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Environmental Impact Assessment and Monitoring the Spatio-Temporal Changes using Remote Sensing and GIS Technology – A Case Study of Nilambur Block, Malappuram District, Kerala

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Abstract **- The study made an attempt to assess the environmental change in Nilambur Block using GIS and Remote Sensing. The Satellite images, toposheet and Block boundary map were used to assess the change between 1992, 1997, 2000 and 2005 were found in the block. The change detection analysis, NDVI and RVI method were used to assess the forest cover, deforestation and vegetation density of Nilambur block. All the data were processed and mapped using ArcGIS Software and the accuracy of the result were compared using Accuracy Assessment in ERDAS IMAGINE Software. The post field verification also done by using GPS and DGPS survey method.**

Key Words: Land Use Land cover Classification, NDVI, RVI, Change Detection etc.

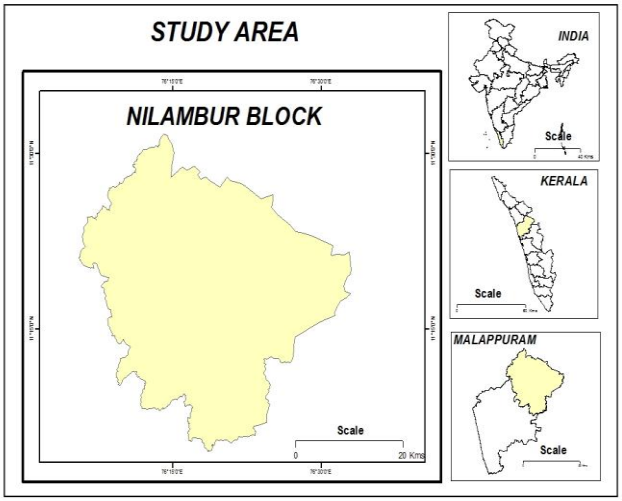
1.INTRODUCTION

People today is faced with an ecological crisis of its own making, the consequences of which would not only be borne by ours future generation but would also drastically alter our lives in the immediate future. The planet is faced with an unprecedented mass extinction of floral and faunal species. Sea levels are rising and many credible scientific and research institutes clearly link and with good reason the increase in temperature; the many severe storms and unregulated industrialization and runaway consumption by our globally connected and market driver community. Closer home in India, the receding glaciers, shrinking cover of natural forests, the rapid loss of biodiversity, the falling ground water levels, inter annual variation in rainfall, rising temperature, falling agricultural productivity point to the destructing health of our ecosystems as if bordering the tipping point if not well past it. In recent years the falling health of our ecosystem is palpably felt in both urban and rural areas.

1.1 Study Area

Nilambur block is located between 76° 05' 34'' – 76° 33' 03'' East longitude and 11° 08' 21''- 11° 31' 40'' North latitude. Nilambur forms eastern block of Malappuram district and a beautiful place having an elegant association of rivers, dense forest and fascinating wildlife. It is bordered by Wandoor and Areacode blocks and Kozhikode district on the west, Wayanad district on the north, Nilgiris district on the east and Wandoor Block and Silent Valley National Park on the South. It covers an area of 1083.57 Sq.km and was originally owned by Zamorin of Kozhikode.

Map 1: Study Area Map



The major portion of forest area of Malappuram district is concentrated in Nilambur block in the Western Ghats. A mammoth effort under the Nilgiris Biosphere Project is underway to protect and regenerate the natural forests. Afforestation is also being done under the Wasteland Development Programme.

2. METHODOLOGY

2.1 Data and Software Used

2.1.1 Data Used

For the present study the toposheet, satellite images, GPS and DGPS survey data, survey and land records map and administrative boundary map were used. All these details were clearly explains the following tables 1 and 2.

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Table 1
Data Used

Name of Block	Toposheet Number	Scale	Year of Survey
Nilambur	58 A3, 58 A7, 58 A8, 58 A2, 58 A11	1:50000	1996 -1968, 1969 - 1970 and 1970 -1971
IRS -1D LISS III Images	-	-	1992,1997,2000and 2005

Table 2
Satellite Image Details

Sl. No	Satellite	Sensor	Path & Row	Resolution	Date of Acquisition	Year	Source
1	Landsat	TM	144 - 52	28 m	14-JAN		GLCF
2	IRS 1C	L3	99 - 65	23.5 m	26-FEB	1997	NRSA
3	IRS I C	L3	99 - 65	23.5 m	18-JAN	2000	NRSA
4	IRS I D	L3	99 - 65	23.5 m	18-JAN	2000	NRSA
5	IRS P 6	L3	99 - 65	23.5 m	08-FEB	2005	NRSA
6	IRS P 6	L4 MX	102 - 127	5.8 m	05-JAN	2007	NRSA

2.2 Software Used

Toposheets and other maps are scanned with resolution of 200 dpi usinga 0 drum scanner and saved in the TIFF format. These scanned maps brought to GIS environment using Arc GIS 9x software and were georeferenced using tool provided with software. For Georeferncing, geographic coordinates of known points (control points) were taken from Toposheet and maps are updated with Georeferncing tool, later rectified and saved. 'Shapefiles' were created using Arc Catalog module and added to Arc Map over the georeferenced maps, feature classes were digitized using editor tool provided. GCPs collected using GPS taken to the system using Map World GPS software, after changing its coordinated units in to DD then saved in to DXF format, then added to Arc Map window and converted into 'shapefile' using 'Data export' option. Both tracks and GCP were exported. For image processing and map preparation the Arc GIS and ERDAS IMAGINE software were used. For the ground survey and lat/long identification the Map Source 4.09(GPS software) and Garmin GPS were used. For data process and tabulation the MS-Excel and MS-Office software were used. For improving image contrast and brightness of image enhancement process like histogram equalization were used.

2.3 Methods

The study extent and density and type of vegetation and analyses the deforestation following methodology was adopted. Integrated use of GIS and Remote Sensing and Digital Image Processing techniques was used for the study. The study was carried out specifically for the years, 1992, 1997, 2000, and 2005. All satellite images were corrected for both Geometric and Atmospheric corrections. Using the sub setting options these images were later subsetted as per the study area .These images were later classified using the hybrid classification method by taking approximately 100 classes. Based on the spectral reflectance of the different land use classes the 100 classes were grouped in to ten classesand their aerial extent was calculated. The vegetation indices NDVI was used to identify the changes in the density of vegetation after the implementation of the government restoration efforts.

The NDVI helps in identifying the changes in the vegetative cover apart from the normal vegetation. The change matrix technique was used to identify the variations in the land cover over a period of time from one type to another. The field survey was carried out using the DGPS to mark the location of the critical places in the study area and also to check the field accuracy of the land use land cover map prepared from the satellite imagery. After the field visit the accuracy assessment method was used to test the accuracy of the land use land cover results generated from the satellite imagery. For the change detection studies the pre and post satellite data was taken for performing the change detection studies.

2.3.1 Normalized Difference Vegetation Index (NDVI)

NDVI values lies between -1and +1.Vegetation in good condition shows higher NDVI values.This is used to eliminate the seasonal sun angle difference and minimize atmospheric effects.Higher values indicate more density and vigor of the vegetation.NDVI is extensively used to detect seasonal variations among vegetation.

NDVI=NIR – Red / NIR + Red

2.3.2 Ratio Vegetation Index (RVI)

RVI is used to study transmission of forest canopies. RVI values in normal conditions ranges from 0 to 20. RVI values indicate the vegetation vigor and abundance.Higher values indicate higher vegetation vigor and density.

RVI = NIR / RED

2.3.3 *Filed Survey and Sampling*

3.2.3.1 Preliminary Field Visit

To get an idea about vegetation, terrain, people and climate, a preliminary field visit was carried out in the early periods of project and necessary literatures and statistical information such as rainfall, temperature, agriculture were collected and incorporated with further studies.

Post field Visit

After completing all kind of analysis and preparation of land use/land cover maps, an organized field visit was carried out. During the field accuracy of classified maps were cross checked with ground. GPS control points were collected for Carrie out further accuracy assessment with help of system. In order to delineate current forest boundary, a GPS survey was conducted along the forest boundary where the deforestation is reported.

2.4 Accuracy Assessment

Classified images were further subjected to accuracy assessment process using the Accuracy assessment tool provided with ERDAS software. For checking the accuracy of image classification 30 GPS points collected from the field were used as the reference point with known land use/ land cover. But the problem is it is valid only for recent imagery, LU/LC of older imageries under respective to this present GCP were may not be the same as now. Even though the classification accuracy of each thematic maps were above 90 %.

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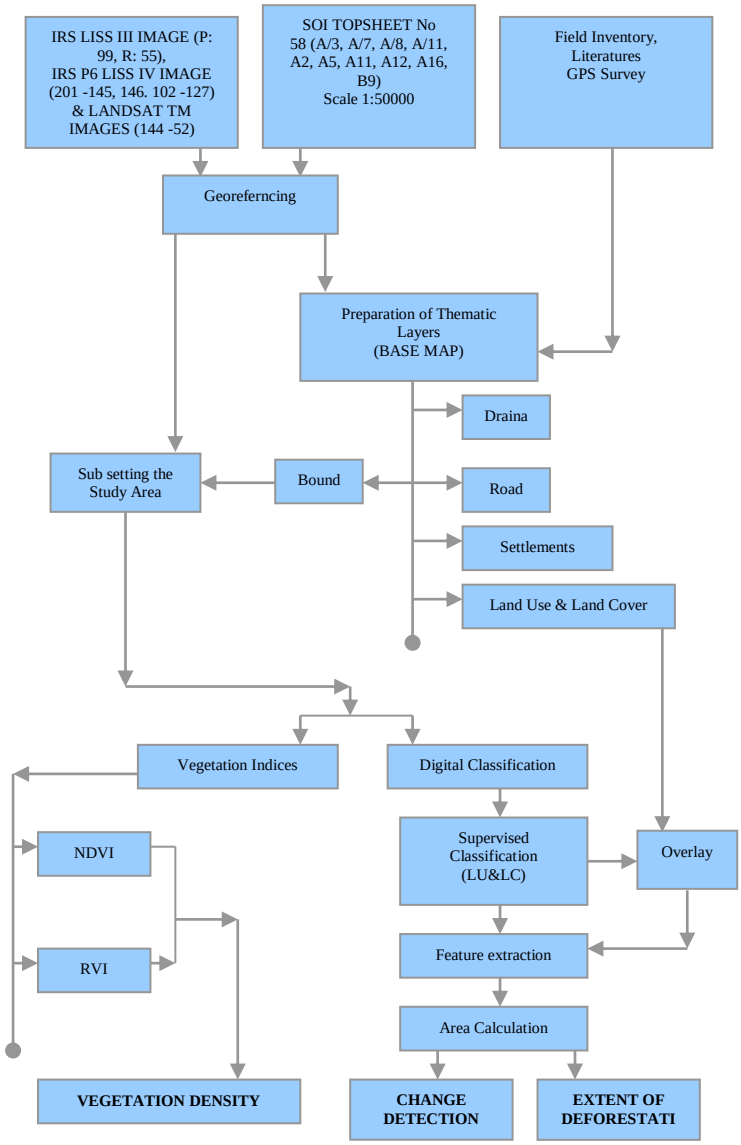
Flow Chart 1: Methodology



3. RESULT AND DISCUSSION

3.1 Land Cover/Land Use Analysis

Results of Land use/land cover (LU/LC) analysis for the following years- 1992, 1997, 2000 and 2005 are given in the table 00. LU/LC classes classified from the images are Dense Forest, Open forest, Forest Plantation, Agriculture Fallow, Agriculture Plantation, Agriculture Fallow, Water Body, Scrub / Grass Land and Settlements. Hybrid approach (a combined use of unsupervised classification and supervised classification was adopted for deriving the LU/LC classes.

Table 3
Nilambur Block
LU/LC (1992 - 2005)

SL. NO	Class Name	Class Code	Area (Sq.km)			
			1992	1997	2000	2005
1	Agriculture Crops	CR	260.81	170.37	268.40	162.45
2	Agriculture Fallow	AF	66.65	24.14	49.55	49.01
3	Agriculture Plantation	AP	31.93	93.84	32.69	114.43
4	Barren Rocky	BR	18.41	88.21	33.75	29.86
5	Dense Forest	DF	384.22	328.82	385.07	343.74
6	Forest Plantation	FP	87.32	117.63	98.56	135.65
7	Open Forest	OF	191.05	175.31	170.68	192.02
8	Settlement	ST	0.06	0.11	0.10	0.14
9	Scrub /Grass Land	SG	36.80	79.16	39.34	50.92
10	Water Body	WT	3.33	2.99	2.43	2.36
			1080.57	1080.57	1080.57	1080.57

Map 2: LU/LC - 2000

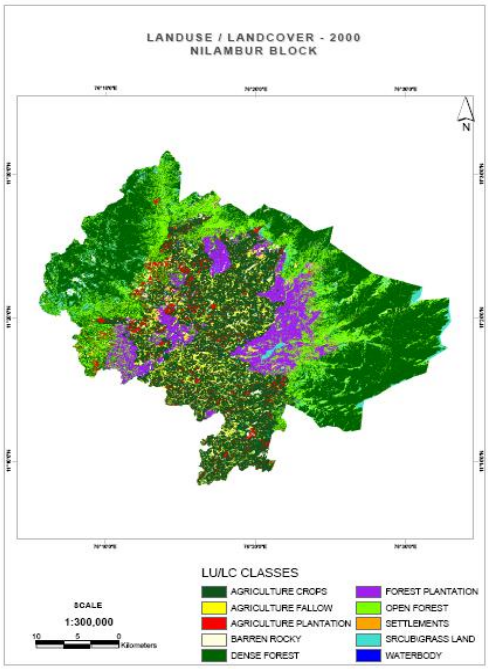
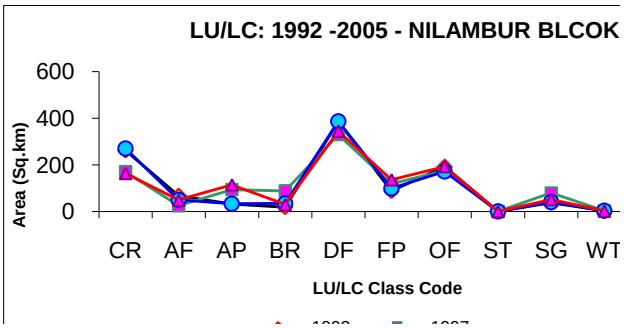


Figure 1: LU/LC Class 1992 - 2005



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3.2 Crops and Plantation

In Nilambur block more than 70 % of the population is depends on agriculture. Major crops cultivating in Nilambur block are rice, banana, vegetables, tapioca etc. in plantation sector rubber is the major plantain. Private as well as government owned plantation are there in Nilambur block. In the case of agriculture crops after 1997 there is sharp increase is noticed this may be due to price loss of rubber, so that in that time many people stops growing rubber and cultivated other food crops. But after few year the trend began to change and plantation sector regains its strength over food crops.

Figure 2

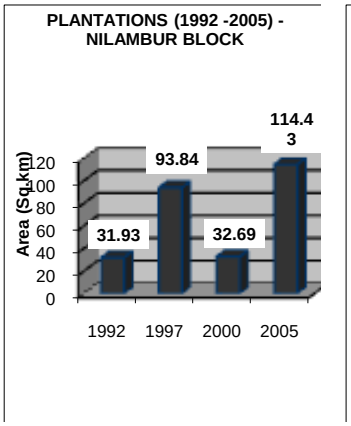
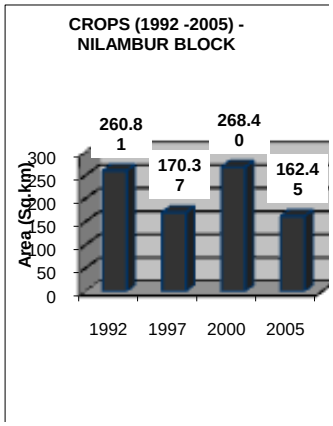
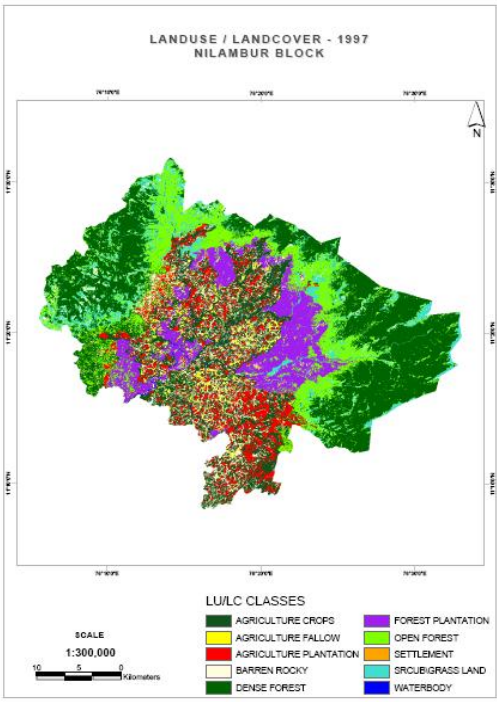


Figure 3

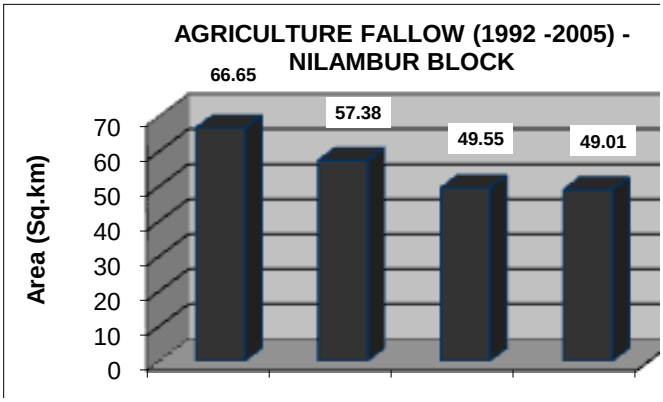


Map: 3
LU/LC - 1997



Most of the paddy fields are used for raising rice, become temporary fallow during the February – May period due to lack of sufficient water for irrigation. Though the trend is that the area under agriculture fallow is decreasing as gradually. This implies that the areas are converting to others crops or plantation instead of cultivating rice. It is known that most the non-forest areas in the 1970s were cultivated with rice; in that time even land rice verities were cultivated. Even now we can see the evidences of the epoch in the form small rundown canals.

Figure 4



3.3 Forest Resources

Forest of Nilambur block falls under Manipulation (Forestry) and Core zone of Nilgiris Biosphere Reserve. More than 55 % total land of Nilambur block comes under forest. Three forest categories were classified from the imagery, tabulated and results depicted below in the form charts. There no major difference in the area with in the three categories is noticed. That the forest of Nilambur stable, even though some treats like encroachment and fire still existing. In the foot hills of Nilambur forest area bamboos are growing extensively. One notable thing is that, in the past government hand over forest land for setting up plantations, these areas were thickly vegetated and trees were fell down neglecting its importance.

Figure 5

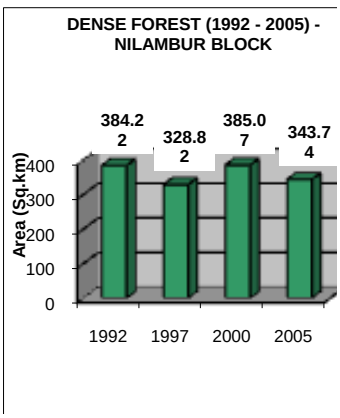
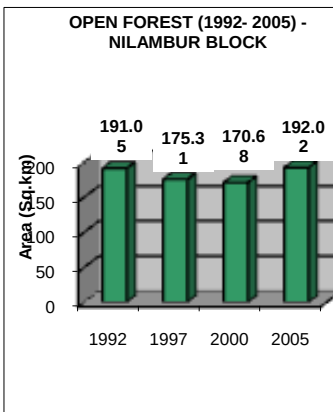


Figure 6



The Nilambur Forests can certainly claim the pride of place as being the first in India and perhaps in the whole of Asia, to have received systematic scientific treatment. It was here that a noble beginning was made for the artificial propagation of teak. How the nucleus of the mighty project of Teak plantations started on a modest scale by the renowned Mr. H.V. Conolly, later assumed and accomplished the shape and size of the world's most spectacular and valuable forest plantations at Nilambur, is indeed a sweet and holy tale, dear and encouraging to foresters, the world over. It was here that the technique of planting and maintaining teak was experimented and perfected (Ramankutty, 2001).

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Figure 7

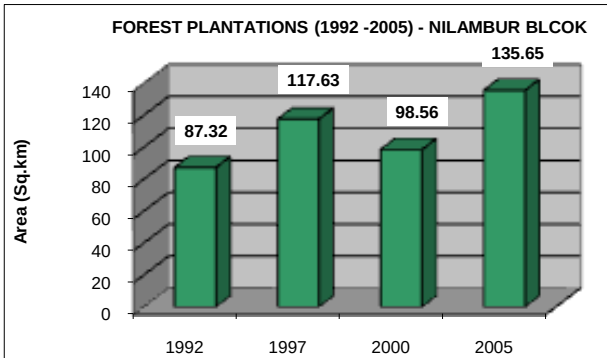


Figure 8

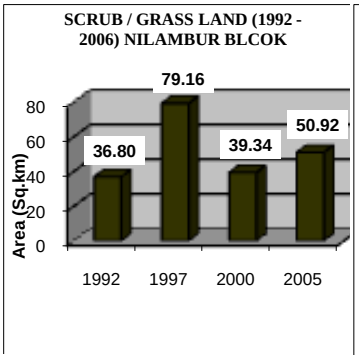
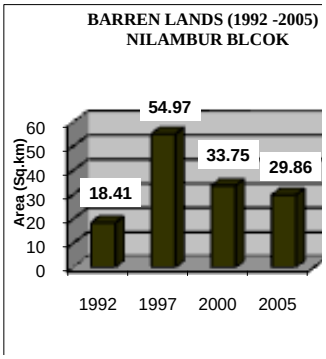
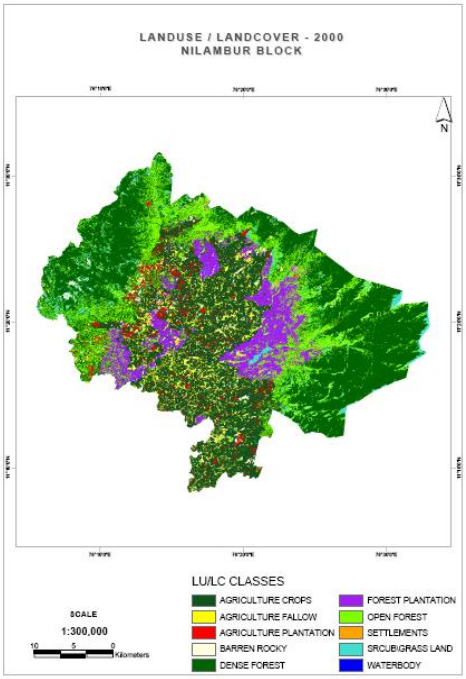


Figure 9



Map 4
LU/LC - 2000



3.4 Scrub or Grass, Barren and Water body

Scrubs are seen only in eastern hilly areas but grass lands are seen on the surrounding of rocky out crops where soil thickness is very less. Most of the grass land become dry in summer season and cause the immediate spread of forest fire. Barren lands are seen in the rocky exposures in the eastern, northern and western hilly areas. In 1997, it is noticed that a considerable decrease in plantation area and it may be the reason for a sharp increase in the extent of scrub and barren land.

Chaliyar the only major river flowing through the Nilambur block. Because of increased impact of high temperature during summer, most of the tributaries becomes dry, many first order streams are very difficult identify or vanished. So that the water flow in Chaliyar river in summer is very less. Kavanakallu Regulator cum Bridge helps to keep water level to some extent in summer season in the areas - Vazhakkad to near Edavanna.

Map 5
LU/LC 2005

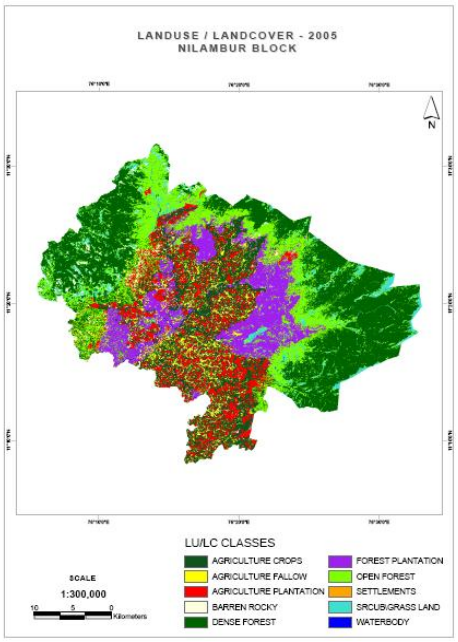
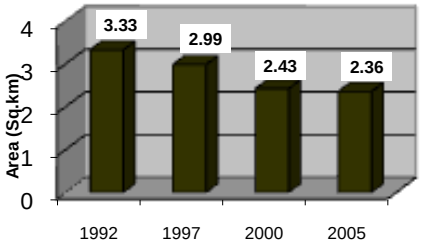


Figure 10
WATERBODY (1992 -2005) - NILAMBUR BLCOK



At the present time Punnapuzha is also facing water crisis because water in the upper catchments are diverting to the Tamil Nadu.

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Table:4
Nilambur Block
Land Use/Land Cover (1992 -2005)

SL. NO	Class Name	Class Code	Area (%)			
			1992	1997	2000	2005
1	Agriculture Crops	CR	24.14	15.77	24.84	15.03
2	Agriculture Fallow	AF	6.17	5.31	4.59	4.54
3	Agriculture Plantation	AP	2.95	8.68	3.03	10.59
4	Barren Rocky	BR	1.70	5.09	3.12	2.76
5	Dense Forest	DF	35.56	30.43	35.64	31.81
6	Forest Plantation	FP	8.08	10.89	9.12	12.55
7	Open Forest	OF	17.68	16.22	15.80	17.77
8	Settlement	ST	0.01	0.01	0.01	0.01
9	Scrub /Grass Land	SG	3.41	7.33	3.64	4.71
10	Water Body	WT	0.31	0.28	0.22	0.22
			100.00	100.00	100.00	100.00

A comparative analysis of land useland coverof 2000 – 2005 is as follows: Around 10 % decrease recorded in the case of agriculture crops, but in the case of plantation 7 % increase is recorded. Agriculture fallow remains the same. Forests category exhibiting small fluctuations, it may due to the effect of rainfall and other climatic variables. Settlements are not exactly mapped. Water body is also keeping the same percentage in both the years.

3.5 Deforestation

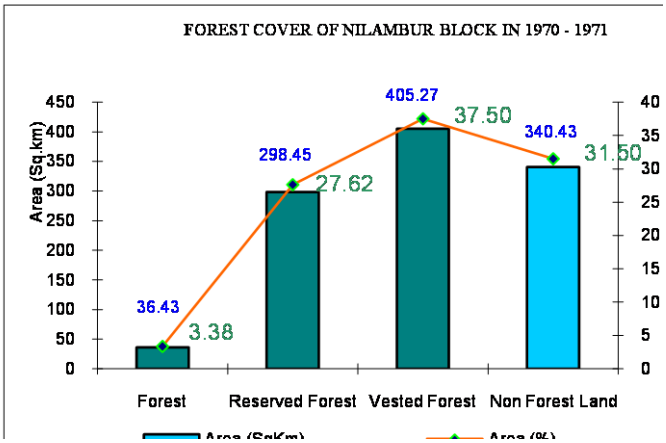
Deforestation is brought about by the following: conversion of forests and woodlands to agricultural land to feed growing numbers of people; development of cash crops and cattle ranching, both of which earn money for tropical countries; commercial logging (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forests for agriculture; felling of trees for firewood and building material; the heavy lopping of foliage for covering cultivated are; and heavy browsing of saplings by domestic animals like goats. To compound the problem, the poor soils of the humid tropics do not support agriculture for long. Thus people are often forced to move on and clear more forests in order to maintain production.Forest cover of Kerala is largely spread over the Western Ghats which border the state. The Western Ghats represent one of the world's 18 hotspots of biodiversity and is considered to be a repository of endemic, endangered and rare flora and fauna. Estimated the rate of deforestation in the Western Ghats to be 0.57% annually during the period 1920–1990 (Menon and Bawa, 1998) and Prasad *et al*.(1998) have assessed 0.90% annual decline in natural forest cover in Kerala for the period 1961–1988.

The recorded forest area is 11,125.59 Sq.km; the percentage of forest cover in Kerala is 28.90 which is higher than the national average of 19.50. This includes 9157.10 Sq.km of reserve forests, 214.31 Sq.km proposed reserve and 1754.18 Sq.km vested forests. Out of the total 11,125 Sq.km recorded forest area the effective forest area is only 9400 Sq.kms (Government of Kerala, 2007). Before 1977, vested forest of Nilambur block is owned by The Thrikkaliyur Devaswom (Management of Temple property), The Nilambur Thirumulpad (Senior Member of Kovilakam), The Wandoor Namboodiripad (Senior Member of Kovilakam) and The Zamorin (Raja) of Calicut, (Ramankutty, 2001) . The forests of this Nilambur Block are the absolute property of the State The Govt. of Kerala had promulgated an ordinance which became an Act later on known as Kerala Private Forests (Vesting Assignment) Act 1971, accordingly all the Private forests were "Deemed Reserved Forest" and are the absolute property of the government of Kerala and have been notified as per G. O (MS) No. 82055/FS/21/76/AD dated 11th January 1977 and published in Kerala Gazette No. 4, dated 15th January 1977. LU/LC of Nilambur block in 1970-71 categorized into Forest plantations, Reserve Forest, Vested Forest and Non Forest land and details are given below.

Table:5
Nilambur Block
Forest of Nilambur Block In 1970s

Sl. No	Land use / land cover	Area (Sq.km)	Area (%)
1	Forest Plantations	36.43	3.38
3	Reserved Forest	298.45	27.62
4	Vested Forest	405.27	37.50
2	Non Forest Land	340.43	31.50
	Total	1080.57	100.00

Figure 11



Subsequently after the migration of people from central parts of Kerala along with extension of plantation frontier, forest of Nilambur began to shrink. Most of the deforestation taken place during the period of 1970 – 76, i.e., before the enactment of Kerala Private Forests (Vesting Assignment) Act 1971. Deforested areas are delineated from the IPS P6 LISS IV multispectral images and with the help of GPS survey. Details of deforestation are furnished in the table below.

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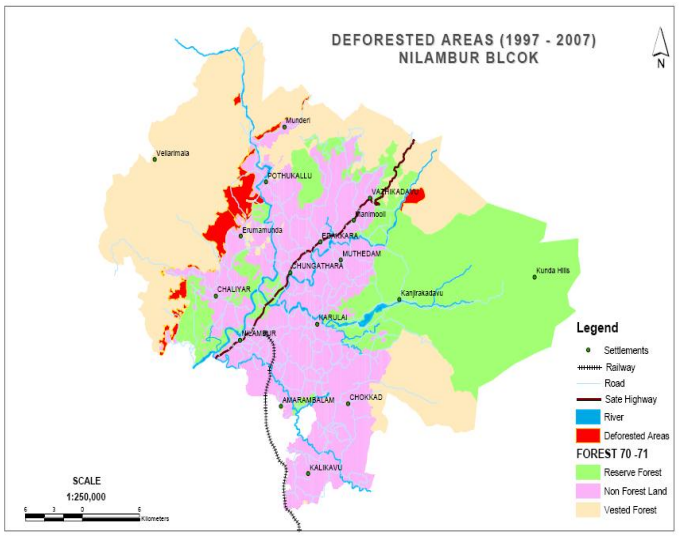
Table 6
Nilambur Block
Details of Deforestation after 1971.

Si. No	Encroachment Type	Area in Sq.km	Area in Ha	% of Total Area of Vested Forest
1	Private	21.79	2178.85	5.38
2	Government	4.25	425.04	1.05
	Total:	26.04	2603.89	6.43

Map 6
Deforestration Area – 1997 - 2007

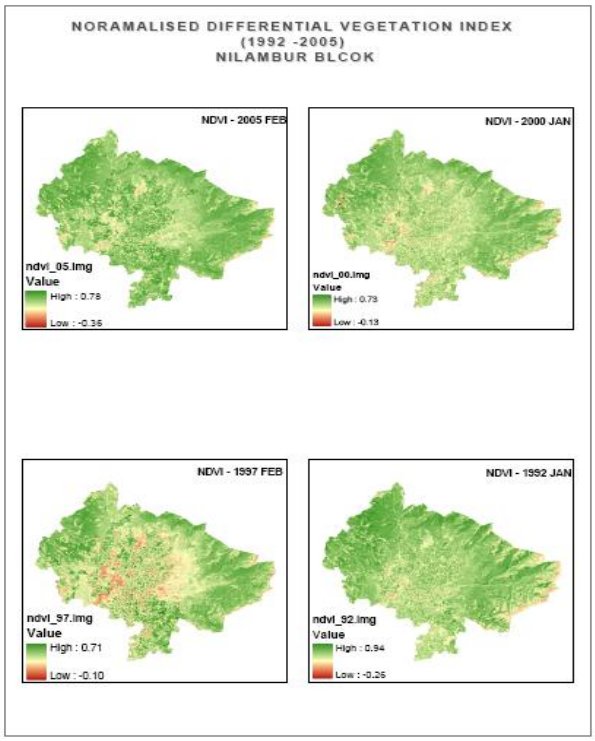


3.6 Density Mapping

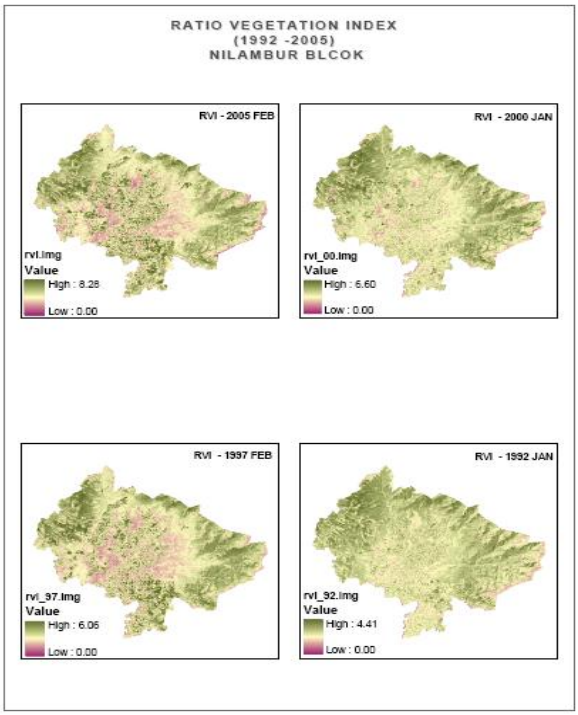
Vegetation density mapping is carried with helps vegetation indices such as NDVI and RVI. Vegetation indices widely employed for determination of density of vegetation, water stress, and crop health monitoring(Lyon *et al*, 1998; Yamagata, 1999; Ramsey *et al*, 1995;Bastiaanssen, 1998). Vegetation density mapping was carried out for Nilambur block.

Common classification techniques employed for NDVI derived IRS images, while NDVI derived from Landsat TM image different and classification was carried out based on assigned land use classes. Results displayed in the form of maps.

Map7
NDVI 1992 – 2005



Map 8
RVI 1992 - 2005



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5. CONCLUSION

As ecological security is the foundation for sustainable and equitable development, we are committed to strengthening, reviving or restoring, where necessary the process of ecological succession and the conservation of land and water resource in the country. While nature functions as fairly independent system and could perhaps rejuvenate and react in equally good sate in the long run. The result of Land use/land cover analysis of Nilambur block were clearly indicate that these lands deserving more and wide attention, that are able to penetrate to all zone of its degrading parts of ecosystems. Analysis regarding deforestation shows that isolation of forest from non-forest land with help of strong and concrete boundary indicating structures is an urgent requirement. If there is any periodical monitoring system for checking the boundary, which will definitely help to arrest deforestation. Use of Geographical Information System will enable concerned authority to monitor and manage forest resources effectively, i.e., modernization of Government departments that dealing with the affairs pertaining to natural resources is indeed.

Regarding to vegetation density mapping, result is showing that very undulations with respect to season and date of data acquisitions, and it happens during a period, so that without continues monitoring of it is not easy to interpret the results. Even though some remarkable change noticed that, the density of vegetation in the forest land increasing, it may due to considerable reduction of human interference in the forest, hunting, incidence of forest fire and chopping of forest trees are reduced to a considerable level.

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