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A study on the classification of land cover in Kanyakumari district, Tamilnadu India using geo-spatial techniques

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ABSTRACT

Land use and land cover change is a major issue in global environment change, and is especially significant in rapidly developing regions in the world. With its economic development, population growth, and urbanization, Kanyakumari, the southern district of Tamil Nadu , have experienced a dramatic land use and land cover (LULC) change over the past 30 years. Fast LULC change have resulted in degradation of its ecosystems and affected adversely the environment. It is urgently needed to monitor its LULC changes and to analyses the consequences of these changes in order to provide information for policymakers to support sustainable development. This study employed Landsat TM/ETM+ images of 1972, 1982 and 2001. The type, rate, and pattern of the changes were analyzed in details by supervised classification.

KEYWORDS

Land use/cover;
LANDSAT;
Kanyakumari.

INTRODUCTION

The human society is closely depending on natural resources. On the other hand the earth suffers growth of population, deforestation, depletion of natural resources and these resources are becoming always more scare. The change detection of land-cover and land-use (LCLU) has been applied in many different countries and ecosystems of the world, for example, in Canada[1], United States of America[2], Kenya[3], Thailand (Crews-Meyer, 2004), Cameroon[3] or in Madagascar[4]. Different approaches have been used to understand where LCLU changes are occurring and to study the driving forces of these changes[5]. Currently, in many parts of the world, human activity is the major force in shaping LCLU change although the underlying physical structure of landscape may constrain CLU[1,6]. For example, soil conditions or terrain slopes may make the cultivation of some crops difficult. Therefore, an integration of biophysical and human factors in the explanation of LCLU dynamics remains as an important research[7].

Many studies have conducted spatial predictions based remotely sensed data[8-15]. Few studies have been conducted on estimations of forestry relevant variables using spatial models, although a large number of spatial-statistical and prediction models are available in the literature[16-19]Goovaerts (1997)Masellj and Chiesi (2006), Buddenbaum et al. (2005), Berterretche et al. (2005), Tuominen et al. (2003), and Zhang et al. (2004) applied geostatistical models to estimate forest variables, such as leaf area index, and to classify forest lands based on remote sensing data. Gilbert and Lowell (1997) used kriging to predict stem volume in a 1500 ha balsam fir

(Abies balsamea) dominated forest. Prediction based on 5.6 m and 11.3 m radius plots resulted in a RMSE of 54% (of the mean) and 39%-46%, respectively. Methodologically, the accuracy rate of the predicted variable could be improved by incorporating close field observations as predictors in spatial modeling.

Study area

Kanyakumari is located at the southern tip of the Indian subcontinent, with an area of 1682 sq.km. Kanyakumari occupies 1.29% of the total extent of Tamil Nadu. The District is bound by Tirunelveli District on the North and the east. The South Eastern boundary is the Gulf of Mannar. On the South and the South West, the boundaries are the Indian Ocean and the Arabian Sea. On the West and North West it is bound by Kerala. The district takes its name from the tourist town of Kanyakumari, which is at the tip of the Indian peninsula and faces the Indian Ocean. The headquarters (capital) of the District is Nagarcoil, which is 22 km from Kanyakumari town.Commonly referred to as the *Land's End*, Kanyakumari District is located at the southern tip of peninsular India and bordered by Thiruvananthapuram district of Kerala state to the west and Tirunelveli District of Tamil Nadu to the north and east. , Kerala is a state on the Malabar Coast of southwestern India.The district lies between 77° 15' and 77° 36' of the eastern longitudes and 8° 03' and 8° 35' of the northern Latitudes. The south-eastern boundary (coastal) is the Gulf of Mannar (Bay of Bengal), while on the South and the South West, the boundaries are the Indian Ocean and the Arabian Sea. The Gulf of Mannar is an arm of the Indian Ocean, lying between the southern tip of India and the west coast of Sri Lanka at a width of between 160 and 200 km (100 to 125 mi).

Geology, geomorphology and Land cover

The geological formation of the district is made up of marine and alluvial soils, raised beaches and alluvium, sand stones. The beach deposits at Manavaalakurichi, Cape comerin and other coastal contain such heavy minerals of Industrial use as ruttle, illuminite, zircon, monazite etc. The District is generally hilly, with plains found near the coast. The land from the sea-coast gradually rises from sea-level to the Western-Ghats hills on the other side of the town. The District has 62 km of coast on the Western side (Arabian Sea coast) and 6 km of coast on the Eastern side (Bay of Bengal coast).

Remote sensing based change detection studies

Detection of changes in the land use/ land cover involves use of at least two period data sets (Jenson, 1986). The changes in land use/ land cover due to natural and human activities can be observed using current and archived remotely sensed data (Luong, 1993). Land use/ land cover change is critically linked to natural and human influences on environment. With the availability of multi-sensor satellite data at very high spatial, spectral and temporal resolutions, it is now possible to prepare up-to-date and accurate land use/ land cover map in less time, at lower cost and with better accuracy. Following the above in view, the present work has been undertaken to prepare the multi-date land use/ land cover maps of Kanyakumari District from multi-sensor satellite data and to monitor the changes in various land use/ land cover classes using digital remote sensing techniques.

METHODOLOGY AND MATERIALS

The overall methodology adopted for the preparation of land use/ land cover map and change analysis is shown with the help of a flow chart. (Figure 2) Digital image processing techniques have been used for preparation of land use/ land cover maps from the multi-date, multi-sensor satellite data. The Anderson's multilevel classification system has been adopted (Anderson, et. al., 1976). ERDAS IMAGINE 8.4 image processing software and its GIS analysis capabilities (VECTOR module) have been used for the preparation of multi-date land use/land cover maps and to monitor the change pattern

RESULTS

1972-Landsat 1-MSS Data- was classified four categories known as Forest land, Cultivation land, Barren land, and water bodies. In that time the study area had 36.5% forest land and it covered entirely the northern and central portions. Cultivation land was about 22% and it was seen in patches in the south eastern part of study area. Barren land was 40.5% and it cov-

ered southeast and south western part of the study area. In this study area Water bodies occupy just 1% of total area identified as Perunchani lake, Kodayar lake and some ponds.

1992- Landsat 5-TM Data-Classified four categories of land elements known as Forest land, Cultivation land, Barren land, and water bodies were found. Kanyakumari district in that time had 18% forest land comparatively less than seen in 1972 data and it covered entirely the northern side. Cultivation land 58.3% which was comparatively more than 1972 and it covered the centre to Northern west part and seen in the form of patches in the south eastern part of the district. Barren land with an areal coverage of 22.4 % found to be comparatively less than seen in 1972 and it covered the southeast and south western part of the district. Water bodies occupy just above 1% than found in the satellite data of 1972.

Figure 1 : Location map of the study area.

2001-Landsat 7-ETM+ Data-Classified four categories known as Forest land, Cultivation land, Barren land, and water bodies. As per the this data the study area contains 31% forest land comparatively less than 1972 but more than seen on the satellite data of 1992 and it covered entirely in the North and North Western part of the district. Cultivation land contains 28.4% comparatively more than 1972 data but lesser than the proportion seen in 1992 and it covers the plain region of the eastern side. Barren land contains 39.3%, more or less equal to 1972 and comparatively higher than seen in 1992 data and it covers the southeastern part of the study area. Water bodies occupy just above 1% but the sizes of them have increased from that seen in the data on 1972 and 1992.

DISCUSSION

The present study clearly shows the usefulness of satellite data for the preparation of land use/ land cover

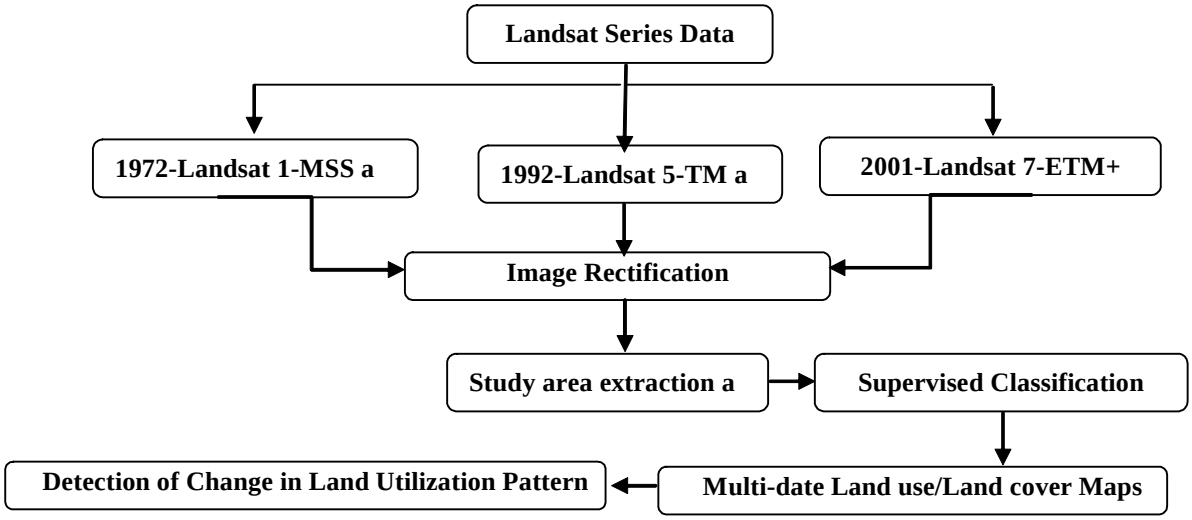

Figure 2: Showing the flow chart explaining the methodology

TABLE 1 : Distribution in terms of area and percentage of the land units

Field	1972	1992	2001
Forest	61624(36.5%)	30359(18%)	52,316(31%)
Cultivation	36995(22%)	98368(58.3%)	47,991(28.4%)
Barren	68369(40.5%)	37812(22.4%)	66,192(39.3%)
Water bodies	1688(1%)	2137(1.3%)	2,177(1.3%)
Total area in hectares	168,676(100%)	1,68,676(100%)	1, 8,676(100%)

TABLE 2: Changes in area and the percentage values of the land units

Field	1972-1992		1992-2001	
	Area(Ha)	%Change	Area(Ha)	%Change
Forest	-31,265	-18.5	21,957	14
Cultivation	61373	36.3	-52,120	-29.9
Barren	-30557	-18.1	28,380	16.9
Water Bodies	449	0.3	40	<0.1

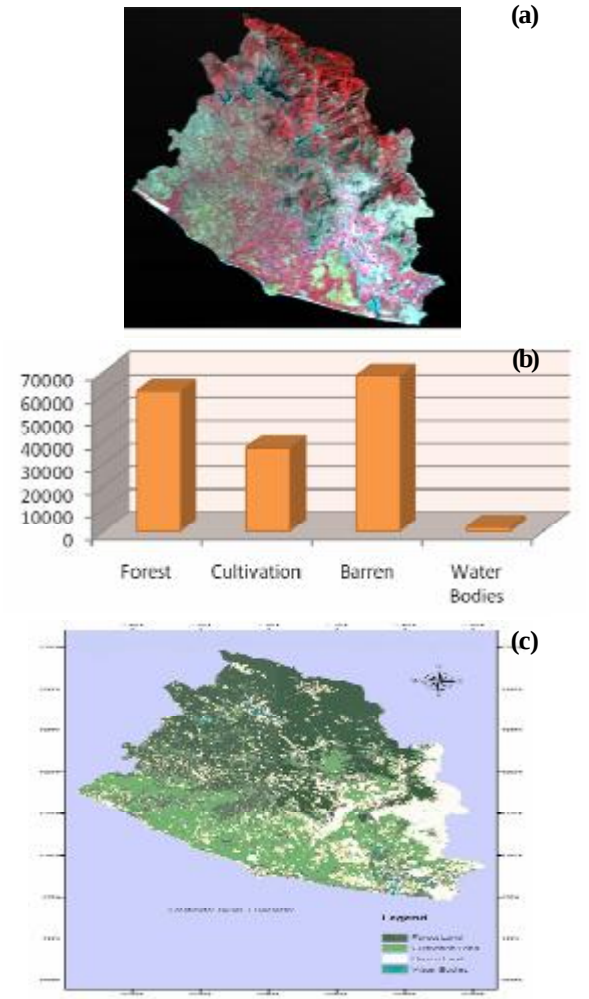

Figure 3 : (a) 1972-Landsat 1-MSS data, (b). Bar diagram showing classification units of 1972 (in hectares), (c).Supervised Classification of study area, 1972

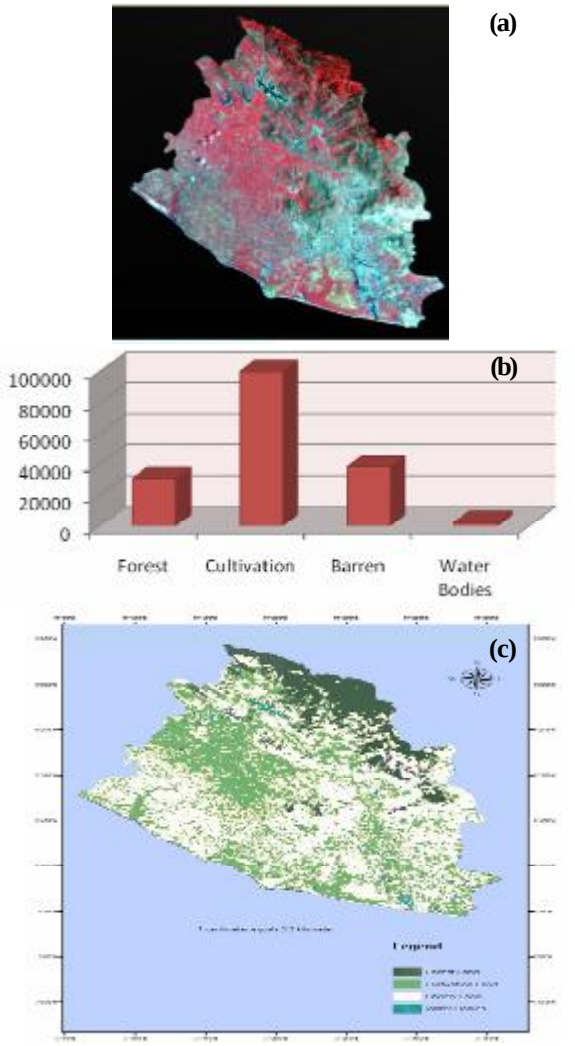

Figure 4 : (a). 1992-Landsat 5-TMData, (b). Bar diagram showing classification units of 1992 (in hectares), (c). Supervised classification of study area, 1992

maps and analyzing their change pattern and future trend for entire Kanyakumari District by utilizing digital image processing techniques. From the TABLES 1 and 2, it can be inferred that in the study area Forest land had decreased by 5.5%, Cultivation land increased by 6.4%, Barren land decreased nearly 1% and water body area is just increased on last 3 decades. Some forest lands were converted into cultivation land in the last 30 years. The present study clearly shows the deforestation. The rate of deforestation is 5% per 30 years. The current rate of deforestation clearly shows that the entire district will be deforested after 200 years. Steps must be taken to stall deforestation and afforestation of the barren lands would further improve the situation.

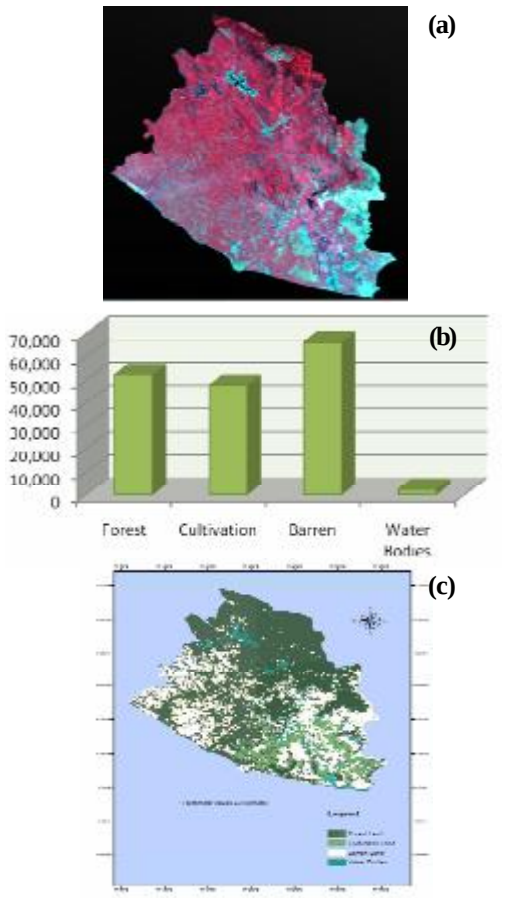

Figure 5: (a). 2001-Landsat 7-ETM+ Data, (b). Bar diagram showing classification units of 2001 (in hectares), (c). Supervised Classification of study area, 2001.

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