Land Use and Land Cover Change Detection of Periyar Main Canal Command through Remote Sensing Using Multi-Temporal Satellite Data

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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 Periyar main canal (PMC) in Madurai district. In this paper an attempt is made to study the changes in land use and land cover in PMC command area over a period of 38 years period. The study has been done through remote sensing approach using LANDSAT imageries of October 1973 and November 2010. The land use land cover classification was performed based on Satellite imageries. GIS software is used to prepare the thematic maps. The data were analyzed and the objective of the study was derived from the data analysis. The present study reveals the rate of change in urbanization in study area with in the period of 38 years. In period of (1973 to 2001) 28years the destructive deviations in the greenish area (Dense scrub and open scrub) is -12267 ha. At the same time within the period of (2001 to 2010) 10years is -9422ha. In settlement category (Village, town, Commercial and industrial) the changes in 28 years is + 2635 ha. But within 10years +7388ha. These destructive changes in study because of the growth of rapid urbanization.

Keywords: Land use, Land covers, Change analysis, remote sensing, change detection, unsupervised classification

1. INTRODUCTION

The urban is a compound system of human and nature. It is also a high-dense geographical synthesis of population, resources, environment, and social, economic and so on. Land is most important and basic resource concerning the urban development. Population growth, unplanned industrialization, urbanization and its consequences adversely affect the regional environment. Improper land use practice results in an adverse impact on ecosystem. So the two words "Land cover" and "Land use" have important significance in regard to land. Land cover implies the physical or natural state of the Earth's surface.

On the other hand a tract of land is covered by forest or a building or a water body or so but it is quite difficult to say what purpose a building may be used for as it may be used for residential or commercial simultaneously. e.g., a multi-complex building often is being used for cinema hall and at the same time one part of it is being used as commercial area / shopping market. Land use is the manner in which human beings employ the land and its resources. Thus urban development is strictly depends upon Land Use/ Land Cover (LULC) of that area. Several knowledge-based approaches were used by Anderson, 1971, Hutchinson, 1982, Jenssen et.al., 1992 for LULC classification by utilizing additional geographical data beside satellite images. The framework of a national land use and land cover classification system was presented by Anderson, et.al. 1976, for use with remote sensor data. Different workers worked even on municipality level using Geographical Information System (GIS) and Remote Sensing (RS). Recent legal requirements in Colombia require each municipality to develop land use plans for the next decade (Ministerio del Medio Ambiente de Colombia, 1997). For municipal-level general land use planning, Rubiano et al., 1997 makes land use restriction recommendations. To support the specific land use planning, Hyman et.al., 2000 developed spreadsheet programs that run parallel to the GIS to help the municipal agricultural extension service assess agricultural restrictions for different types of land units (Rodriguez et al., 1999). 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). In this work a LULC classification scheme of Periyar main canal area is generated on the basis of United States Geological Survey (USGS) classification system, concerning the existing LULC features of that area i.e. Habitation is sub dived in to Town, Village, Commercial and Industrial. Greenish area Sub dived in to Dense Forest, Dense Scrub,

Open Scrub water bodies and tanks are sub dived in to River and stream and Tanks. Land is sub divided into many other sub Classes.

2. Study Area

Periyar Main canal (PMC) is an important water Infrastructure for agriculture in Madurai district. The area selected for the present study is PMC command Area of Madurai district in the State of Tamil nadu. The study area stretched between the latitudes of 10°5'22.12" to 9° 59'27.32" N and longitudes of 77° 51' 15.03" to 78° 25' 52.13"E.

PMC is part of Periyar Vaigai System show in fig1. This system is unique in nature, The Periyar-Vaigai system is one of the oldest irrigation systems in India. It is a trans-basin scheme, which came into existence towards the end of the nineteenth century. The system consists of two reservoirs namely, the Periyar reservoir on the Periyar river in the Kerala state, the Vaigai reservoir on the Vaigai river in the state of Tamil Nadu, and the irrigation command areas in the Vaigai basin. The Periyar River, which originates on the western slope of the Western Ghats, flows westwards and discharges into the Arabian Sea. The Vaigai River, which originates on the eastern slope of the Western Ghats, flows east and discharges into the Bay of Bengal.
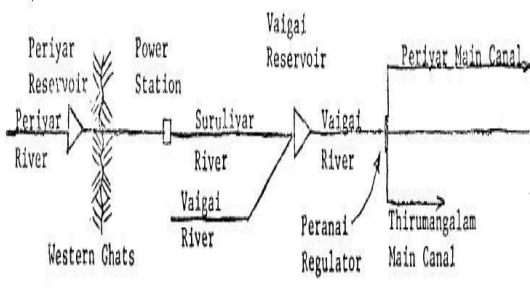

Fig: 1 Periyar trans basin scheme

There are three main hydraulic structures in the Periyar-Vaigai system. The most important among them is the Periyar reservoir, which is located in the state of Kerala and satisfies most of the demands of the system. The credit for the Periyar Dam goes to the noted British engineer, Colonel John Penny quick. Releases from the Periyar reservoir are picked up at the Vaigai reservoir, which is a balancing reservoir. After coming out of the Periyar power house, the releases of the Periyar reservoir and the natural flows of the Vaigai basin flow through the Cumbum valley. The Cumbum valley agriculture areas are irrigated through the channels taking off from 15 anicuts constructed across the rivers Vairavanar and Suruliyar. After that the rivers suruliyar, upper vaigai and theniyaru get combined in theni district in the place of vaigai reservoir. Vaigai reservoir was constructed across Vaigai River during 1954-59. Peranai regulator is located downstream of the Vaigai dam. From the peranai regulator the periyar main canal is orginated as shown in fig 2 its pass through major taluks (Vadipatti, Madurai North, and Melur) in Madurai District. It covers more agriculture land from Anaippatti to Alampatti through lined channel its having a length of

58Kms and 12 branch 64 distributary. In addition, the command area has a number of system tanks which store the runoff from their own catchment areas and the irrigation return flows. There are 251 tanks up to the Kallandiri regulator which is located downstream of the Peranai regulator. The water available in the tanks is used for irrigation. This irrigation system is mainly operated for cultivation of rice crop in the command area. It covers major settlements like as Alanganallur, Melur, and Paravai etc.
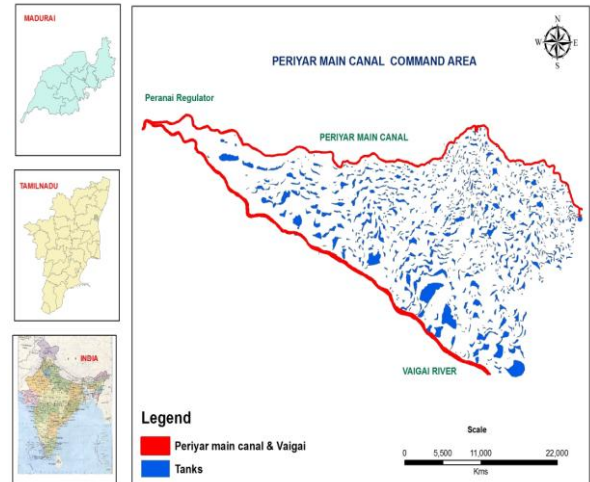

Fig: 2 Study Area Map – Periyar Main canal

3. Aims and objectives

The objective of this paper to understand the early history of Land use and land cover changes detection using multi temporal satellite data of PMC command area, Madurai District, Tamilnadu. This present study also find out the volume of deterioration of Agriculture and Increasing Volume of urbanization during 1973, 2001 and 2010 in the study area.

4. Materials and Methods

- ➢ A Topo sheets of Madurai District (58K1, 58K5, 58F16, 58G13, 58J4, 58J8)
- ➢ Satellite image (Landsat imagery of 1973, 2001, 2010).
- ➢ ArcGIS 9.1 and Erdas 9.2 and Global mapper

For the study, Landsat satellite images were acquired for three year; 1973, 2001 and 2010. Both were obtained from Global Land Cover Facility (GLCF) an Earth Science Data Interface. Topo sheets are purchased from Survey of India (SOI), data source detail as (Table1) in below

Table 1: Spatial Data Source

s.no	Data Type	Date of production	Scale	Source
1.	Landsat image	21.10.1973	30m ETM	GLCF
2.	Landsat image	19.10.2000	30m ETM	GLCF

3.	Landsat image	23.10.2010	30m ETM	GLCF
	Toposheet No			
	58F16	1995 - 96	1:50000	
4.	58K1	1990 – 91	1:50000	
	58J8	1997 – 98	1:50000	SOI
	58J4	1968 – 69	1:50000	
	58K5	1968 – 69	1:50000	

In this work a LULC classification scheme of Periyar main canal area is generated on the basis of United States Geological Survey (USGS) classification system, concerning the existing LULC features of that area i.e. Habitation is sub dived in to Town, Village, Commercial and Industrial. Greenish area Subdivided in to Dense Forest, Dense Scrub, Open Scrub water bodies and tanks are sub dived in to River and stream and Tanks. Land is sub divided into many other sub classes.
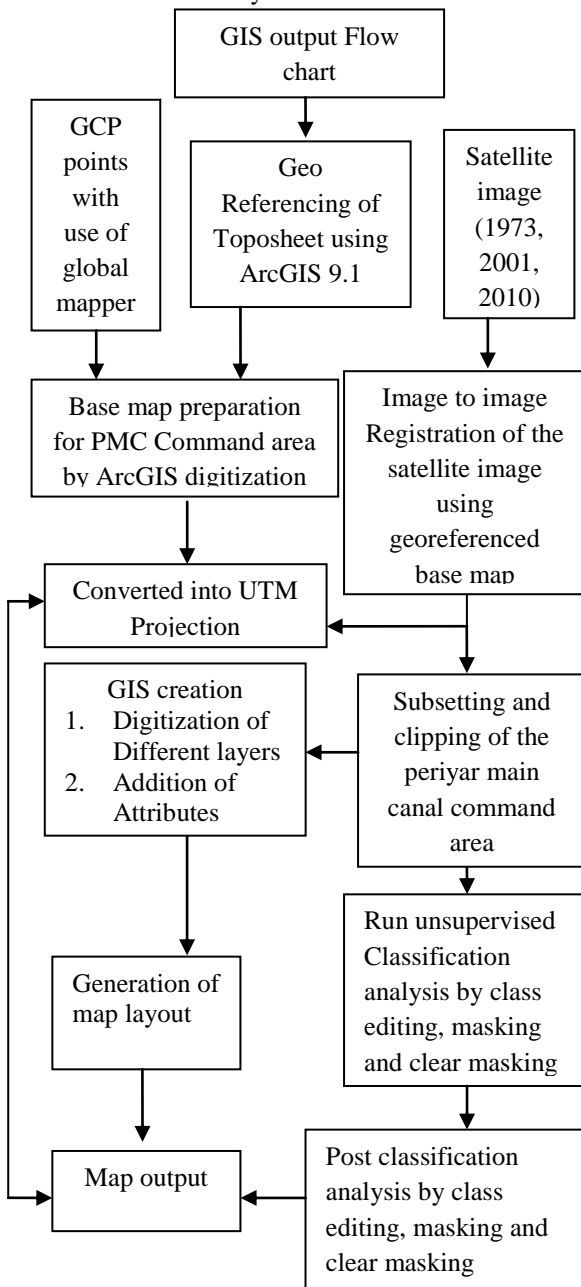
To understand the deterioration of Agriculture and urbanization growth, both primary and secondary data relevant to topic have been gathered from a wide range of sources. The urbanization cover of the area has been properly highlighted by deriving data from the Survey of India topographic maps of,1:50000 scale and the satellite imagery of ETM multi-spectral imagery attained during 1973, 2001 and 2010 combined with detailed field verification. The demographic data for the PMC Command area for the period from 1973 to 2010 have been analyzed. The land use maps prepared by using potential of Arc GIS software.

6. RESULT AND DISCUSSION

Land Use / Land Cover Distribution - The static land use land cover distribution for each study year as derived from the maps are presented in the Tables in below

Table 2: Land use / Land cover change of Periyar main canal command area (1973 -2001)

Land use/ Land cover categories	1973	2001	1973-2001 changes
	Area (ha)	Area (ha)	Area (ha)
Dense Forest	8933.30	7162.33	-1770.97
Dense Scrub	29585.16	24352.03	-5233.13
Open scrup	20220.74	13186.02	-7034.72
Barren land	6558.47	16641.54	10083.07
Village	1700.21	2748.00	1047.79
Town	3352.94	4891.13	1538.19
Commercial and Industrial	40.00	89.00	49.00
Tanks	65.52	60.00	-5.52
Inland water	1032.39	2250.10	1217.71
River and Streams	739.00	739.00	0.00
Mining	282.42	391.00	108.58
Total	72510.15	72510.15	

Land use / Land Cover in 1973

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, and town, commercial and industrial,

tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 8933.3ha (12.32 %) in Agriculture area, Dense Scrub covers 40.80% , open scrub covers 27.89 totally the Agriculture area as 68.96 % Barren Land covers 9.04% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 2.34%, Town covers 4.62% and industrial and commercial areas covers 0.06 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.09% inland water covers 0.06% Rivers and streams 1.02% and 0.39% Mining area Covers in total Command area. Land use and land cover map in 1973 as shown in fig2
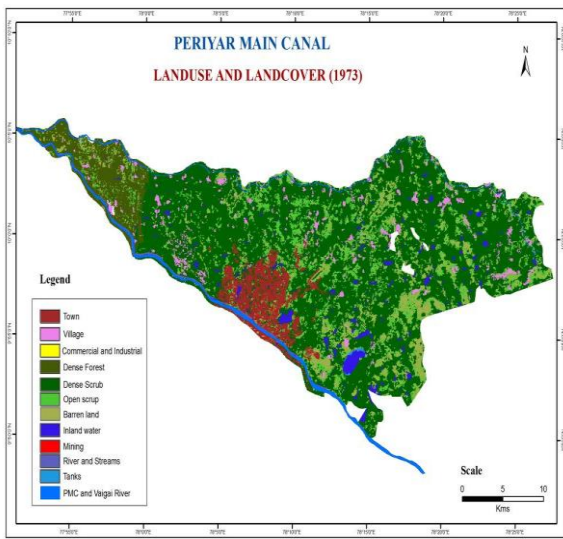

Fig 2: Land use and Land cover (1973)

Land use / Land Cover in 2001

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, town, commercial and industrial, tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 7162.33ha (9.88%) in Agriculture area, Dense Scrub covers 33.58% , open scrub covers 18.19% totally the Agriculture area as 51.77 % Barren Land covers 22.95% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 3.79%, Town covers 6.75% and industrial and commercial areas covers 0.12 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.08% inland water covers 3.10% Rivers and streams 1.02% and 0.54% Mining area Covers in total Command area.
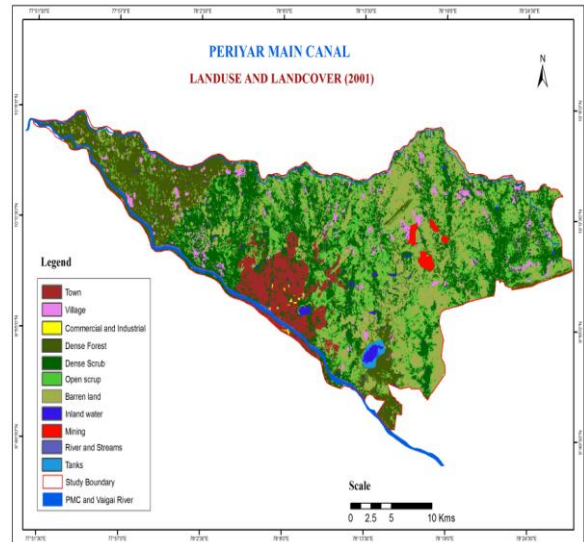

Fig 3: Land use and Land cover (2001)

Land use / Land Cover in 2010

As per the land use map prepared by the Survey of India toposheet 1:50000 scale, there are 11 major land use categories. They are dense forest, dense scrub, open scrub, barren land, village, town, commercial and industrial, tanks, inland water, River & stream and mining. In overall 72510.15ha command area dense forest is cover 5738.00ha (7.91%) in Agriculture area, Dense Scrub covers 23.64% , open scrub covers 15.13% totally the Agriculture area as 38.77 % Barren Land covers 28.86% the settlements are classified in to Village, Town, Commercial & Industrial. In that Village covers 9.33%, Town covers 11.23% and industrial and commercial areas covers 0.29 % Water Bodies are Classified in to three categories as Tanks, Inland Water and Rivers and streams,. Tanks areas covers 0.08% inland water covers 1.36% Rivers and streams 1.02% and 1.14% Mining area Covers in total Command area.
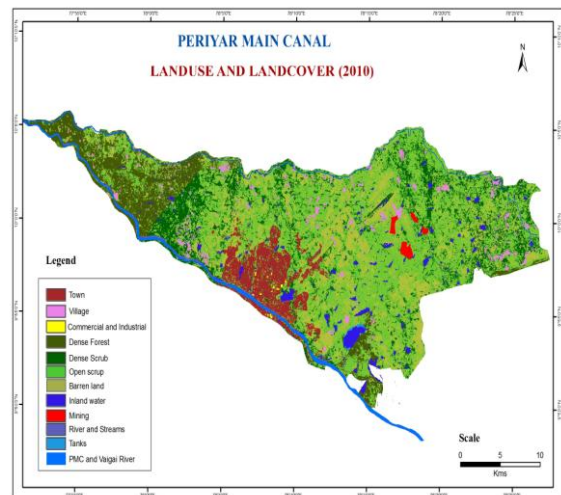

Fig 4: Land use and Land cover (2010)

Table 3: Land use / Land cover change of Periyar main canal command area (2001-2010)

and use/ Land cover categories	2001	2010	2010-2001 Changes
	Area (ha)	Area (ha)	Area (ha)
Dense Forest	7162.33	5738.00	-1424.33
Dense Scrub	24352.03	17143.10	-7208.93
Open scrup	13186.02	10972.82	-2213.20
Barren land	16641.54	20928.05	4286.51
Village	2748.00	6762.03	4014.03
Town	4891.13	8144.08	3252.95
Commercial and Industrial	89.00	210.04	121.04
Tanks	60.00	58.00	-2.00
Inland water	2250.10	986.03	-1264.07
River and Streams	739.00	739.00	0.00
Mining	391.00	829.00	438.00
Total	72510.15	72510.15	

Land use / Land Cover changes

The growth of industrial sector and urban center of all scale and categories have made drastic changes in LULC all over the Periyar Main Canal (PMC) Command area. The cultivated land has been converted into settlement areas and many ponds are being filled up for the purpose of Residential buildings in PMC Command area. Whether it is industrialization or urbanization, the face of the land is altered based on, LULC scenario of total PMC Command. By comparing LULC data observing the following changes in PMC Command area. In dense forest changes it is observed that as -2.44% in between the period of 1973 – 2001 but at in the same time the changes between 2001-2010 with in 10years the area of dense forest is got reduced drastically due to deforestation in command area the changes are in   -1.96 % of total command area.in Agriculture area, Dense Scrub and open scrub is get reduced due to the urbanization. The area in between 1973 to 2001 the change is – 16.92% but in between 2001 and 2010 the area of Agriculture field is converted as plots. Area the changes are in -12.99% of total command area.

The important observation in settlement category (Village and Town) in that category in between 28years period the changes are 3.57% but within 10years growth of urbanization is enormous the changes is 10.03%. Due this enormous growth of urbanization in study area the

Agriculture fields are converted as plots and residential buildings, and the surface tanks are converted in to plots and storage place of stone guvaries. Due to this issues Environmental pollution and Ecosystem issues was occurred in the PMC Command area.

7. CONCLUSION

The objective of this study were to provide recent perspective for land use type and land cover changes that has been taken place in the last thirty eight years, using remote sensing and GIS capabilities in studying the spatial distribution of land cover changes PMC Command area was found to have experienced rapid changes in land use/ land cover Particularly in open scrub land. Open scrub land has decreased by 20220.74 ha. In 1973 to 13186.02 ha in 2001. Here open scrub land converted to build up land. Due to these changes we lost our natural ecosystem and biodiversity also. The increase in the area under built up lands may lead to a lot of environmental and ecological problems. Hence government should come forward to take effective measures to protect the land under agriculture in Periyar main canal command area. Here proper land use planning is needed otherwise we lost our natural resources

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