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LAND USE LAND COVER CHANGE DETECTION USING REMOTE SENSING AND GIS TECHNIQUES - A CASE STUDY OF AMBULIYAR WATERSHED IN 2003 AND 2012

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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 Ambuliyar watershed, Tamilnadu, India. The relationship between Land Use Changes and its trend is analyzed using IRS LISS III data. Further, the preparation of LU/LC map using Survey of India (SOI) Toposheet for the year of 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, 2003 and 2012 which was obtained from Institute of Remote Sensing, Anna University (IRS) and digitized, is using Arc GIS 9.1 software. About 79.77 per cent of land is devoted to agricultural practices under agriculture and cropland has a major impact over the hydrological processes of the watershed. 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.

INTRODUCTION

Land is the most important natural resources on which all activities are based. Land use unlike geology, is seasonally dynamic and indeed is more changing. The increase in population and human activities are increasing the demand on the limited land and soil resources for agriculture, forest, pasture, urban and industrial land uses. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularize the use of such resources. India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. As a result Land use Land Cover (LULC) change has become a topic of tremendous interest within the human dimensions of the Environmental change research community. Consequently, quantifying and understanding the extent and spatial distribution of LULC is a crucial importance to the study of Environmental change at various scales. Moreover this type of analysis provides a valuable tool to increase the efficiency of land use and land cover, and to diminish the negative environmental and societal impacts related to LULC.

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Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy. Remote sensing technology and Geographic Information System (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. Analysis of satellite data in conjunction with drainage, lithology, and land use land cover collateral data facilitates effective evaluation of geomorphological conditions and status of degraded landforms. This data set is the core of the Geographic Information System (GIS) that provides an excellent means of spatial data analysis and interpretation. It also provides a powerful mechanism, not only to monitor degraded lands and environmental changes, but also permits analysis of information of other environmental variables. In this present study, an investigation has been carried out in Ambuliyar Watershed to detect the land use land cover changes.

Study Area

The Ambuliyar Watershed has been taken for the present study since the areas spotted with numeric surface water configuration mainly tanks and it is main source for the fresh water, bounded on North by Agniar Sub Basin, East by Bay of Bengal West by South Vellar sub basin and South by south Vellar Sub Basin. River Ambuliyar has its origin in the Catchment area of Manjan Viduthi tank in (up lands of

Manjan-Viduthi village) Alangudi taluk of Pudukottai district (Fig. 1). The River after traversing a total length of 48 km empties into Bay of Bengal in Ammachathiram village of Pattukottai taluk in Thanjavur district. The total Watershed area of Ambuliar is 702.91 sq.km.

Review of Literature

According to the United States Geological Survey (USGS) devised a land use and land cover classification system to use in the remote sensing data in the mid 1970's

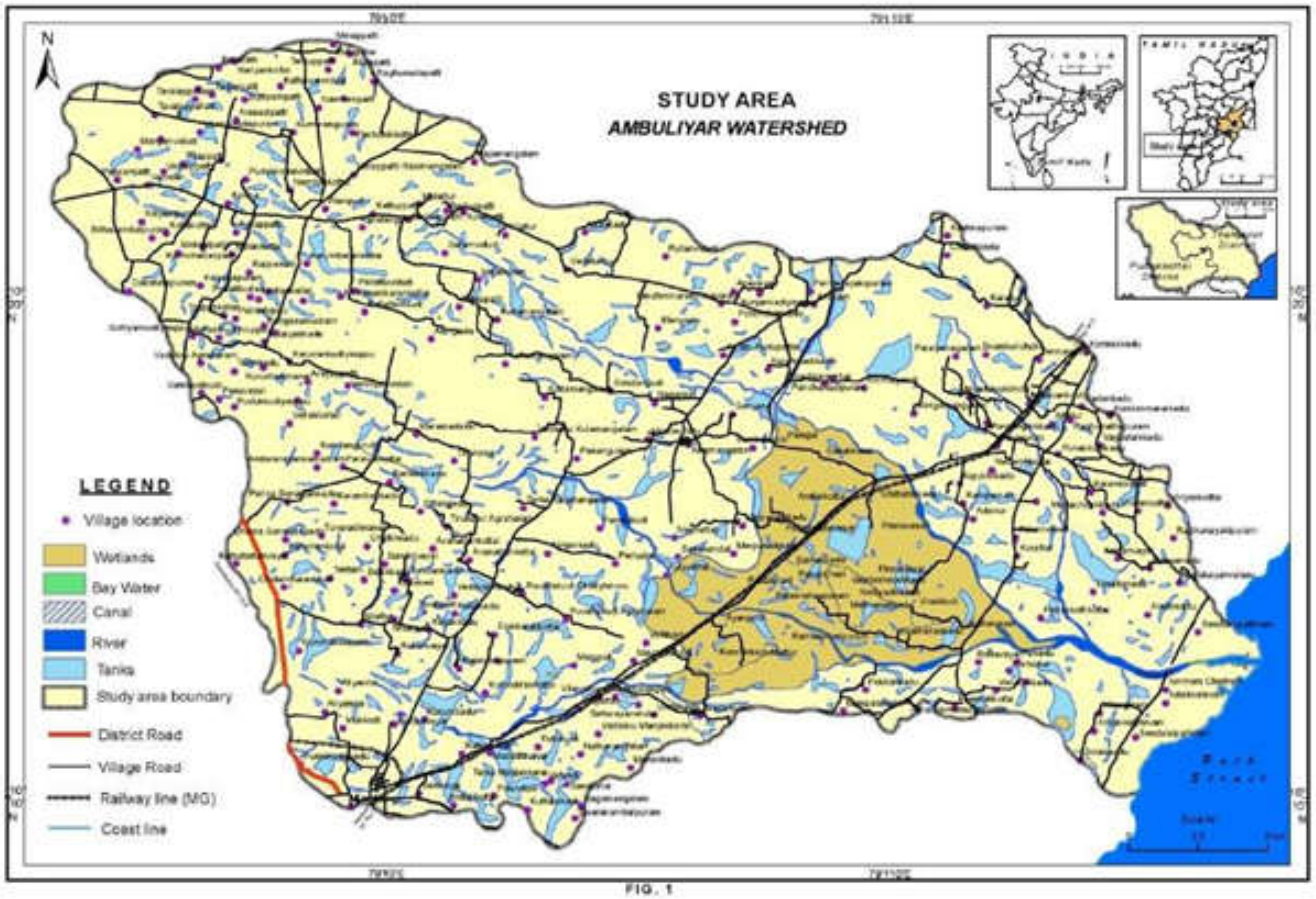


FIG. 1

Table 1. Land Use/ Land Cover Classes in 2003 and 2012

Sl No	Land use		2003		2012	
	Level I	Level II	Sq.km	%	Sq.km	%
1	I Built Up Land	Built Up area (Rural)	33.24	4.73	28.11	4.00
2		Mixed Built Up area	3.59	0.51	3.6	0.51
		Total	36.83	5.24	31.71	4.51
3	II Agricultural Land	Single Crop	114.18	16.24	125.8	17.90
4		Double Crop	153.91	21.90	148.12	21.07
5		Triple Crop	95.35	13.57	95.29	13.56
6		Agriculture Plantation	97.88	13.92	91.43	13.01
7		Current Fallow	97.13	13.82	100.07	14.24
		Total	558.45	79.45	560.71	79.77
8	III Forests	Forest Plantation	9.59	1.36	10.46	1.49
9		Horticulture Plantation	13.2	1.88	13.49	1.92
10		Scrub Forests	2.74	0.39	1.96	0.28
		Total	25.53	3.63	25.91	3.69
11	IV Waste lands	Land with scrub	0.16	0.02	0.16	0.02
12		Land without scrub	1.78	0.25	1.98	0.28
13		Sandy area	1.38	0.20	2.24	0.32
14		Salt affected land	3.85	0.55	3.85	0.55
15		Mine / Quarry	0.43	0.06	0.22	0.03
16		Mining / Industrial area	0.43	0.06	0.43	0.06
		Total	8.03	1.14	8.88	1.26
17	V Water Bodies	Wetlands	3.39	0.48	5.56	0.79
18		Aquaculture	3.9	0.55	3.46	0.49
19		River	11.08	1.58	11.08	1.58
20		Water bodies	55.7	7.92	55.6	7.91
		Total	74.07	10.54	75.70	10.77
		Grand Total	702.91	100.00	702.91	100.00

(Anderson *et al.,* 1976). This classification system designed to use four "levels" of information could be drawn from aerial photos and satellite images, depending on the sensor system and image resolution. Levels I and II are principally of interest to users who desire to get information on a nationwide, interstate, or statewide basis. Levels III and IV can be utilized to provide information on regional (district), taluk, or local planning and management activities. In India, the National Remote Sensing Agency (NRSA) has developed a standard classification system for Indian conditions. It is adaptable for both visual and digital interpretation. The present study has adopted this classification system to bring out the various land use classes of the study area. The study follows the GIS based land use / land cover database employing remote sensing data. It is a hierarchical structure containing 20 different categories up to the level II and by assemblage of these, the land use/land cover classes are grouped into five major categories at level I.

The information is derived manually by visual image interpretation. The hierarchical structure of the land use / land cover classes allows logical class aggregation, and hence abstract mapping. The classification system is extendable by adding classes to level two. This operational

classification chain enables faster and more frequent update as well as improved class information. The derived land use / land cover classification system builds upon two different themes of datasets such as feature class and shape file (*.shp) format in the GIS environ. Land use mapping as mentioned earlier, the NRSA's classification system has been adopted for the present study. The IRS-1D LISS III, FCC geocoded data have been used in obtaining land use / land cover details for the major seasons of the region viz, Kharif (summer) and Rabi (winter). By visual image interpretation, land use / land cover was classified into five classes: 1) Built-up lands 2) Agricultural Lands 3) Forests 4) Wastelands and
5) Water bodies.

Objective

The main objective of the present paper is to analyze nature and extent of land use land cover changes in Ambuliyar watershed of Thanjavur and Pudukkottai District in the past 9 years.

MATERIALS AND METHODS

The base map of the study area is prepared from the Survey of India 1:50000 scale topographical sheets 58 J /15, 16, 58 N/3, 4, 7 and 8. To make the change analysis of the study area, two images from the satellite IRS LISS III (Path.142 and 143 Row) 2003 and 2012 is used which is obtained from Indian Remote Sensing Centre, Anna University, Chennai. Maps are acquired between February and April during the dry season. The resolution is 30 meter/pixel in IRS and 23 meter in LISS III image. Digital land use land cover classification through supervised classification method is done to perform the LULC classification in ERDAS IMAGINE 9.1 software environment. Area statistics of each land use category is calculated in hectors in attribute table in ERDAS IMAGINE 9.1 (Table-1). Recoding method is also done for converting pixel value into proper class. This software consists of accuracy assessment tool. The land use land cover map should be in raster format to run this tool. By applying random points in accuracy assessment window we got accuracy report which contains overall classification accuracy. In this land use land cover classification, overall classification accuracy is 81%. Ground checking is also done by collecting GPS points to make the confirmation of result obtained for different land use characteristics.

RESULTS AND DISCUSSION

The general land use of an area depicts an idea of overall areal utilisation of resources, natural or cultural. In this paper, changes in the land use and land cover of Ambuliyar Watershed are evaluated from the differences between 9 years of period (2003-2012) in figure-2, figure-3 and figure-4. The findings of the present investigation are presented in Table 1 cited below. The table shows 20 categories of land use i.e. Built Up area (Rural), Mixed Built Up area, Single Crop, Double Crop, Triple Crop, Agriculture Plantation, Current Fallow, Forest Plantation, Horticulture Plantation, Scrub Forests, Land with scrub, Land without scrub, Sandy area, Salt affected land, Mine / Quarry, Mining / Industrial area, Wetlands, Aquaculture, River and Water bodies.

Built-up Lands

Build-up Lands are comprised areas of intensive use with much of the land covered by structures, such as cities, towns, villages, strip developments along highways, transportation power and communications facilities and areas of those occupied by mills shopping centers, industrial and commercial complexes and institutions that may in some instances be isolated from urban areas, Settlements, , industrial structures, buildings or any other artifact or physical spread or sprawl, along with density or transport network are useful surrogates to classify it as urban or rural. Perceptible land transportation can be noted around built-up land. Built-up lands are in dark bluish green in the core and bluish in the periphery of the satellite imagery. Built up areas are classified as level II classes such as those of Built Up area (Rural), and Mixed Built Up area. Built Up area has covers 33.24 sq.km in the year of 2003 and till more decreased in 2012 as 28.11sq.km. The areal extent of Mixed Built up area in the study area is 3.59 sq.km in 2003 has increased but in 2012 remaining the same as 3.6 sq.km. When comparison of 2003 and 2012 Built Up land has decreased from 5.24 per cent to 4.51 per cent.

Agricultural Land

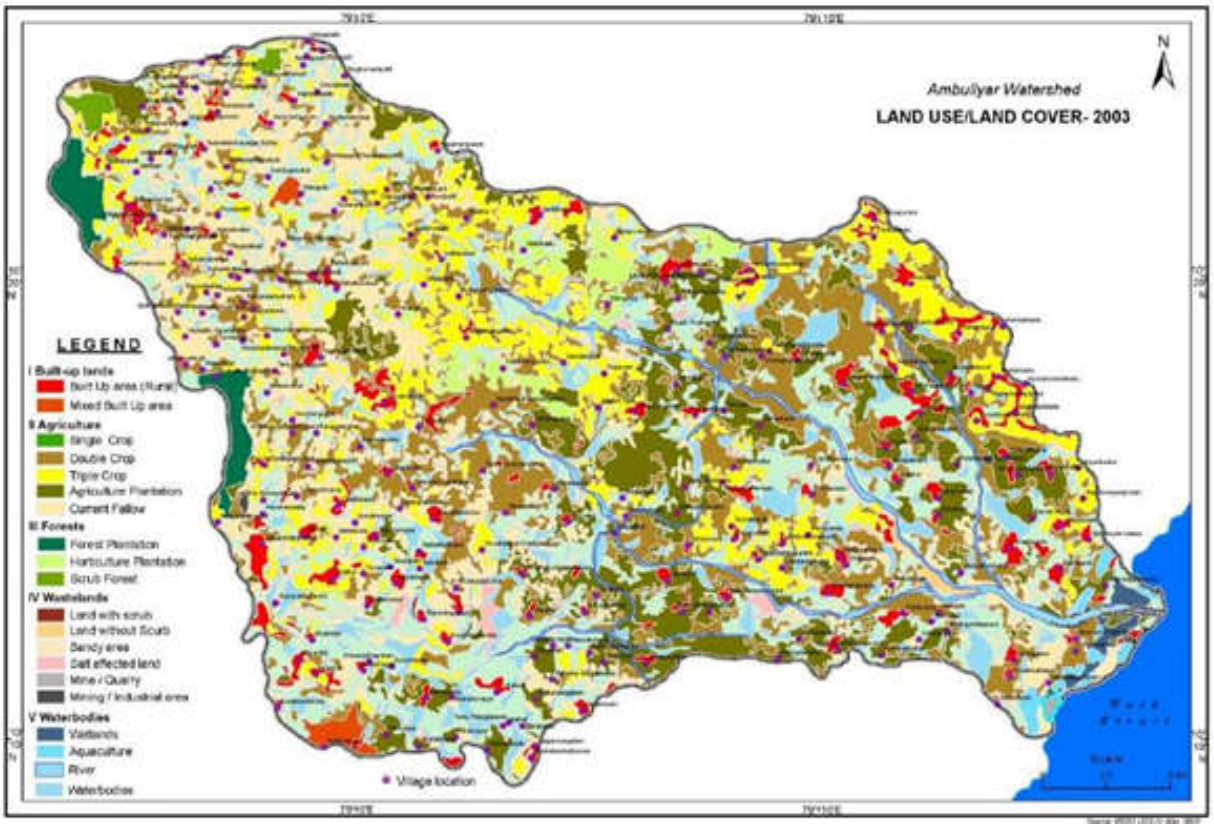
Agricultural lands of the Ambuliyar watershed are classified upto level II, such as agricultural land (Level I), single crop, double crop, triple crop, agricultural plantation and current fallow (Level II). The agricultural lands of the Watershed are primarily used for farming activities (domestication of crops and animals). It includes food crops, horticultural crops and commercial crops of different kinds under irrigated and rain fed conditions, which are however grown under different seasons, different farming activities and land use tenure systems. Agricultural activities in the study area are mainly dependent on the southwest and northeast monsoons. They are affected, mostly by the natural hazards such as the drought due to uncertainty of monsoon rains, floods, soils and topography. There are two seasons of farming in the study area, namely, the kharif (summer) and rabi (winter). Crops sown in June and harvested during September – November are called the kharif crops and those sown during October-November and harvested in February –March are called the Rabi crops. Rabi cropped areas have short-term crops such as pearl millets (cumbu), maize (cholam), ragi, black, black and green grams and chilies. These crops are mainly dependent on the short spell of rains (but more rainfall) of the northwest monsoon. The area, under this season, is mostly single-cropped, whereas the area under kharif season is used partly for rabi season also.

Single Crop

Rabi crops were seen in eastern parts of the study area and which accounts for 114.18sq.km (16.24 per cent) in 2003 and 125.8sq.km and it accounts 17.90 per cent in 2012. Single crop land has increased for the year of 2003 and 2012.

Double Crop

These lands were distributed throughout the area. It occupies an area of 148.12 sq.km and it accounts 21.07 per cent in 2012. While in 2003 153.91 sq.km and accounts 21.90 per cent. There is slight decreased in 2003 and 2012.



Ag riculture Plantations

Agricultural plantations consist of a variety of trees, orchards and groves. Agricultural plantations have dark red to red in colour and regular with sharp edges on the satellite imagery. These are associated with dry lands or unirrigated lands, uplands occasionally amidst cropland, proximity to rivers and on gentle hill slopes. Agricultural plantations were noticed in the areas of central and eastern region of the study area. High area of the study area occupies this category and it accounts for 97.88sq.k or 13.92 per cent of the total area of the study area in 2003. In the year of 2012, these lands cover an area about 91.43sq.km or 13.01 per cent of the total of the study area. All parts of the study area have this category.

Current Fallow

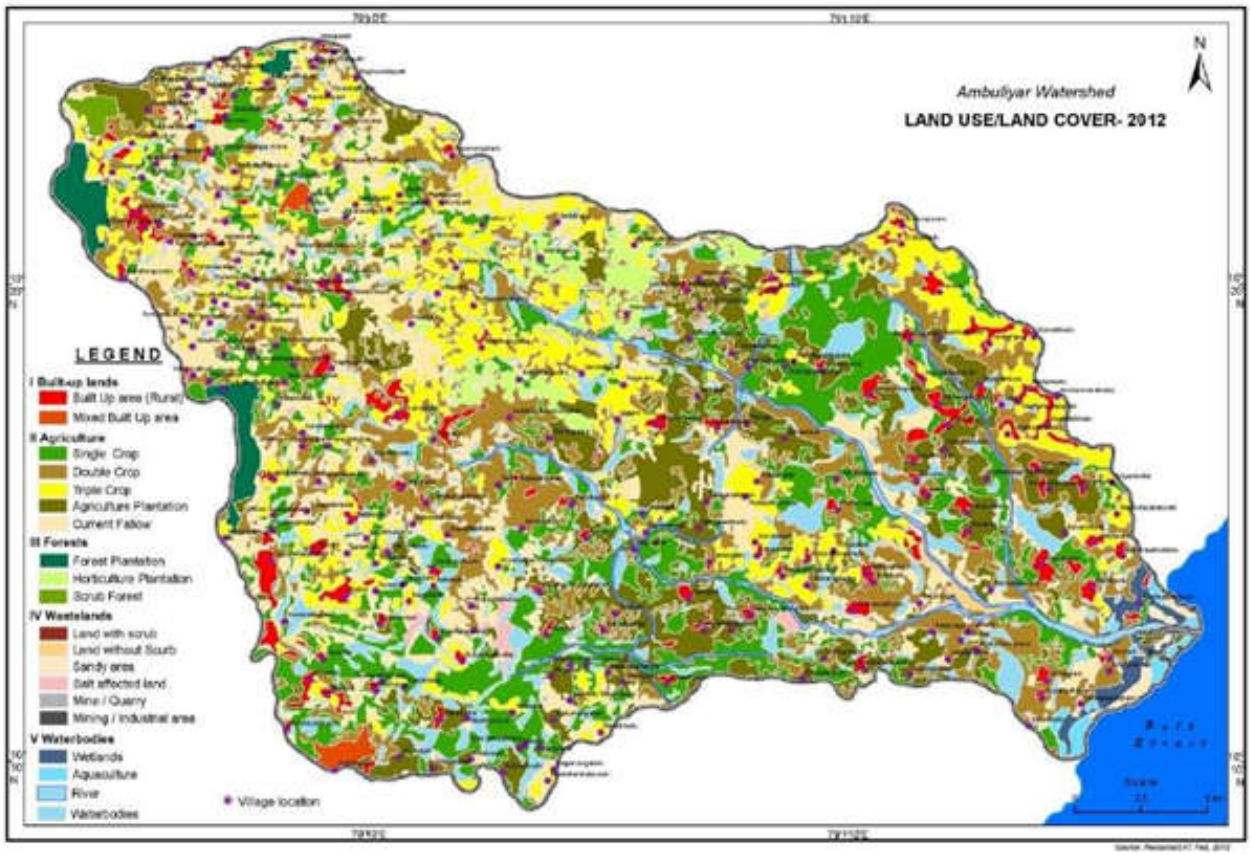
It comprises of different arable lands left uncultivated as season or temporary fallow for less than a year and as permanent fallow up to 5 years or more because of diverse seasons. Fallow lands devoid of vegetation and accelerates erosion. These lands are associated with crop land as harvested agricultural fields, etc. These lands are identifying on the satellite imagery using the colour of yellow to greenish blue depending on the soil types and moisture of the area. These lands comprise an area about 97.13 sq.km or 13.82 per cent of the total area of the study area during the period of 2003. Fallow lands cover some area of the study area. In the year of 2012, these lands consists an area about 100.07sq.km or 14.24 per cent. In general, the agriculture lands increased 0.32 per cent of the study area from 2003 to 2012.

Forest

It is an area (within a notified forest boundary) having an assemblage of trees, vegetation types, capable of producing timber, other forest products and also based on a vegetation density. Forests define all lands bearing vegetative association dominated by trees. The forests are categorized into forest plantation, horticulture plantation and scrub forests in Ambuliyar watershed.

Forest plantations

Forest plantations are forested areas artificially established by planting or seeding. The trees usually belong to the same specie (whether native or introduced), have the same age and are regularly spaced. The objective of forest plantations can be the production of wood and non- wood goods (productive forest plantations) or the provision of ecosystem services (protective forest plantations). These forests plantations were observed in the western and northwestern parts of the study area. In the year 2003, however the forest plantation covered and area of 9.59 sq.km and accounted for only for 1.36 per cent in the year of 2012 covers a 10.46sq.km and 1.49 per cent. Changes were seen in the year of 2003 and 2012 Forest plantation has increased.



Horticulture plantation

It is growing of fruits, vegetables and flowers and crops like spices condiments and other plantation crops. These horticulture plantations are seen in central northern portion of the study area in 2012. These horticulture plantation are occupied an area of 13.2sq.km in 2003 and increased in 2012 as 13.49sq.km. and 1.96sq.km accounted for 01.88 per cent and 1.92 per cent.

Scrub Forest

Scrub forest is a plant community characterized by vegetation dominated by shrubs, often also including grasses, herbs, and geophytes. The scrub forests covered an area of 2.74 sq.km and accounted as 0.39 per cent in 2003 and 1.96sq.km and accounted as 0.28per cent. A decrease of 0.28 per cent was observed in the year of 2012. Totally forest areas are increased from to 25.91 per cent in 2012.

Wastelands

Wastelands are degraded land and can be brought under vegetative cover with reasonable effort by at present they are unutilized. These lands are deteriorating due to the lack of appropriate land, water and soil management or on account of natural causes. Wastelands are the resultant of inherent or imposed constraints, such as location, environment, physical and chemical properties of the soil or by financial or management constraints. The level II category of wastelands is Land with scrub, Land without scrub, Sandy area, Salt affected land, Mine/Quarry Mining/Industrial area.

Land with scrub

It is one of the wasteland categories. It is generally associated with foothills, bazadas relatively high topography like the uplands, the high grounds, areas covered by a thin veneer of soils, eroded lands, and bad land topography and so on. It is generally distributed over the western portion of Ambuliyar watershed. In 2003 and 2012 Land with scrub is remaining the same and occupied as 0.16sq.km and 0.02 per cent.

Land without Scrubi

It has the same characteristics of land with scrub category. These lands were notably recorded an area of 1.78sq.km (0.25%) in 2003 and 1.98sq.km (0.28%) in 2012. But it is high, when compared to 2003 and 2012.

Sandy area

These lands occurred in small patches in the western and central side of the study area. In the year 1.38sq.km in 2003 and in 2012 as 2.24sq.km. When compared to 2003 to 2012 sandy area is increased as 0.20 per cent and 0.32 per cent.

Salt affected land

Salinity results due to capillary action in dry climate or due to excess uses of fertilizers, intensive irrigation and impeded drainage or due to brackish water near near coastal areas. They hamper the growth of vegetation. Generally, they are seen in the river plains, valleys, coastal lowlands and desert plains, etc.

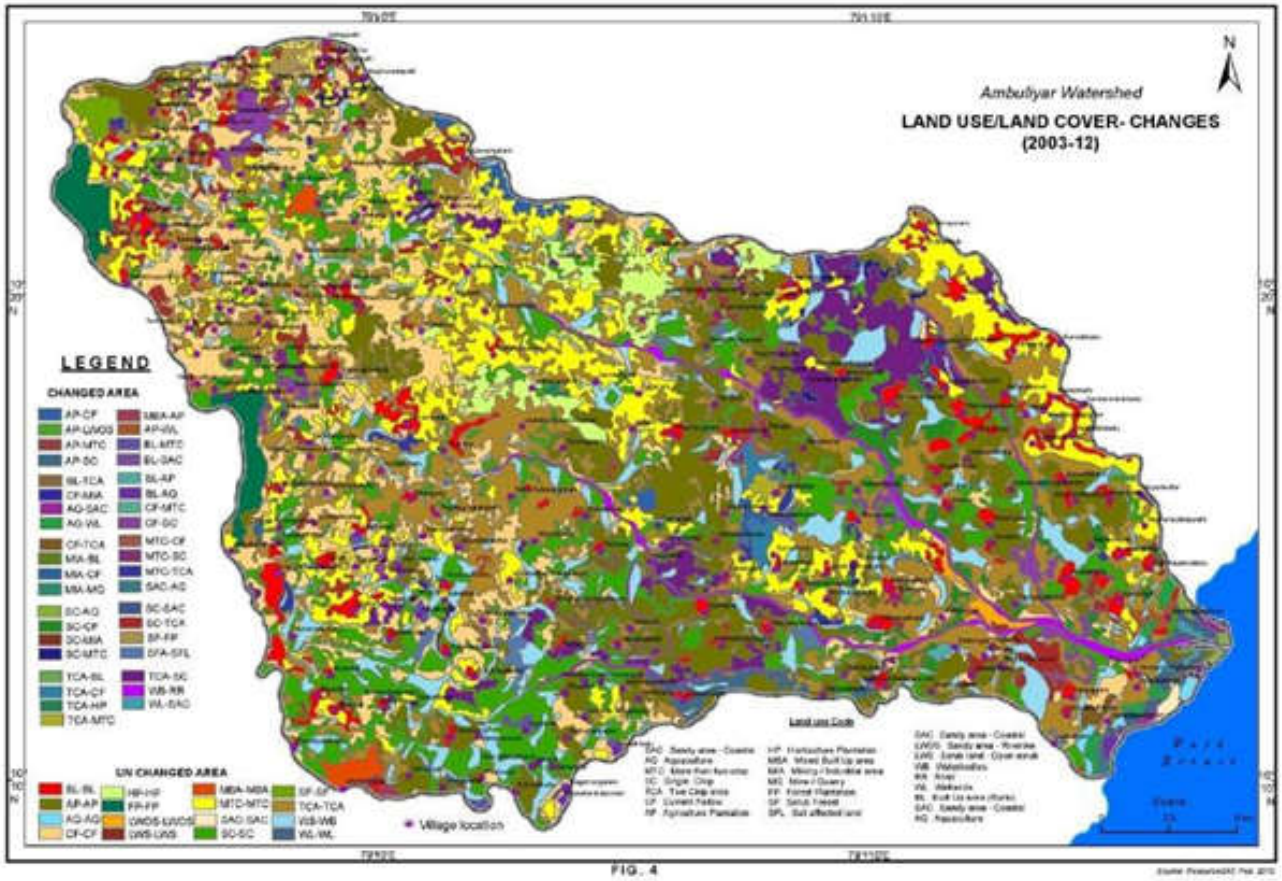


FIG. 4

These lands are associated with irrigated agriculture lands with excess salt and poor drainage amidst crop land and around tidal marshes, logons and inland/coastal salt/lakes. These lands appear in white to light blue on the satellite imageries. In the study area, salt affected lands were observed in small portions of the western parts. Small pockets were enormously seen in the year of 2012. These salt affected lands comprise an area about 3.85sq.km, which accounts for 0.55per cent of the total area of the study area (2003). In the year 2012, these lands occupy the same as in 2003.

Mine / Quarry

Mine/Quarry place where dimension stone or aggregate (sand, gravel, and crushed rock) is mined. The products of dimension stone quarries are prismatic blocks of rock such as marble, granite, limestone, sandstone, and slate. These lands occupy an area about 0.43sq.km or 0.06 per cent in 2003 and in 2012 0.22sq.km and 0.03 per cent. It shows mining has decreased from 2003. *Mining/Industrial Area.* An area that predominantly has industry as its main land use is known as Industrial area. Industrial area was found in the western portion near Chinna Sonaiyankadu village. This category covers an area of 0.43sq.km and it accounts for 0.06 per cent in 2003 and 2012. The area remains as the same. Totally Wastelands has increased from 8.03sq.km (1.14 per cent) to 8.88sq.km (1.26 per cent).

Water bodies

These are impounded water an often with a resultant flow of water. They include both natural and manmade reservoirs/lakes/tanks/canals/and creaks.

Lakes/ Reservoirs and tanks with or without plantations are delineated in the study area. They cover an area about 75.70sq.km of the total area.

Wetlands

Land consisting of marshes or swamps; saturated land. They could be seen in the areas adjacent to the Ambuliyar River. In the year of 2003 the wetlands area was 3.39sq.km (0.48 per cent). In contrast, in the year 2012, the area was 5.56sq.km (0.79 per cent). From this wetlands are increased from 0.48 per cent to 5.56 per cent of the total area.

Aquaculture

The term aquaculture refers to the cultivation of both marine and freshwater species and can range from land based to open ocean production. Aquaculture was seen in the western and southeastern part of the study area in 2003, nearby mudflat. It accounts for 3.9sq.km or 0.55 per cent in 2003. Changes are seen in the year of 2003 and a reduction of 0.49 per cent was recorded over the year of 2012.

River

It is a large natural stream of water flowing in a channel to the sea, a lake, or another river. River is found in eastern region of the study area. In the year of 2003 it covers an area of 11.08sq.km and it accounted for 7.91 per cent. Changes are not seen during 2003 and 2012. It remains the same.

Water bodies

Body of water forming a physiographical feature, for example a sea or a reservoir. It is found in eastern region

near Palk Strait. They covered an area of 55.6sq.km (7.92 per cent). This feature also remains the same as 2003. Finally, water bodies have increased from 2003 to 2012 such as 10.54 per cent to 10.77 per cent.

Summary

Land use/land cover classification over the years of 2003 and 2012 are discussed. There are 9 years (year 2003and year 2012) land use/land cover classes were delineated and also maintained level I and level II classifications. Built-up lands cover an area of 36.83sq.km or 5.24 percent (year 2003) and 31.71sq.km or 4.51 per cent (year 2012) of the total area of the study area. Built-up lands has decreased while analysis. Agriculture land is increased from 558.45sq.km to 560.71sq.km. These lands occupy an area of 79.45 per cent (558.45sq.km) in the year 2003 and 79.99 per cent (560.71sq.km) in the year 2012. Forests land consist an area about 25.53sq.km or 3.63 per cent (2003) and 25.91 or 3.69 per cent (2012). Forests lands are also increased 0.06 per cent of the total study area. Wastelands occupy an area of 8.03sq.km (1.14 per cent) in the year of 2003 and in 2012 8.88sq.km (1.26 per cent). Wastelands also increased from 2003 to 2012. Water bodies occupy an area about 74.07sq.km or 10.54 per cent (year 2003) and 75.70 sq.km or 10.77 per cent (year 2012). Changes are not seen in water bodies when compared to 2003 and 2012. Based on the analysis of changes in land use / land cover some of the remedial measures are suggested, which are essential for optimum and sustainable utilization of land resources and prevention of further undesirable and deteriorated changes in land use. Crop rotation could help to improve the land potential and to avoid poor yield. Base on the soil suitability fruit trees could be planted to improve the economy of the people.

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