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DETECTION OF LAND USE PATTERN CHANGES AND MANAGEMENT PRIORITIES FOR THRISSUR DISTRICT, KERALA, INDIA

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Abstract

Thrissur district is leading in its production of clay bricks and tiles for construction. The district has huge paddy fields possess heavy and good quality clay. The brick industries are growing phenomenally, for the past few decades. This has adversely affected the existing land use/ cover practices of the district, particularly, Nenmanikkara panchayath of Mukundapuram taluk is the most affected area in the district. In this context, the present study analyses the impact of clay mining over land use pattern. For which, the topographic data of 1966 and Cartosat-1 satellite data of 2010 was used for mapping of land use pattern. Then, the change detection has been made using GIS overlay function. It was observed that, the large areas of agricultural land are being lost continuously to this irreversible developmental process. Finally, the proper management plans have been suggested to curtail further degradation of the agricultural land and degraded zones of land.

Keywords: Tile/brick Clay, mining, land use, overlay analysis

Introduction

Thrissur district is situated in the central part of Kerala and is also known as the 'Cultural Capital', it is leading in its production of clay bricks and tiles for construction. In order to meet the demand due to urban expansion and export to neighboring states, the surface occurrence of clay is mined extensively, but most of them are unscientific way. By the increase of human population and his excessive demand on limited land resources without adequate conservation techniques land degradation is also on the increase day me day [10]. The paddy fields of the district, which has got a vital role in the eco-balance of the area, are virtually destroyed leading to an irreversible ecological imbalance. This has led to extensive mining of clays which in turn has adversely affected the land use system of the district. The highly affected taluks of the district include Thalapally, Thrissur and Mukundapuram. According to KSLUB report during 1981, among the 294 tile/brick manufacturing factories in the state, 135 were in Thrissur district [2]. Now 283 tile/brick industries are functioning in the district.

The long term brick kiln industrial activity is reportedly a threat to land and environment that adversely affects human health and vegetation, soils and productivity. The heat from the brick kiln alters the physico-chemical properties and habitats of nearby soils by destroying the top soil nutrient elements and soil biota which are likely to impact species diversity and biomass structure of the neighboring plant communities [5]. Nenmanikkara panchayath of Kodakara block is the most clay mining affected area in the district, in which 9 locations of the panchayath are severally affected due to unscientific mining. Huge dump of clay resource are present in mining area as well as tile/brick industrial area [9]. The paddy fields of the district possess heavy and good quality of clay. The dominance of kaolinite and gibbsite in various depositional environment is due to the intense chemical weathering taking place from the source rocks (Precambrian crystalline rocks and lateritic) under the prevailing warm and humid conditions [1]. The land covered by vegetation and settlement have decreased at the expense of mining activity which is reflected in the increase in area of overburden dump, barren land, wasteland and quarry water in Raniganj coal mining area, Bardhaman district, West Bengal [6]. In order to understand the impact of clay mining over land use pattern, the present study has been under taken to analyses the land use pattern during 1966 – 2010 with the help of old topographical data and CartoSat-1 data and GIS analysis has done and suggest suitable remedy for the study area.

Study area

The study area Thrissur district covers an area of 3,032 sq.km and having Thrissur Corporation, 6 Municipalities, 17 Blocks and 92 Panchayaths. It is located in the central region of Kerala state lying between 10^0 13' and 10^0 44' North latitudes and 75^0 39' and 76^0 52' East longitudes (Fig.1). It is falling in the Survey of India Topo Sheet No. 58B/1, B/2, B/3, B/4, B/5, B/6, B/7, B/8, B/11 and 49N/14. The district

is well connected by road network. Canoli canal is also present in western part of the district for water transportation.

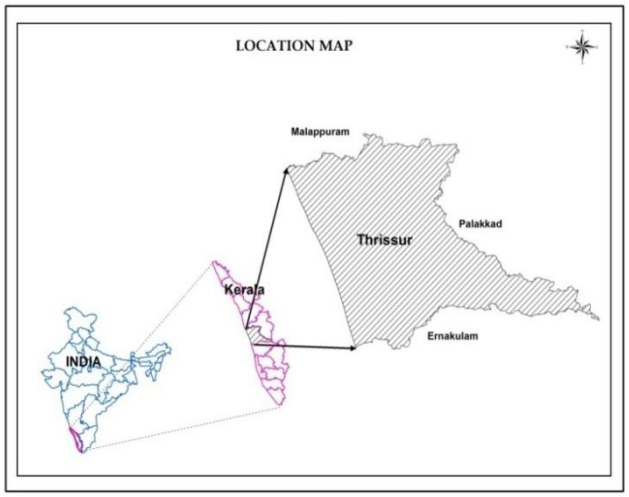

Fig.1: Location map

Methodology

The methodology involves, the land use/ land cover pattern was interpreted from the topographic data for the year 1966 and same has been converted as digital databases in GIS environment. Next, the high resolution Cartosat-1 satellite data for the year 2010 was used for interpretation of current land use land cover pattern of the study area and generated GIS data bases. The classes were derived based on LULC classification standards of NRSC during 2011 [3]. GPS is used to distinguish waterlogged area from natural water bodies. The change detection was made using GIS overlay techniques. Finally, the derived themes were analyzed and suggested the management plans for degraded and non reclaimable zones.

Results and discussions

Land use/ cover pattern of the Year 1966.

Since, paddy fields are the locations of tile and brick clay mining, land use classification was done by giving more thrust to this sector. The 1966 topographic data was used for mapping of land use categories. The following land use practices, viz. paddy, mixed crop, built-up land, coffee, eucalyptus, forest, rubber, teak, land with scrub, stoney waste, river, and water bodies are mapped and shown in Fig. 2. The area and percentage of land use pattern categories are tabulated in Table 1. A careful scrutiny of this map vouches that land use practices have not been greatly influenced by clay mining activity at that point in time. Traditional paddy farming is practiced in the fertile lands of the area.

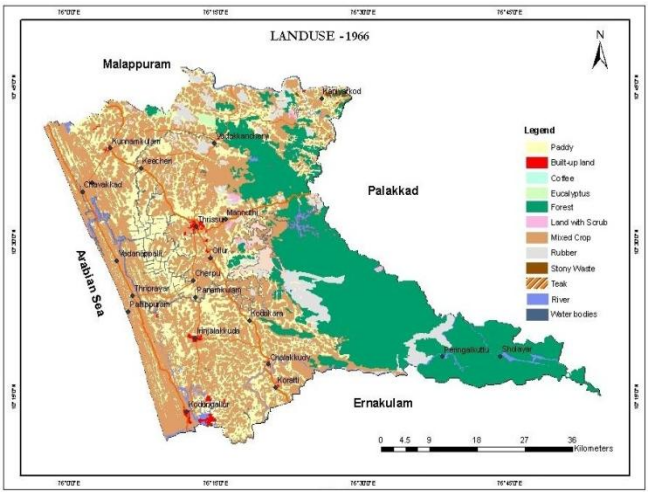

Fig. 2. Land use pattern of the year 1966

Table I: Area and percentage of various land use categories during 1966

Sl. No.	Landuse Classes	Area (Km^2)	% of Total Area
1	Paddy	636.60	21.00
2	Mixed crop	1266.22	41.80
3	Built-up land	18.90	0.62
4	Coffee	0.36	0.01
5	Eucalyptus	3.03	0.10
6	Forest	873.04	28.79
7	Rubber	147.44	4.86
8	Teak	0.55	0.02
9	Land with scrub	8.89	0.29
10	Stoney waste	3.17	0.10
11	River	70.66	2.345
12	Water bodies	0.15	0.005
Total		**3029**	**100**

Land use/ cover pattern of the Year 2010.

The study area, detailed land use level III classification has been done using high resolution satellite data of Cartosat-1 for the year 2010. In the study area, the following categories were observed namely, waterlogged/ fallow area due to clay mining, fallow land, double crop area, coconut dominant mixed crop, current fallow, fallow land, arecanut (converted from paddy), coconut (converted from paddy), banana (converted from paddy), rubber (converted from paddy), pine apple, mixed crop (converted from paddy), commercial (converted from paddy), mixed crop (converted from paddy), residential (converted from paddy), built up land, reserve forest, open forest, rubber (R.F), cashew (R.F), eucalyptus (R.F), eucalyptus and soft wood (R.F), teak (R.F), land with

scrub, barren rocky/stoney waste, rock quarry, beach, water bodies, river, river island, reservoir bed and marshy land and shown in Fig. 3. The individual area of various categories are calculated and tabulated in Table 2. It has been observed that 15.26 Km^2 area in the district is affected due to clay mining.

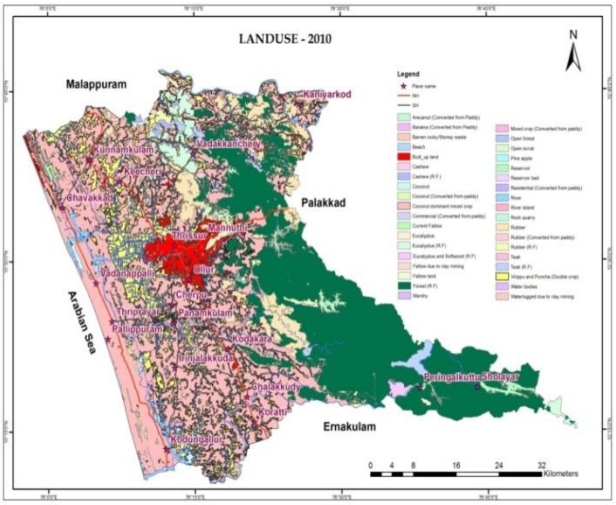

Fig. 3: Land use/ land cover map of the year 2010

Table 2: Area and percentage of land use categories during 2010

Sl. No.	Landuse Classes	Area (Km^2)	% of Total Area
1	Waterlogged due to clay mining	14	0.46
2	Fallow due to clay mining	1.26	0.04
3	Virippu and Puncha (Double crop)	398.52	13.15
4	Current fallow	7.95	0.26
5	Fallow land	4.06	0.13
6	Arecanut(Converted from paddy)	0.02	0
7	Coconut (Converted from paddy)	26.31	0.86
8	Banana (Converted from paddy)	0.05	0
9	Mixed(Converted from paddy)	23.87	0.79
10	Rubber(Converted from paddy)	0.71	0.02
11	Commercial(Converted from paddy)	1.69	0.06
12	Residential(Converted from paddy)	12.48	0.41
13	Coconut dominant mixed crop	1146.01	37.81
14	Built-up land	95.49	3.15
15	Rubber	170.14	5.61
16	Coconut	20.66	0.68
17	Pine apple	0.15	0
18	Forest (R.F.)	856.94	28.27
19	Open forest	3.84	0.13
20	Rubber (R.F.)	27.46	0.91
21	Cashew (R.F.)	8.38	0.28
22	Eucalyptus	2.34	0.07
23	Eucalyptus (R.F.)	59.17	1.95
24	Eucalyptus & Soft wood (R.F.)	7.23	0.24
25	Teak (R.F.)	34.17	1.13
26	Land with scrub	14.59	0.48
27	Barren rocky/stoney waste	5.55	0.18
28	Rock quarry	1.03	0.03
29	Beach	4.51	0.15
30	Marshy	0.72	0.02
31	River	47.17	1.56
32	River island	0.1	0
33	Reservoir	28.89	0.95
34	Reservoir bed	4.66	0.15
35	Water bodies	1.89	0.06
Total		**3032**	**100%**

Waterlogged due to clay mining

In the study area, the artificial water body generated due to extensive clay mining in the paddy field is defined as waterlogged due to clay mining. The total areal extent is 14.00 Km^2 and which comprises 0.46% of the total geographical area of the district.

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Fallow due to clay mining

Fallow lands resulted due to clay mining is derived under this class. The total areal extent is 1.26 Km^2 and which covers 0.04% of the total geographical area of the district.

Virippu and Puncha (Double crop)

Paddy cultivation is the traditional agriculture in low lands/midlands and two crops of rice is cultivating in the district, Viruppu seasons (April-August) and other in Mundakan season (September - December). The total areal

extent of the paddy is 398.52 Km^2 which comprises 13.15% of the total geographical area of the district.

Current fallow

These are the crop land areas, which are un-cropped during the agricultural year under consideration. Those areas are mapped in this categories and it has total areal extent of 7.95 Km^2 and 0.26% of total geographic area of the district.

Fallow land

Fallow lands are the crop land areas, which are un-cropped for two to five agricultural years from the base year. The total areal extent of this class is 4.06 Km^2 and which comprises 0.13% of total geographic area of the district

Arecanut (Converted from paddy)

Arecanut is one among the crops used for permanent reclamation in fringes of paddy fields and converted from paddy fields. These lands are very less area of 0.02 Km^2.

Coconut (Converted from paddy)

Coconut is the other crop used for permanent reclamation in paddy fields. The total areal extent of this class is 26.31 Km^2 which comprises 0.86% of the total geographical area of the district

Banana (Converted from paddy)

Banana is the seasonal crop cultivating in the paddy fields**.** The total areal extent of this class is 0.05 Km^2

Mixed (Converted from paddy)

Mixed crop used for permanent reclamation in paddy field is included in this class. The total areal extent of this class is 23.87 Km^2 and which comprises 0.79% of total geographic area of the district.

Rubber (Converted from paddy)

Rubber plantation used for permanent reclamation in the paddy field, it has been included in this categories. The total areal extent of this class is 0.71 Km^2 and which comprises 0.02% of total geographic area of the district.

Commercial (Converted from paddy)

Due to the urban expansion, the paddy fields are converted in to commercial purpose, those areas was mapped in this categories. The total areal extent of this class is 1.69 Km^2 and which comprises 0.06% of total geographic area of the district.

Residential (Converted from paddy)

The paddy fields converted for residential purpose is included in this class. The total areal extent of land use is 12.48 Km^2 and which comprises 0.41% of the total geographic area of the district.

Coconut dominant mixed crop

This is the major land use practices in the study area, settlement with mixed crops is found and coconut, arecanut, mango, jack, cashew are the crop types. Coconut is the major crop in this group. The total areal extent of this class is 1146.01 Km^2 and which comprises 37.81% of total geographic area of the district.

Built-up land

Built–up land can be defined as an area of human habitation developed due to non-agriculture use and that has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands. Built-up land includes both commercial and residential area. The total areal extent of this class is 95.49 Km^2 which comprises 3.15% of the total geographical area of the district.

Rubber

Rubber is the major plantation found in the midland and highland region of the district. These are the areas under agricultural tree crops planted adopting certain agricultural management techniques. The total areal extent of this class is 170.14 Km^2 and which comprises 5.61% of total geographic area of the district

Coconut

Coconut is the major plantation found in the lowland and mid land region of the district. The total areal extent of this class is 20.66 Km^2 and which comprises 0.68% of total geographic area of the district.

Pine apple

The pineapple plantation is noticed in midland and highland regions of the district as small patches. The total areal extent of this class is 0.15 $Km^{2.}$

Forest (R.F.)

These are the areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundaries) capable of producing timber and other forest produce. Forest consists of dense mixed, dense mixed with bamboo and teak. The forest plantations present are Teak, Eucalyptus etc. The total areal extent of forest 856.94 Km^2

and which comprises 28.27% of total geographic area of the district.

Open forest

The forest outside the notified forest boundary is included in this class. The total areal extent of this class is 3.84 Km^2 and which comprises 0.13% of total geographic area of the district. In the year 2010 the various land practices are observed within the reserved forest land and those plantations have discussed in detailed.

Rubber (R.F.)

The rubber plantation has been observed inside the notified forest boundary, those areas are mapped in this class and have the total areal extent of 27.46 Km^2 and which comprises 0.91% of total geographic area of the district.

Cashew (R.F.)

The cashew plantation area has interpreted within the forest land and it occupies an area of 8.38 Km^2 and which comprises 0.28% of total geographic area of the district.

Eucalyptus

The eucalyptus plantation present outside the forest area are mapped and has the areal extent of 2.34 Km^2 and which comprises 0.07% of total geographic area of the district.

Eucalyptus (R.F.)

Eucalyptus is one among the plantations found in the district and mostly in north eastern part of the district. These are the areas of tree species of forestry importance, raised and managed especially in notified forest area. The total areal extent of this class is 59.17 Km^2 and which comprises 1.95% of total geographic area.

Eucalyptus and Soft wood (R.F.)

The eucalyptus and soft wood plantation inside the forest area is included in this class. The total areal extent of this class is 7.23 Km^2 and which comprises 0.24% of total geographic area of the district.

Teak (R.F.)

Teak is one among the forest plantations and it covers 34.17 Km^2 of the district. These are the areas of tree species of forestry importance, raised and managed especially in notified forest area. It comprises 1.13% of total geographic area of the district.

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Land with scrub

This area possess shallow and skeletal soils, at times chemically degraded, extremes of slopes, severely eroded and lands subjected to excessive aridity with scrub dominating the landscape. They possess sparse vegetation or devoid of scrub and have thin soils cover, those areas are mapped as land with scrub category. The total areal extent of this class is 14.59 Km^2 and which comprises 0.48% of total geographic area of the district.

Barren rocky/stoney waste

These are rocks exposures of varying lithology often barren and devoid of soil and vegetation cover. The total areal extent of this class is 5.55 Km^2 and which comprises 0.18% of total geographic area of the district.

Rock quarry

The active rock quarries are identified in midland and highland regions of the study area, the same has been mapped as quarrying areas. In the study area, the total areal extent of this class is 1.03 Km^2 and which comprises 0.03% of total geographic area of the district.

Beach

The site of accumulation of sediment deposited by waves and currents around a sea margin, those areas are mapped in this class. The total areal extent of this class is 4.51 Km^2 and which comprises 0.15% of total geographic area of the district.

Marshy

A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions. This class is included under wasteland category. The total areal extent of this class is 0.72 Km^2 and which comprises 0.02% of total geographic area of the district.

River

The natural water body formed by the discharge from streams in up lands and flowing towards westward direction. The total areal extent of this class is 47.17 Km^2 and which comprises 1.56% of the total geographical area of the district.

River Island

The sand bodies found inside the river is classified as river island, those areas are mapped and having thetotal areal extent of this class is 0.1 Km^2 .

Reservoir

Reservoir is an artificial lake created by construction of a dam across the river specifically for hydel power generation, irrigation and water supply for domestic or industrial need, flood control, either singly or in combination. The total areal extent of this class is 28.89 Km^2 and which comprises 0.95% of the total geographical area of the district.

Reservoir bed

The area formed due to fluctuation in water level in reservoir is included under this class. The total areal extent of this class is 4.66 Km^2 and which comprises 0.15 % of the total geographical area of the district.

Water bodies

Water body is a natural or artificial body of impounded water often with a regulated flow of water which includes manmade tank, pond and canal. The total areal extent of this class is 1.89 Km^2 and which comprises 0.06% of the total geographical area of the district

Change detection

The land use/cover pattern of the study area during 1966 and 2010 was compared through overlay analysis in GIS platform. It was found that, marked difference in aerial extend during the last 44 years. From the analysis, the paddy field was reduced when compared to 1966 as the expense of mining activity which is reflected in the generation of waterlogged area and fallow land (Fig.4). The main causes of soil physicaldegradation are inappropriate land use and soil management practices [8]. Desurfacing of farm land for brick industry is another source of soil degradation (Fig.5). Thousands of Ha of lands are losing their productive potential due to unscientific extraction of soil [4]. The paddy area shows decreases an area of 238.08 km^2, paddy cultivation mixed crop an area of 96.43 km^2 and river/streams an area of 23.39 km^2. But at the same time, there has increasing trend for built-up land an area of 90.76 km^2, rubber plantation an area of 23.41 km^2, forests and area of 120.21 km^2 and water bodies are 30.63 km^2 and tabulated in Table 3. In addition, an area of 15.26 Km^2 paddy field of the district is affected due to open cast clay mining.

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Fig. 4. Waterlogged mining pits in Kadalassery (Nenmanikkara Panchayath)

Fig. 5. Brick kilns in Chathanchal (Kadukutty Panchayath)

Sl.No.	Landuse class	Area change (km^2)
		1966-2010
1	Built – up	+90.76
2	Paddy	-238.08
3	Clay mining area	+15.26
4	Rubber	+23.41
5	Mixed crop	-96.43
6	Forest	+120.21
7	River/streams	-23.39
8	Water bodies	+ 30.63

Table 3. Changes of Land Use practices during 1966-2010

Conclusion

The land use pattern changes were analyzed in GIS platform during 1966 – 2010 and found that the large areas of agricultural land are being lost continuously to this irreversible developmental process. In the study area, there are 85 clay mining locations were identified in 23 panchayaths, Thrissur Corporation and Chalakudy Municipality. It shows that the agricultural land become converted through clay mining, it creates environmental problems like water scarcity during summer months due the over exploitation of water from the mining pit. Mining also triggered soil erosion and deterioration of soil fertility due to the removal of top soil. The paddy cultivation is found decreasing in the district due to socio-economic problems like shortage of labors and low price for produce. Finally, the proper management plan was suggested to curtail further degradation of the agricultural land and already degraded zones in the form of refilling of mining pits with top soil for regaining the equilibrium of the ecosystem, the waterlogged mining pits can be utilized for pisiculture and floriculture. The vegetables and seasonal crops can be practiced in fallow lands where paddy is not cost effective. The utilization of fly ash bricks produced from thermal power plants as an alternative to clay bricks [7].

Acknowledgments

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Biographies

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