uses (2003 – 2007).

III. Study Area

The study area lies between the geo-coordinates 11° 28' N to 11° 42' N Latitudes and 79° 14' E to 79° 27' E Longitudes with an aerial extent of 272.89 km^2. The Vellar River flows through the Cuddalore, Villupuram, Salem and Trichy districts of Tamilnadu. The river originates from the Southern slopes of Kalrayan Hills at the Northern boundary of Attur Taluk of Salem District. The river then flows in an easterly direction, crosses the Kumbakonam–Villupuram road through Sethiyathope regulator and finally ends into the Bay of Bengal near Portnovo in Chidambaram Taluk of Cuddalore district. The most predominant land use found is Agricultural with an aerial extent of 81 per cent of the total area. Water bodies and wastelands identified to covers about 7 per cent and 4 per cent respectively.

IV. Materials and Methods

Survey of India topographical map sheets of scale 1:50,000 and interpreted satellite maps of IRS – IC, LISS III data and LISS III with PAN merged data for the year 2003 and 2007 were collected from IRS, Anna University, Chennai.

The image elements correlated with ground truth verification and tonal variation representing the different classes was marked on the hard copy image 1972, 1996, 2003 and 2007. The functionalities of GIS namely, Overlay analysis was applied to identify the areas of changes taken place.

V. Results and Discussion

The major common Land use and Land cover categories such as forestland, wasteland, settlement, water bodies (river and tanks), agriculture land are identified and mapped from the SOI topographic sheets of the year 1972, it was compared with those prepared from the satellite imageries (IRS 1C LISS III), and IRS LISS with Pan merged data. The drawn maps for the year 1996, 2003 and 2007 have digitized and rasterised, it have been carried out using Arc GIS 9.1 Software to create land use coverage and LULCC are identified. Land use and Land cover map of 1972 was prepared from SOI toposheets while those of 1996, 2003 and 2007 were prepared from the satellite imageries based on ground truth observations and verifications. The Visual interpretations techniques adopted and identify its areal extent of total area 272.89 Km^2 (Table 1).

The most salient changes in land use and land cover has been quick augment in total area as percentage represented by graphically shown in Figure 1 (1972, 1996, 2003 and 2007). The Land use and Land cover map shown in Figure 2 (2003) and Figure 3 (2007). The Land use and Land cover changes map (2003 – 2007) deduced as shown in Figure 4. Agricultural plantations changes into other category are built-up land, cropland, degraded forest, dense forest, fallow land, mining, salt affected land, and water bodies of about 20.388 Km^2. The Cropland changes into other categories are built-up land, agricultural plantations, degraded forest, dense forest, fallow land, mining, salt affected land, water bodies of nearly 52.559 Km^2. The degraded forest, dense forest, fallow land, salt affected lands, water bodies are changes into other categories of 7.986 Km^2 are shown in Figure 5 and the area of change detection details are given in Table 2.

VI. Conclusion

Agricultural lands have decreased considerably because of human interference. It is necessary, before implementing any sort of land use practices in the study area in future by considering the existing socio-economic scenario.

It has expected that the findings of the investigation will undoubtedly be useful to planners and local bodies to implement suitable land use plans in the watershed, thereby achieving eco-preservation and enabling the restoration of degraded land units to the maximum possible extent. Local people should aware of the consequences of conversion of paddy fields. Land and water management activities should conducted only after detailed land use planning, sand mining from rivers should be regulated and further expansion of agricultural plantation at the expense of other crops. Remote sensing was quite useful for land use and land cover mapping. It was found that main impact of random growth of settlement is on the surrounding agriculture land and land with or without scrub.

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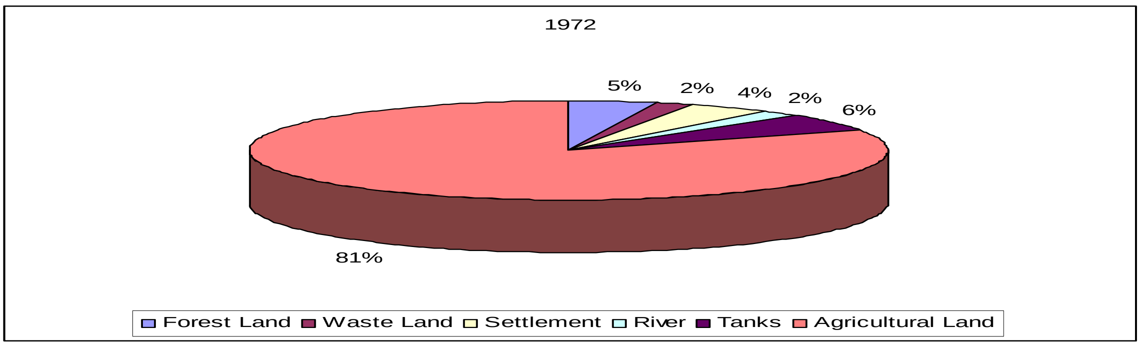
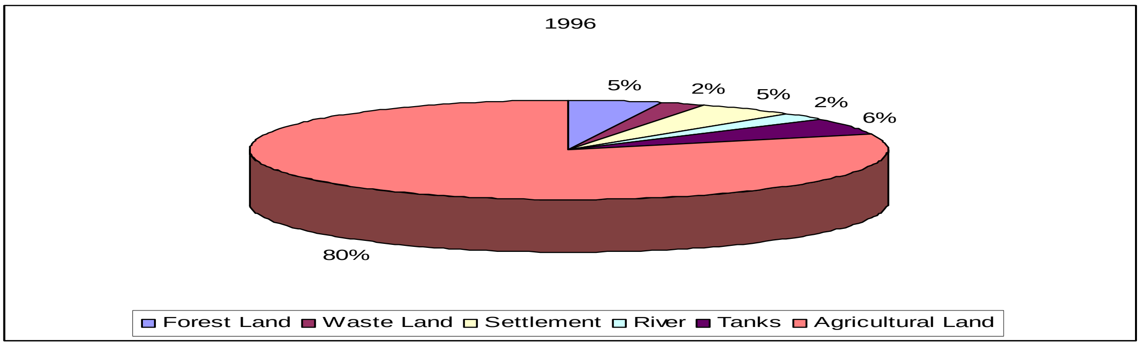
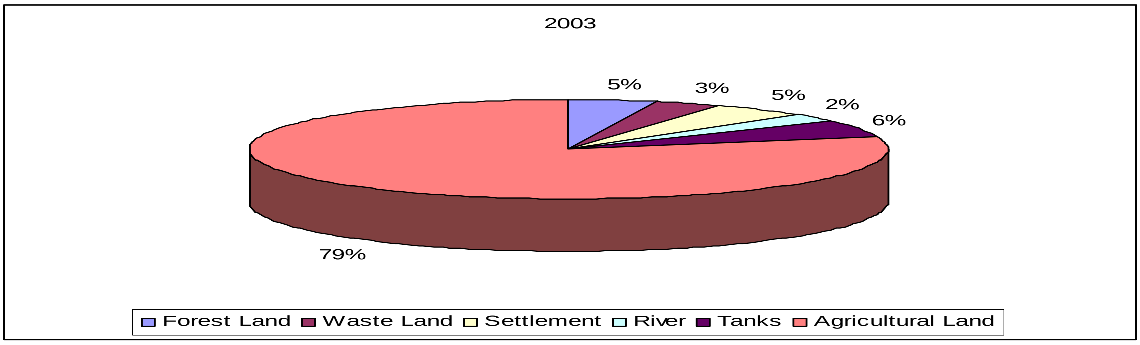
TABLE I: CHANGE DETECTION OF LAND USE/ LAND COVER OF THE STUDY AREA (1972 – 2007)

Sl. No	Level	1972	1996	2003	2007
		Area (Sq.Km)	Area (Sq.Km)	Area (Sq.Km)	Area (Sq.Km)
1	Forest Land	12.415	12.560	12.339	13.646
2	Waste Land	5.002	6.303	8.564	7.527
3	Settlement	11.110	13.669	14.131	15.688
4	River	5.611	6.525	6.519	6.516
	Tanks	15.518	15.347	15.374	15.356
5	Agricultural Land	223.222	218.492	215.969	214.163
Total		272.896			







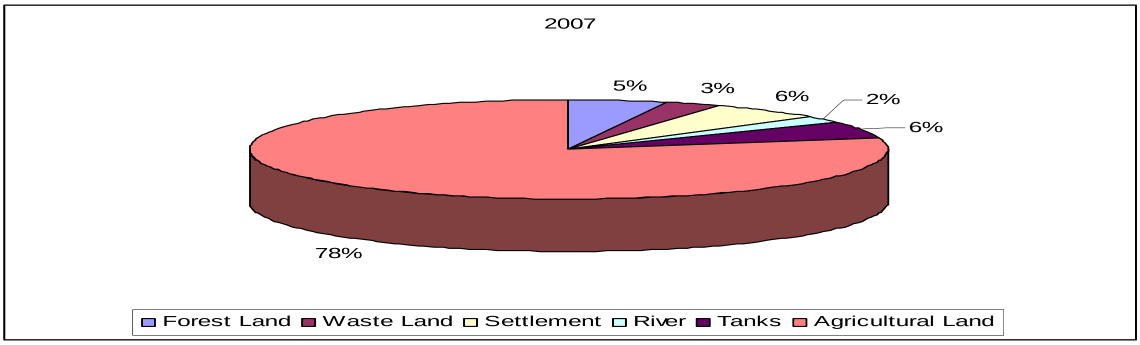


Figure 1. Land use and Land cover pattern (1972, 1996, 2003 and 2007)

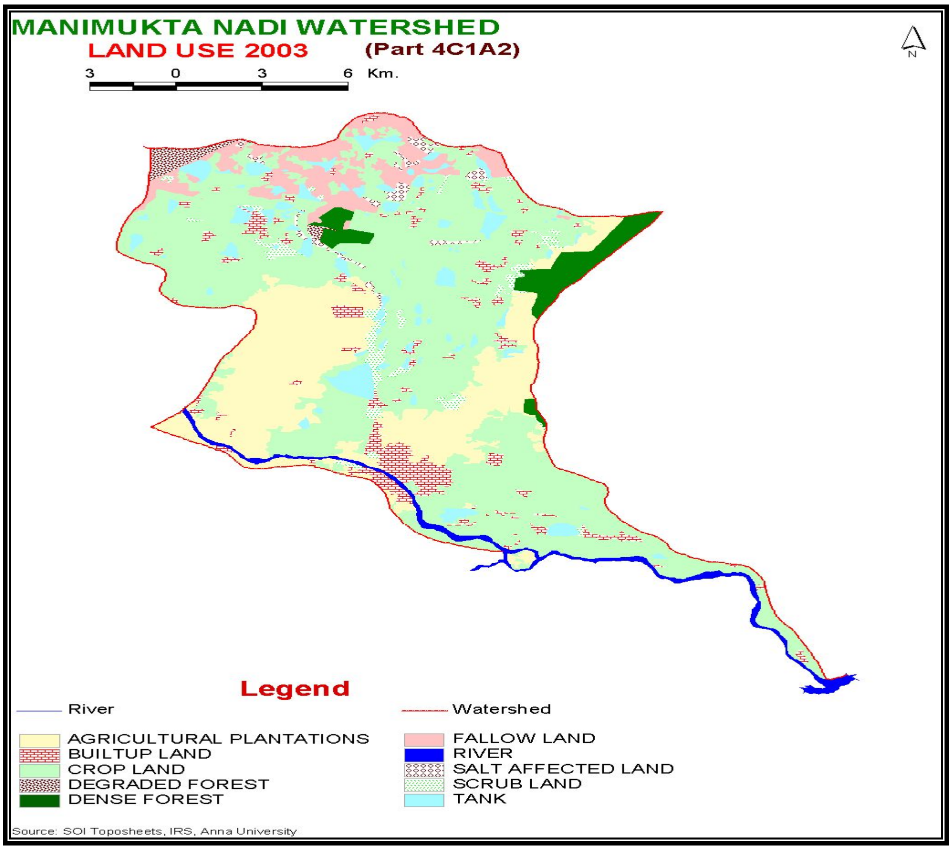


Figure 2. Land use and Land cover map (2003)

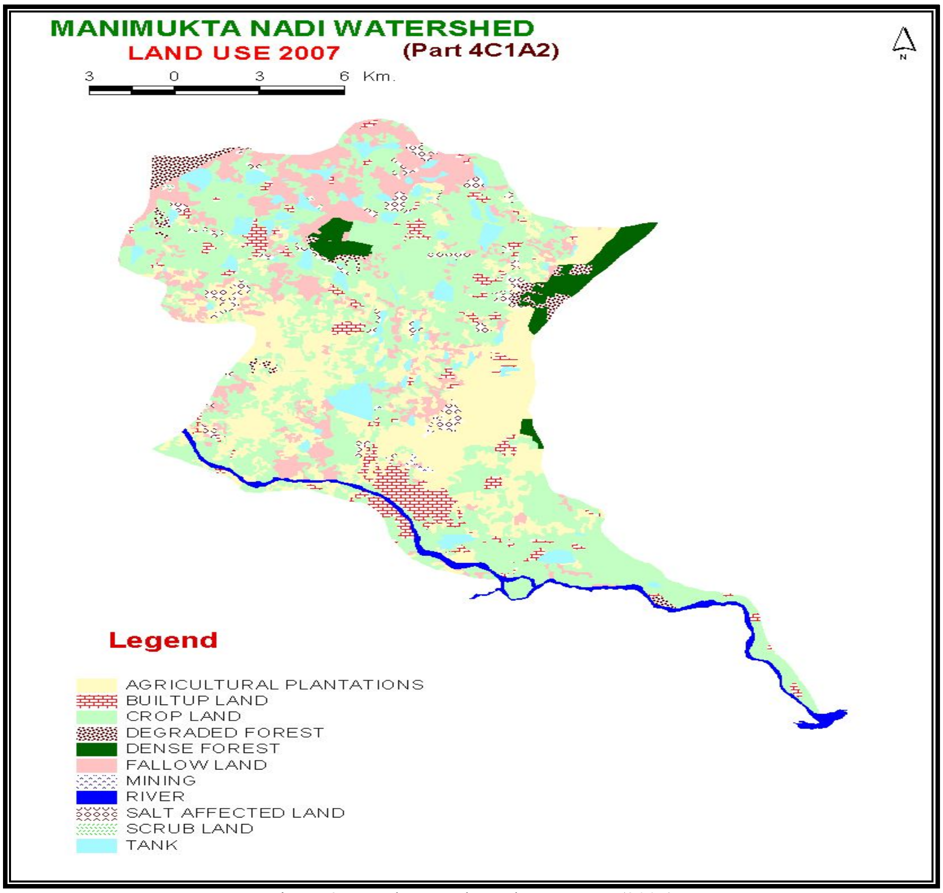


Figure 3. Land use and Land cover map (2007)

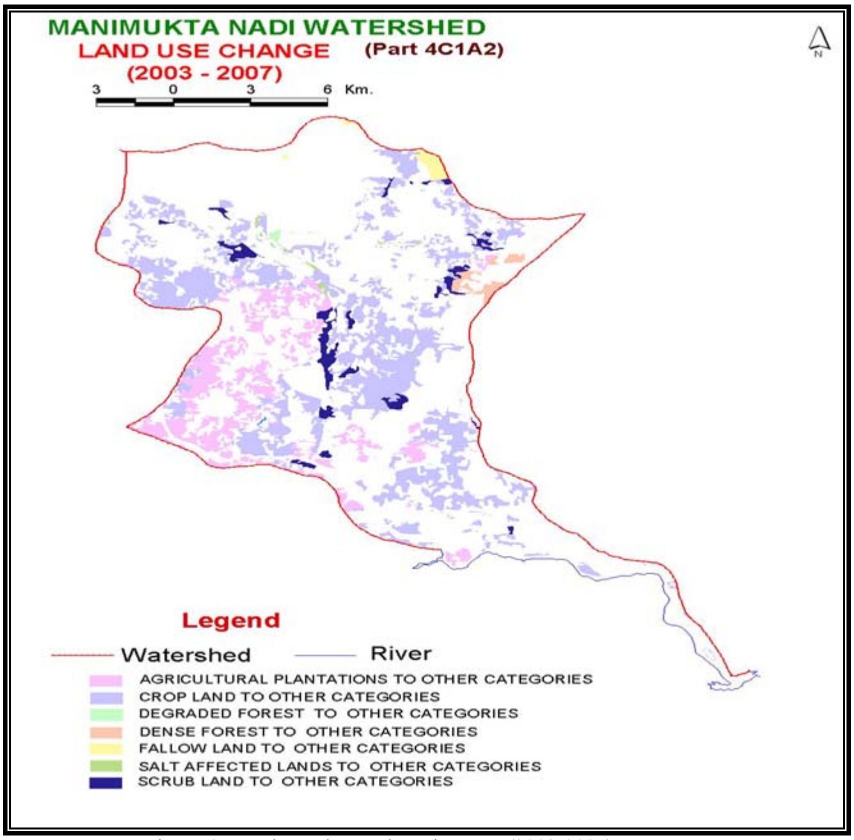


Figure 4. Land use change detection map (2003-2007)

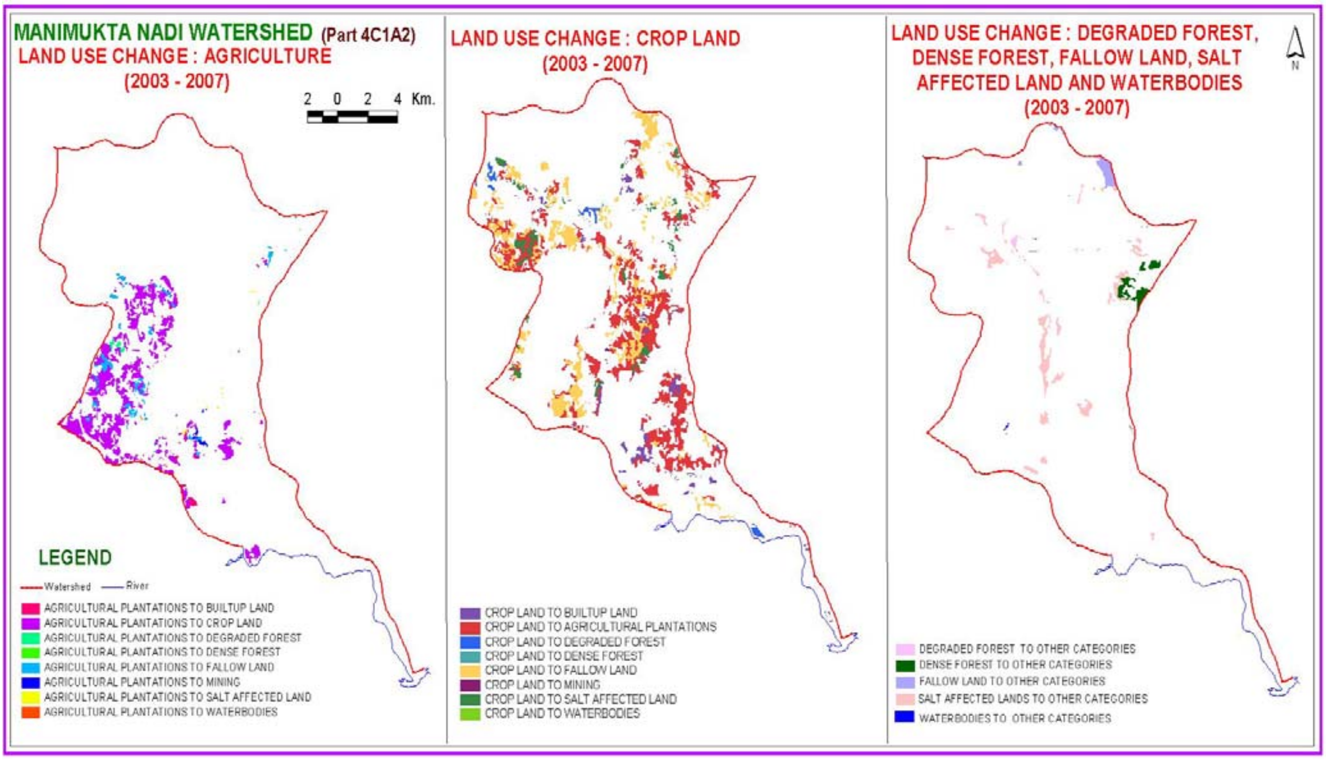


Figure 5. Identification of Land use/ Land cover change detection map (2003-2007)

TABLE II: AREA OF CHANGE DETECTION DETAILS

Existing Land use	Present Land use	Area (Km^2)
Agricultural plantations	Built-up land	0.548
Agricultural plantations	Crop land	16.787
Agricultural plantations	Degraded forest	0.277
Agricultural plantations	Dense Forest	0.028
Agricultural plantations	Fallow land	2.315
Agricultural plantations	Mining	0.246
Agricultural plantations	Salt Affected Land	0.169
Agricultural plantations	Water bodies	0.017
		20.388

Existing Land use	Present Land use	Area (Km^2)
Crop lands	Built-up land	3.355
Crop lands	Agricultural Plantations	27.458
Crop lands	Degraded forest	1.024
Crop lands	Dense Forest	0.016
Crop lands	Fallow land	17.140
Crop lands	Mining	0.071
Crop lands	Salt Affected Land	3.464
Crop lands	Water bodies	0.032
		52.559

Existing Land use	Present Land use	Area (Km^2)
Degraded forest	Crop land	0.001
Degraded forest	Dense Forest	0.207
Degraded forest	Fallow land	0.002
Degraded forest	Salt Affected Land	0.004
Dense forest	Agricultural Plantations	0.029
Dense forest	Crop land	0.009
Dense forest	Degraded forest	1.726
Dense forest	Fallow land	0.006
Dense forest	Salt Affected Land	0.016
Fallow land	Built-up land	0.035
Fallow lands	Agricultural Plantations	0.001
Fallow lands	Crop land	1.332
Salt affected lands	Agricultural Plantations	0.108
Salt affected lands	Crop land	0.237
Salt affected lands	Degraded forest	0.015
Salt affected lands	Dense Forest	0.001
Salt affected lands	Fallow land	0.055
Scrub land	Agricultural Plantations	0.666
Scrub land	Built-up land	0.154
Scrub land	Crop land	2.571
Scrub land	Degraded forest	0.006
Scrub land	Dense Forest	0.006
Scrub land	Fallow land	0.867
Scrub land	Mining	0.004
Scrub land	Salt Affected Land	1.133
Scrub land	Water bodies	0.002
Water bodies	Agricultural Plantations	0.037
Water bodies	Crop land	0.011
Water bodies	Fallow land	0.005
		7.986