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Change Detection of Land use/ Land Cover of a Watershed using Remote Sensing and GIS

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Abstract: - This study reveals to identify the changes of Land Use/Land Cover of the Kiliyar sub-watershed of Tamilnadu. In this study, Kiliyar sub-watershed is chosen as study area which is located partly in Thiruvannamalai and Kanchipuram districts. The objectives of the study are to prepare temporal Land Use/Land Cover maps of the study area to analyze the nature and extent of Land Use/Land Cover changes of the study area and to identify the major components those promote the trend changes in the Land Use/Land Cover. Satellite imageries and toposheets are collected from IRS, Anna University. Both satellite imageries and toposheets are georeferenced to get the Land Use/Land Cover maps for different years (1995, 2003 and 2009) of the study area. The digitization of maps was done using ArcGIS (version 9.3) software. The change detection of LU/LC of the study area are analysed and compared. The results are presented spatially as well as graphically by GIS maps and pie-charts. From this study it is inferred that there are significant changes in wasteland, forest and water bodies in the study area. It is necessary to conserve forest and water bodies of the study area for sustainable development. This study will be useful for efficient watershed management.

Index Terms—Arc GIS, Land Use/ Land Cover, Watershed , Toposheets.

I. INTRODUCTION

A knowledge of land use and land cover is important for many planning and management activities and is considered an essential element for modelling and understanding the earth as system (Lillesand,2008). 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 a accepted practice since the 1940s More recently small scale aerial photographs and satellite images have been utilized for land use/land cover mapping The term land cover relates to the type of feature present on the surface of the earth. Corn fields, lakes, maple trees, and concrete highways are all examples of land cover types. The term land use relates to the human activity or economic function associated with a specific piece of land. As an example, a tract of land on the fringe of an urban area may be used for single-family housing. Depending on the level of mapping detail, its land use could be described as urban use, residential use, or single-family residential use. The same tract of land would have a land cover consisting of roofs, pavement, grass, and trees.

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For a study of the socioeconomic aspects of land use planning (school requirements, municipal services, tax income, etc.), it would be important to know that the use of this land is for single-family dwellings. For a hydrologic study of rainfall-runoff characteristics, it would be important to know the amount and distribution of roofs, pavement, grass, and trees in this tract. Thus, a, knowledge of both land use and land cover can be important for land planning and land management activities. Procedure for Paper Submission

Geographic Information System

Geographic Information Systems (GIS) and Remote Sensing (RS) techniques provide effective tools for analyzing the land use dynamics of the region as well as for monitoring, mapping and management of natural resources. Some recent studies have shown the use of RS and GIS in land use Change Detection. Micro-watershed study helps in identifying the areas causing problems and ultimately becomes a step towards planning to mitigate the problems. The present study aims at mapping of Land Use / Land Cover for the years (1995, 2003 and 2012) and quantifying the changes in Land Use. Another recent development in the use of satellite data is to take advantage of increasing amounts of geographical data available in conjunction with geographic information systems to assist in interpretation. Geographical data describe objects from the real world in terms of (a) their position with respect to a known coordinate system, (b) their attributes that are unrelated to the position (such as colour, type, cost, pH, incidence of disease, etc.) and (c) their spatial interrelations with each other (topological relations), which describe how they are linked together or how one can travel between them (Burrough, 1986).

Change Detection of Land Use/ Land Cover

An increasingly common application of remotely sensed data is for change detection. Change Detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest. Change Detection is useful in such diverse applications as land use change analysis, monitoring shifting cultivation, assessment of deforestation, the study of changes in vegetation phonology, seasonal changes in pasture production, damage assessment, crop stress detection, disaster monitoring, day/night analysis of thermal characteristics as well as other environmental changes (Singh, 1989).

Scope and Objectives of the Study

Tiruvannamalai and Kanchipuram districts, Tamilnadu have witnessed a remarkable expansion, growth and developmental activities such as building, road construction, deforestation and many other anthropogenic activities. This has therefore resulted in increased land consumption and a modification and alterations in the status of Land use/ Land cover over time without any detailed and comprehensive attempt (as provided by a Remote Sensing data and GIS). This Study attempted to evaluate the status of changes occur in LU/LC of the kiliyar sub-watershed (4C2A1C) using RS&GIS. The results of this study will help the planners for efficient LU/LC management in the study area.

The objectives of the study are

- To prepare temporal Land Use/Land Cover maps of the study area
- To analyze the nature and extent of Land Use/Land Cover changes of the study area.
- To identify the major components those promote the trend changes in the Land Use/Land Cover.

II. STUDY AREA

A Kiliyar sub-watershed is one of the tributaries of Cheyyar watershed. Cheyyar sub watershed is one of the tributaries of Palar basin. Kiliyar sub-watershed originates from Thiruvannamalai district and destinates in Kanchipuram district. The study area is covered by Survey of India toposheets of 57P/6, 57P/7, 57P/10, 57P/11 and 57P/14. Kiliyar watershed extends between east longitudes 79° 53' 26" and 79° 25' 10" and North latitudes 12° 41' 9" and 12° 22' 32". Kiliyar sub-watershed boundary of the Palar basin is chosen for the study as presented in Figure 1.

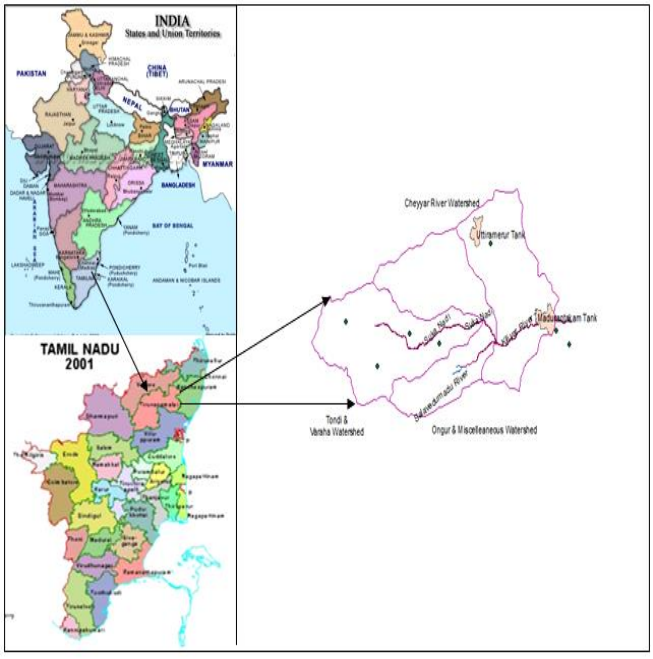

Fig. 1 Index Map of Study Area

Rainfall

There are three rain gauge stations within the sub-watershed with one of the station at Maduranthagam just outside the boundary of the sub-watershed. The annual rainfall in the sub watershed varies from 2600 mm to 800 mm. Three rain gauge stations are Madurantakam, Vandavasi and Uthiramerur. Major storage tank available in the study area are Madurantakam and Uthiramerur tank.

Soil type and Geology

The study area forms a steep slope and soil erosion is a major problem. The total area of this sub watershed is 1663 km^2. Soil types, such as alluvium, silt, clay, sand and gravel are available in this study area and the available minerals are laterite, Quartz, Sand stone and Charnockite.

Land Use/Land Cover

Based on prior knowledge of the study are for 14 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification scheme was developed for the study area such as Agriculture, Wastelands, Water bodies, Forest, Built-up land. The temporal Land Use maps of (1995, 2003 and 2009) are shown in Figures 2-4.

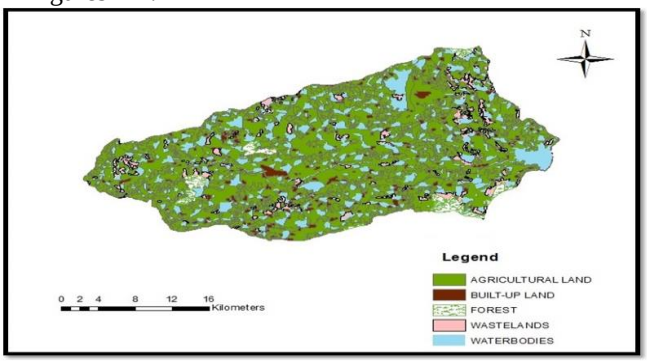

Fig. 2 Land Use/Land Cover Map of Kiliyar Sub-Watershed (1995)

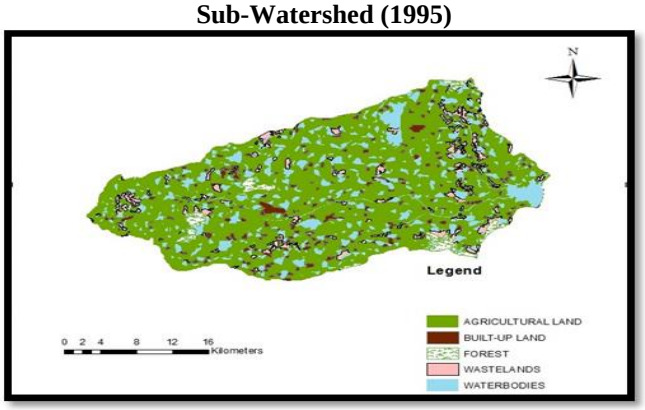

Fig. 3 Land Use/Land Cover Map of Kiliyar Sub-Watershed (2003)

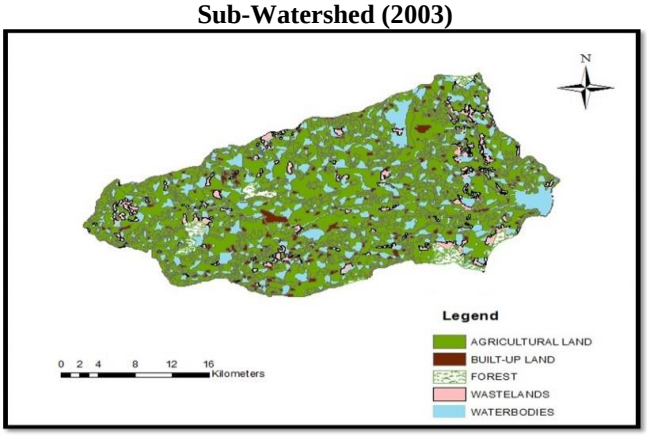

Fig. 4 Land Use/Land Cover Map of Kiliyar Sub-Watershed (2009)

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III. MATERIALS AND METHODS

Data Collection

The following data were used in this study

- Land Use map from Institute of Remote Sensing, Anna University, Chennai.
- Linear Imaging Self Scanning (LISS) image for 1995, 2003 and 2009 were (source: www.from landcover.org website) used.

Methodology

The procedure adopted in this study forms the basis for deriving statistics of land use dynamics and subsequently in the overall, the findings. The methodology adopted in this work was divided into three parts. First part is data collection from various sources; classification is the second part and finally analysis of Land Use/Land Cover system. Toposheets and satellite imageries were processed through Arc GIS software (version 9.3), initially Land Use/Land Cover classification system is done, and then ground truthing and finally Land Use/Land Cover map for different years were prepared. Then change detection analysis is done for different years. The overall procedure of methodology is shown in Figure 5

Development of a Classification Scheme

Based on prior knowledge of the study area for 10 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification scheme was developed for the study area after Anderson et al(1967). The classification scheme developed gives a rather broad classification where the Land Use/ Land Cover was identified by a single digit as shown in table below

Code	Land Use/Land Cover categories
1	Agriculture
2	Wasteland
3	Built-up land
4	Forestland
5	Water bodies

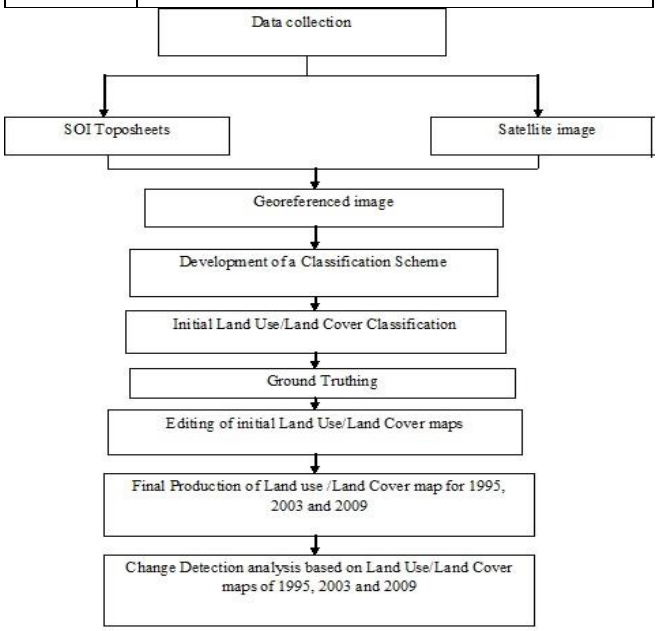

Fig. 5 Methodology for Change Detection of Land Use/Land Cover of the Study Area

IV. RESULTS AND DISCUSSION

The static land use/ land cover distribution for each study year as derived from the maps are presented in the table 1. The pie chart of Land Use Classification System is shown in Figure 6 a, 6b, 6c for 1995, 2003 and 2009 respectively.The major common land use categories such as agriculture, forest, water, built-up lands, and wasteland identified and mapped from the SOI topographic sheets. The land use of the years 1995, 2003 and 2009 were mapped, classified and calculated accurately from the Toposheets, it was compared with those prepared from the satellite imageries (IRS1C LISS III). The IRS 1C LISS III data is used as the source for the Land Use/Land Cover mapping. The registration and digitization of the watershed was done using Arc GIS Software to create land use coverage. Five land use categories i.e. agriculture, forest, water, Built-up lands, wastelands are identified and Land Use/Land Cover map of 1996, 2003 and 2007 were prepared from the satellite imageries based on ground observations. Agricultural land in 1995 is 82.50% is reduced into 82.04 % in 2009 this is due to change in agriculture field into built-up lands and waste lands. Waste land in 1995 is 3.04% is increased into 5.57 %. This is due to change in agriculture lands during that period.

Built-up land in 1995 is 2.57%, when compared to 2009 which is 2.50%. Forestland in 1995 is 2.49% which is reduced to 1.62% in 2009; this class is converted into other land use classification system such as wastelands. Water bodies in 1995 are 9.40% which is reduced into 8.26 % in 2009 this is due to change in other classification systems etc.

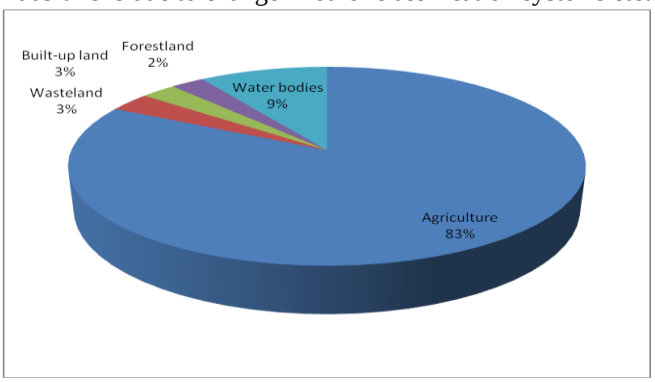

Figure 6 a) Land use Classification (1995)

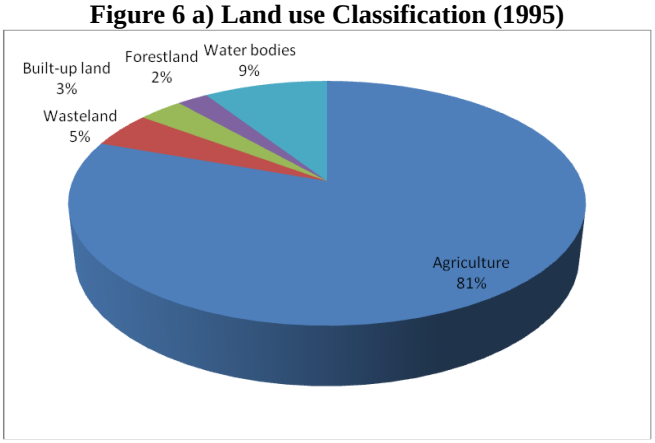

Figure 6 b) Land use Classification (2003)

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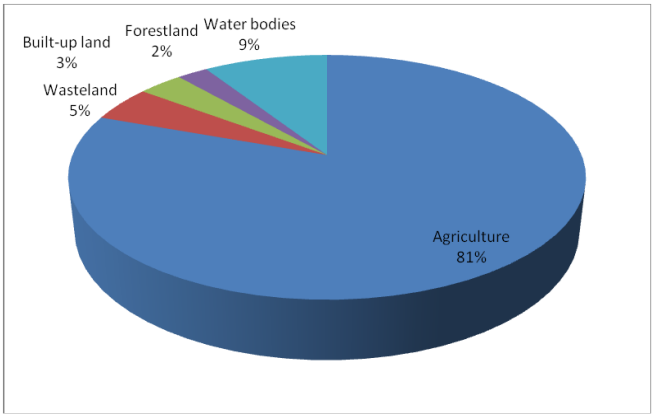

Figure 6 c) Land use Classification (2009)

V. CONCLUSION

This work demonstrates the ability of Remote Sensing and GIS in capturing spatial-temporal data. The study clearly established that the satellite remote sensing coupled with GIS can be a powerful tool for mapping and evaluation of change detection of Land Use/Land Cover of a given area. An attempt was made to capture as accurately as possible the five Land Use/ Land Cover classes as they change through time. The five classes were distinctly produced for each study year, but with more emphasis on agriculture and built-up land as they are the combination of anthropogenic activities. They also affect the other classes of LU/LC. The results of the study showed that the area of Wasteland increased from 3.00 % to 5.57 % when compared to forest land which decreased from 2.49% to 1.62%. There is significant reduction in area of water bodies which is alarming factor and this must be addressed properly. The change in the percentage of water bodies say 9.4% (1995), 9.2 % (2003) and 8.26 % (2009). The conservation and management of water bodies in the study area must be carried out in a systematic way. Rehabilitation and modernisation of water bodies are necessary in the study area. However, these changing trends in LU/LC need to be closely monitored for the sustainability of environment in future. This study will be useful for efficient watershed management and LU/LC planning in the study area.

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Table 1. Land Use/ Land Cover Distribution (1995, 2003 and 2012)

Land Use/Land Cover Categories	1995		2003		2009	
	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)
Agriculture	1372.80	82.50	1337.96	80.45	1364.33	82.04
Wasteland	50.72	3.04	78.48	4.72	92.70	5.57
Built-up land	42.88	2.57	55.20	3.32	41.73	2.50
Forestland	40.86	2.49	38.06	2.28	26.86	1.62
Water bodies	155.74	9.40	153.30	9.20	137.38	8.26
Total	1663	100	1663	100	1663	100

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