Trend in Land Use/Land Cover Change Detection by RS and GIS Application

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***Abstract* – The study aims to effects of Land Use / Land Cover Changes (LU/LCC) is the quantitative method, to expound the impact of land use/land cover changes in Manimuktha sub-watershed of Vellar basin, Tamilnadu, India. The relationship between Land Use Changes and its trend is analysed using IRS IC LISS III and PAN merged data. Further, the preparation of LU/LC map using Survey of India (SOI) Toposheet for the year 1972 has come in handy to know the past land use pattern. Similarly, the Land Use/Land Cover (LU/LC) map of various years, namely, 1996, 2003 and 2007, which was obtained from Institute of Remote Sensing, Anna University (IRS) and digitized, using Arc GIS 9.1 software. About 52.89 per cent of land is devoted to agricultural practices under agriculture and cropland has a major impact over the hydrological processes of the basin. Hence, the information obtained from change detection of LU/LC aids in providing optimal solutions for the selection, planning, implementation and monitoring of development schemes to meet the increasing demands of human needs has lead to land management.**

Keywords – Trend in Land Use/Land Cover Changes, Watershed management, Land management, Remote sensing 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 are presently being 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 been 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, is not only affected by the surface and soil physical properties, but also by the uptake capacity of the vegetation present [2]. Thus, a 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. The knowledge of spatial land cover information is essential for proper management, planning and monitoring of natural resources [4]. For example, it is a desired input for many agricultural, geological, hydrological and ecological models. In addition, any natural hazard study such as landslide hazard zonation [5], [6] highly depends on the availability of accurate and up-to-date land cover information. Due to synoptic view, map like format and repetitive coverage, satellite remote sensing imagery is a viable source of gathering quality of land cover information at local, regional and global scales [7],[8].

The high growth of population, climate change, and overconsumption of ecosystem services emerges to be the greatest threat and tends to the biggest challenge for the society [9]. He [10] states that, land is a raw material for modeling future society and institutions. The land [11] an important resource, it only determines the rate of development of man's economic and social activities. Land is an area of the earth's surface, human interference and interaction with this natural environment result in land use. The Land use [12] of an area is a resultant of human controls over the land resources in relatively systematic manner. The equilibrium of nature was maintained, by maintaining all types of land such as forestland, wetland, wasteland, cultivable land, etc. in a balanced way. 'Land cover describes the physical appearance of the earth's surface, while land use is a land right related category of economically using the land' [13].

The in-depth knowledge gained through the categorization and case studies of land use change will become handy in developing regional and global LULCC models. Land use studies and analysis has become a pre-requisite for proposing for developmental activities in an area. The growing demands on land have resulted in a crisis of land mismanagement. Land resources are the foundation for the socio-economic development at the national, regional and local levels in many of the developing countries such as India.

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 [14]. Often it is forests, which are at risk in the process of LU/LCC [15]. 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 [16] – [19]. 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 main objectives of the study are:

- To analyse the nature and extent of Land Use/Land Cover Changes of the study area in the past 25 years (1972 – 2007),

- To identify the major components that promotes for trend in land uses (2003 – 2007).

II. MATERIALS AND METHODS

The Sub watershed of Manimuktha watershed (4C1A2a) of Vellar Basin in Tamilnadu, India considered for this study. The study area extends between North Latitudes 11° 28’ to 11° 42’ and East Longitudes 79° 14’ to 79° 27’ with an aerial extent of 272.89 km^2. 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 covering about 7 per cent and 4 per cent respectively. The following data used are,

- Survey of India (SOI) topographic maps (58 M/2, 58 M/6, 58 M/7 and 58 M/10) on a scale of 1:50,000, IRS-IC-LISS III data acquired on May 5, 1996, IRS-IC-LISS-III, and LISS, PAN merged data acquired for the year 2003 and 2007 were used for land use classification.

- Base maps including road, railway, settlement, village location and watershed boundary extracted from the topographic sheets and converted into GIS database and further the modifications in the LULC map updated by cross correlating with Remote Sensing Imageries.

- The image elements correlated with ground truth verification and tonal variation representing the different classes was marked on the hard copy 1972 (Figure 1), 1996 (Figure 2), 2003 (Figure 3) and 2007 (Figure 4). The functionalities of GIS namely, Overlay analysis was applied to identify the areas of changes taken place.

III. RESULTS AND DISCUSSION

The major common Land Use categories such as agriculture, riverbed, water, urban, fallow, wasteland identified and mapped from the SOI topographic sheets. The land use of the year 1972 was mapped, classified and calculated accurately from the toposheets, it was compared with those prepared from the satellite imageries (IRS 1C LISS III), and IRS Pan merged data. The IRS 1C LISS III data used as the source for the land use/land cover mapping. The registration and digitization of the watershed was done using Arc GIS 9.1 Software to create land use coverage. Six land use categories i.e. agriculture, urban, fallow, water, riverbed and wasteland are identified. Land use/Land cover map of 1972 was prepared from toposheets while those of 1996, 2003 and 2007 were prepared from the satellite imageries based on ground observations.

The Change Detection of Land use/ Land cover of the study area (1972 – 2007) and its areal extent were given in Table 1. The total study area is 272.89 Km^2. The most salient change in land use has been the quick augment in

area under agricultural land, Cropland from 81.21 % in 1972 to 40.52 % in 2007of the total area, with a related decrease in agricultural plantation from 0.59 % of the area in 1972 to now 24.51 % in 2007. There was small increase in built-up land and mining area from 4.07 % in 1972 to 5.75 % in 2007, possibly due to improve forestland for dense and degraded forest. There was little change in the wasteland such as upland with or without scrub and salt affected land from 1972 to 2007.

The fallow/harvested land was 0.00 % in 1972, 40.54 % in 1996 and 13.45 % in 2007 and the Cropland was 81.21 % in 1972, 35.07 % in 1996, 51.54 % in 2003 and 40.52 % in 2007. The geographical conditions of the study area in the district are quite suitable for paddy and sugarcane cultivation. The land use/ land cover changes for the year 2003 to 2007 are shown in Figure 5. The trend in change detection maps are prepared by overlay analysis of the land use maps of the years 2003 and 2007 (Figure 6). The conversion of fallow/harvested lands, which are reducing for excess water, to other purposes increases the flood hazard. Because of the reduction in water holding areas (wetlands), the district is also facing the threat of drought. Thus, management of land, especially the conversion of paddy fields in to building sites/other crops, under-utilization of potential croplands, coupled with growth in population and industries drive most of the land use changes in the Vellar River Basin.

IV. CONCLUSION

Consideration of the existing socio-economic scenario is necessary before implementing any sort of land use practices in the study area in future. It is expected that the findings of the investigation will undoubtedly be of use to planners and local bodies to implement suitable land use plans in the watershed, thereby achieving eco-preservation and enabling the restoration

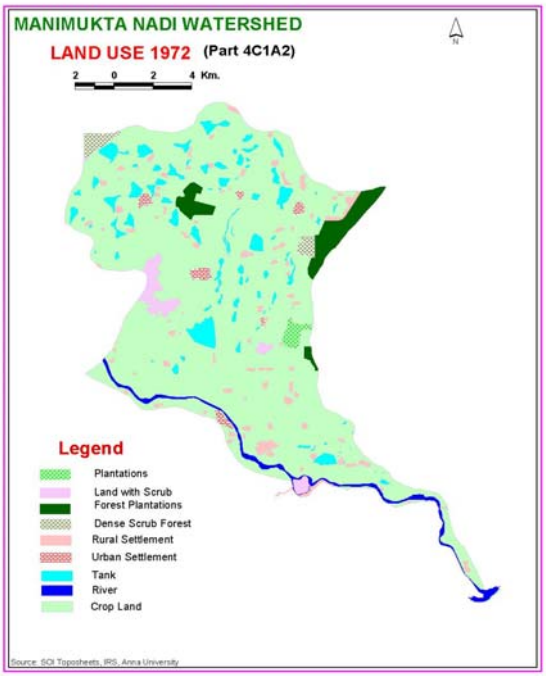

Fig. 1 Land use map (1972)

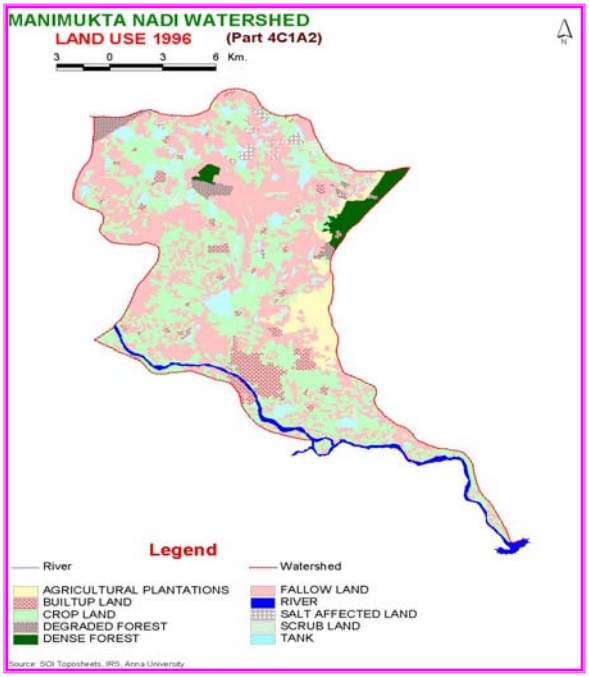

FIG. 2 Land use map (1996)

of degraded land units to the maximum possible extent. Local people must be made aware of the consequences of conversion of paddy fields. Land and water management activities must be 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.

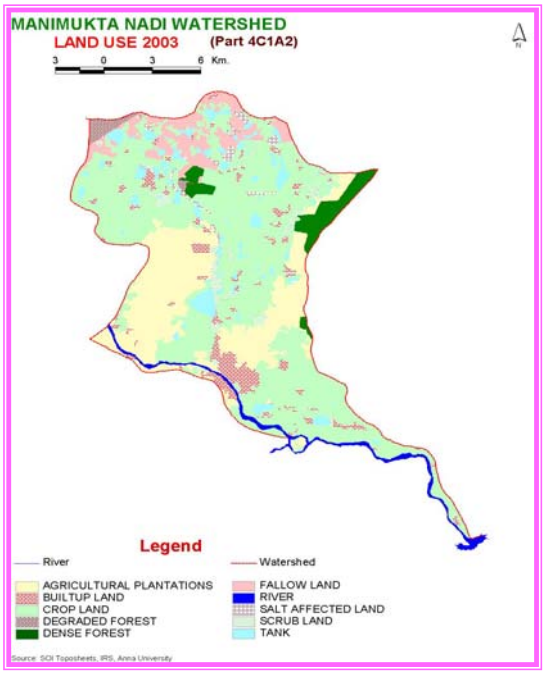

Fig. 3 Land use map (2003)

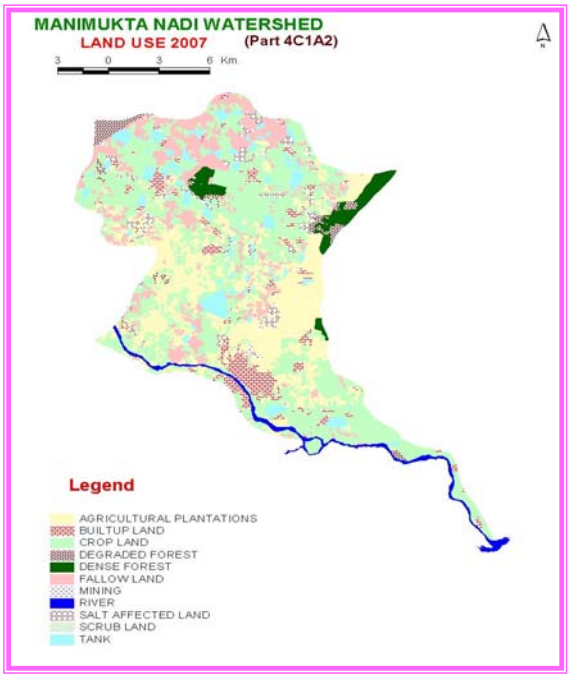

Fig.4 Land use map (2007)

Table 1 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)	Area (Sq.Km)	% Area (Sq.Km)	Area (Sq.Km)	% Area (Sq.Km)
1	Forest Land		12.415	4.550	12.560	4.602	12.339	4.522	13.646	5.000
2	Waste Land		5.002	1.833	6.303	2.310	8.564	3.138	7.527	2.758
3	Settlement		11.110	4.071	13.669	5.009	14.131	5.178	15.688	5.749
4	Water Bodies	River	5.611	2.056	6.525	2.391	6.519	2.389	6.516	2.388
		Tanks	15.518	5.687	15.347	5.624	15.374	5.634	15.356	5.627
5	Agricultural Land		223.222	81.803	218.492	80.064	215.969	79.139	214.163	78.478
Total			272.878	100	272.896	100	272.896	100	272.896	100

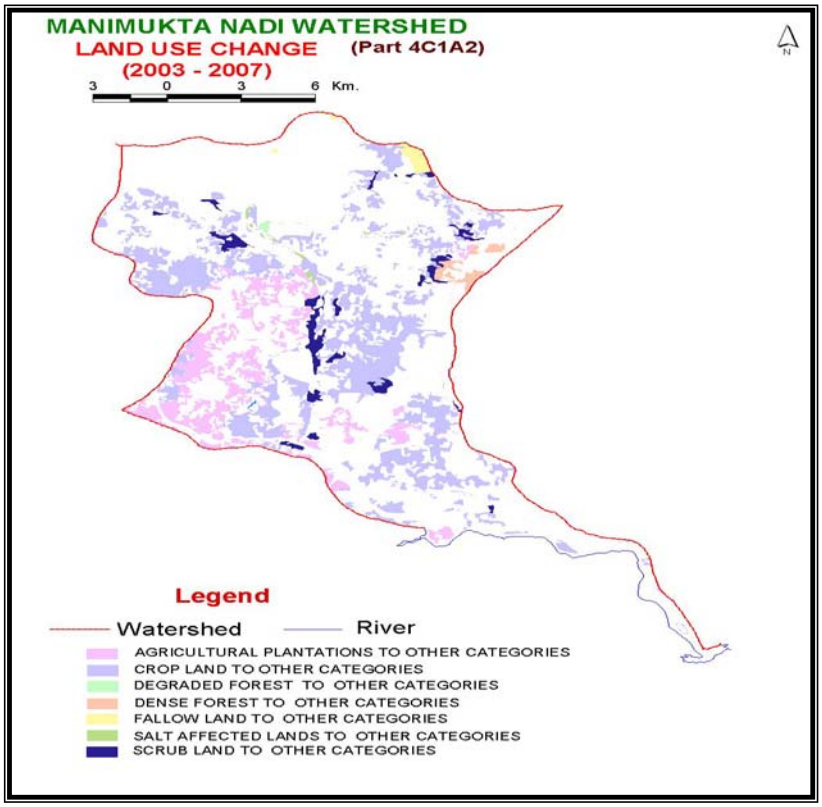

Figure 5 Land use change detection map (2003-2007)

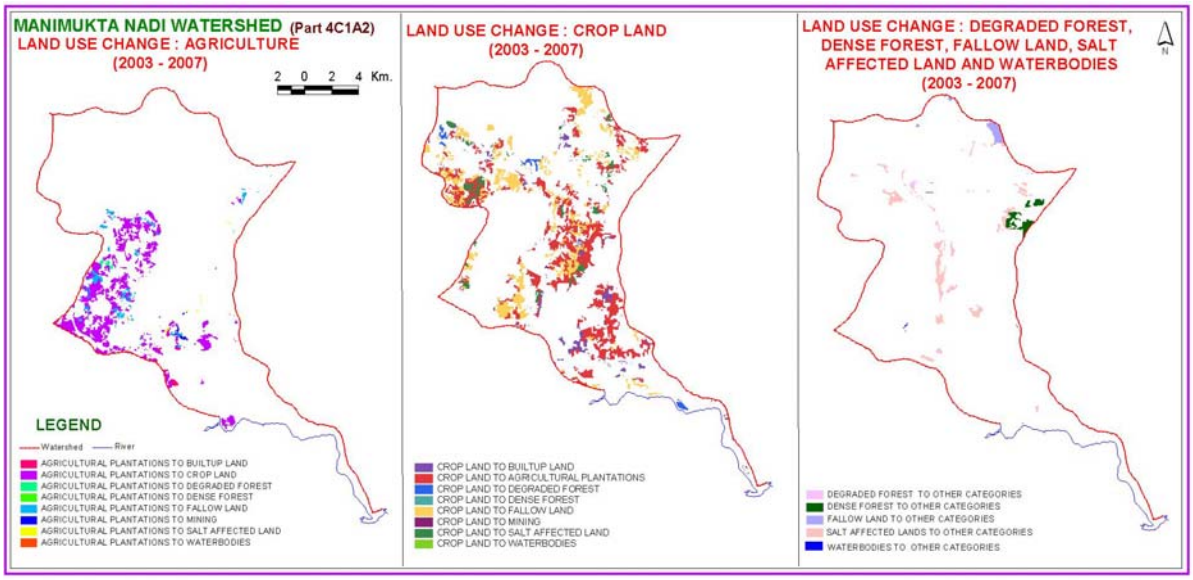

FIGURE 6 TREND IN LAND USE/ LAND COVER CHANGE DETECTION MAP (2003-2007)

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