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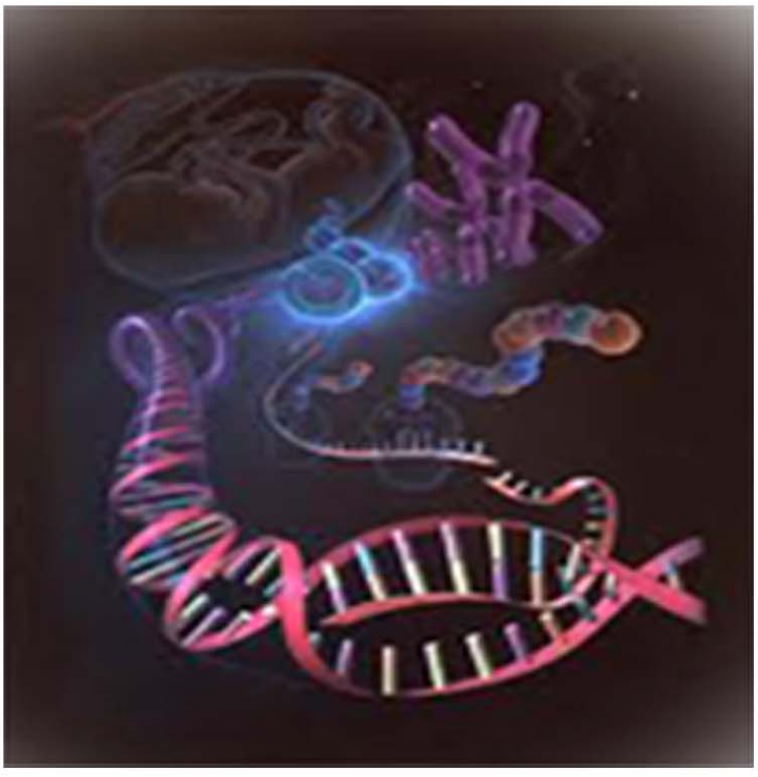

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Research Paper

MONITORING OF ENVIRONMENTAL CHANGE USING GEOINFORMATICS TECHNOLOGY: A CASE STUDY OF ATTAPADY BLOCK, WAYANAD DISTRICT,KERALA

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The receding glaciers, shrinking cover of natural forests, the rapid loss of biodiversity, the falling ground water levels, rising temperature, falling agricultural productivity, point to the destructing health of the ecosystems, not well known in the past. The Nilgiri Biosphere Reserve is not out of bounds for the same and experienced high rates of deforestation over period of time. It is being envisaged judicious and realistic land cover and land use change data in conservation planning, accurate and efficient techniques to detect forest change from multi-temporal satellite imagery are desired for conservation optimally. The Attapady block, in Wynad district of Kerala State was a treasure house of dense forest and biodiversity and over a period of time, with intense pressure of human land use pattern, wide scale degradation occurred. It is imperative to conserve and reclaim lands for judicious and optimum use of land and water potential, and through alternatives for land use, economic, social conditions, and changes of ecosystems. In view of this scenario, a study was taken up in Attapady block, primarily to study changes in vegetation type, density and extent, analyze the extent of deforestation and to understand the temporal changes. NDVI was used to identify the changes in density of vegetation and the change matrix identified the variations in the land cover over period of time. DGPS marked critical locations. Periodic monitoring to arrest deforestation will be a necessity. Regulatory framework on water use for irrigation, land use, forest resource use, incentives on conservation, regeneration and protection measures will remarkably improve the development scenario, for which the monitoring of environmental change using Geoinformatics technology is imperative.

Keywords: Land use land cover classification, Image Classification, NDVI, RVI, Change Detection

INTRODUCTION

Human society today is faced with an ecological crisis of its own making, the consequences of which would not only be borne by our future generation but would also drastically alter our lives in the immediate future. 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

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well past it. In recent years the falling health of our ecosystem is palpably felt in both urban and rural areas. The remote and inaccessible forests of Nilgiri Biosphere Reserve have experienced high rates of deforestation corresponding to human migration and expansion of the agricultural frontier. Given the importance of land cover and land use change data in conservation planning, accurate and efficient techniques to detect forest change from multi-temporal satellite imagery were desired for implementation by local conservation organizations. It is the common agreement to go for exploitation of those resources, which are not attended optimally till now. Two such lands qualify for the category is the Attapady block. Earlier these areas were treasure house of dense forest, was cleared by the people migrated from Tamil Nadu, Karnataka, and from Central Travancore. Intensive and ruthless felling of trees made Attapady as a wasteland. For the conservation and reclamation of these lands it is necessary to map them and monitor the changes in the spatial extent over specified time. Monitoring the locations and distributions of Land Cover changes is important for establishing links between policy decisions, regulatory actions and subsequent land use activities. Planning plays a key role in the management of making best use of limited resources. Land use planning is the systematic assessment of land and water potential, alternatives for land use, economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land area that will best meet the needs of the people while safeguarding resources for the future. Integrated use of GIS, Remote Sensing and Image processing technologies enable us to cope with the objectives of change detection. Most of the changes of ecosystems are happening on earth is in close proximity of human inhabitations.

OBJECTIVES

1. To study changes in vegetation type, density and extent in Attapady block of Palakkad District, Kerala State.
2. To analyze the extent of deforestation in Attapady Block.
3. To identify the changes in density of vegetation.
4. To understand the temporal changes.

STUDY AREA

Attapady is situated in an elevated picturesque mountainous plateau in Western Ghats and geographic coordinates are 76° 23'13" - 76° 48' 08" E Longitude, 10° 55' 06"-11° 14'16" N Latitude at the South-Western part of Nilgiri Biosphere Reserve portion of the Kerala state. The area is bounded in the north by Nilgiri District of Tamil Nadu, in West by Malappuram District and Mannarkad Blcok, in the south by Mannarkad and Malampuzha blocks of Palakkad District and in the east by Coimbatore District (Tamil Nadu).

Data Products Used

Name of Block	Toposheet Number	Scale	Year of Survey
Attapady	58 A8, 58 A12, 58 A16, 58 B9	1:50000	1969-1970 and 1975 -1976
IRS 1D LISS III Images			1992,1997,2001 and 2005

METHODOLOGY

The study was taken up to assess the measures taken up by the government for prevent the deforestation in the attapady block. The study was carried out specifically for the years, 1992, 1997, 2000, 2001, 2005 and 2007.To reach the objectives of the study, the satellite images were procured for every year starting from 1992. These images were corrected for both Geometric and Atmospheric corrections. Using the subsetting 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 classes and their aerial extent was calculated. The vegetation indices NDVI were 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.

RESULTS AND DISCUSSION

Land use/ land cover Analysis of Attapady was carried out for the years 1992, 1997, 2001 and 2005 to identify the changes in land use/ land cover. Based on Spectral reflectance coupled with field knowledge, the area was classified into 10 classes. In Attapady block more than 60 % of area is forest. Details of land use/land Cover classification for the years (1992, 1997, 2001, and 2005) are furnished in Table 1 and Graphical representation of result is given in chart 1.

Agriculture Crops and Plantation: The Attapady Block is surrounded by the rivers Bhavani, Siruvani, Kodungara palam on both sides, serves as the source for the food crops such as banana, rice, ground nut, sugar cane, chamai, sorghum, ragi, sunflower etc. These crops are grouped and classified as Agriculture Crops. Agriculture

Table 1: Land Use/Land Cover, 1992-2005 - Attapady Block

S. No.	Class Name	Class Code	Area (Sq.Km)			
			1992	1997	2001	2005
1	Barren Land	BR	33.78	24.28	69.32	53.34
2	Crops	CR	24.20	68.65	23.38	20.48
3	Degraded Forest	DGF	14.78	73.59	61.28	68.37
4	Dense Forest	DF	277.26	248.89	246.04	234.43
5	Dense Scrub	DS	75.48	44.77	63.57	102.40
6	Land with Scrub	LWS	95.95	102.27	87.97	87.77
7	Land without Scrub	LWOS	46.25	37.15	51.25	65.28
8	Open Forest	OF	142.55	119.47	93.94	53.56
9	Plantations	PL	31.09	20.57	44.31	55.17
10	Water Body	WT	3.66	5.36	3.95	4.20
		Total	745.00	745.00	745.00	745.00

Plantation comprises of rubber is found in the southern part of Attapady block. Coconut, Arecanut are seen on either side of the rivers. Chart 2 and Chart 3 is graphically represent, the trends in cultivation of crops and area change of plantation during the period of 1992 -2005. From the charts it is visible that area under crops remained stable throughout the period. But a two fold increase was recorded in 1997; it may be due to high rainfall during 96-97, moreover in these periods cash crops are facing severe price depreciation so that people may be entrusted in the production of food crops. In the case of plantation, a gradual and steady increase is seen.

Landuse/Landcover (1992-2005) - Attapady Blcok

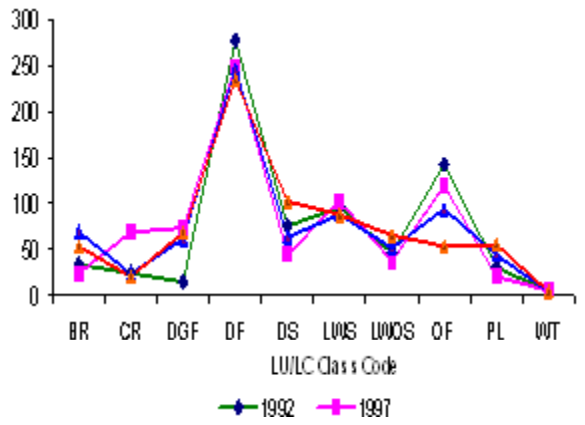


Chart 1: Crops (1992-2005) - Attapady Block

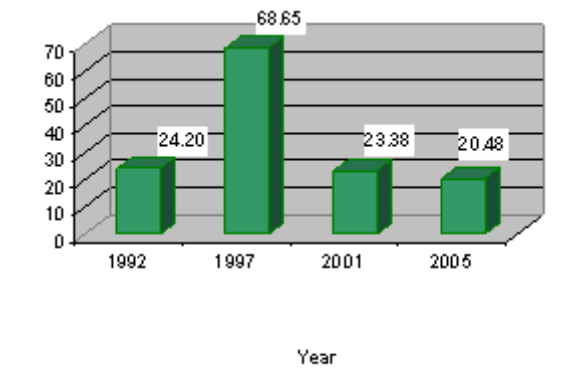
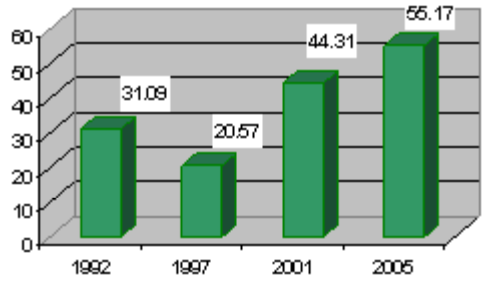


Chart 2: Plantations (1992-2005) - Attapady Block



Forest: In Attapady block forests are classified into four types' namely dense forest, open forest, degraded forest, and dense scrub. Dense forest (> 40% canopy cover) is seen in the undisturbed area of Attapady block and is characterized with dense foliage. Chart 4 graphically represents, the Geographical extent of dense forest from 1992 - 2005 period is remaining almost stable, minor fluctuations are noticed, may be due to variation in the rainfall and other climatic variables.

Chart 3: Dense Forest (1992-2005) - Attapady Block

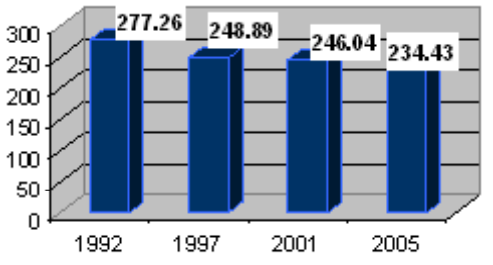


Chart 4: Open Forest (1992-2005) - Attapady Block

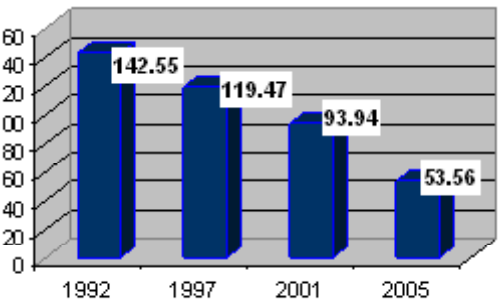


Figure 1

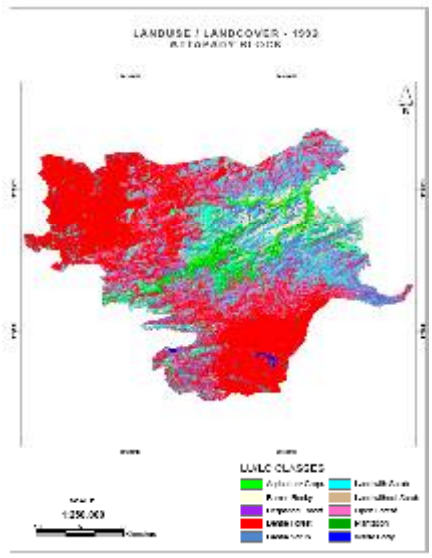
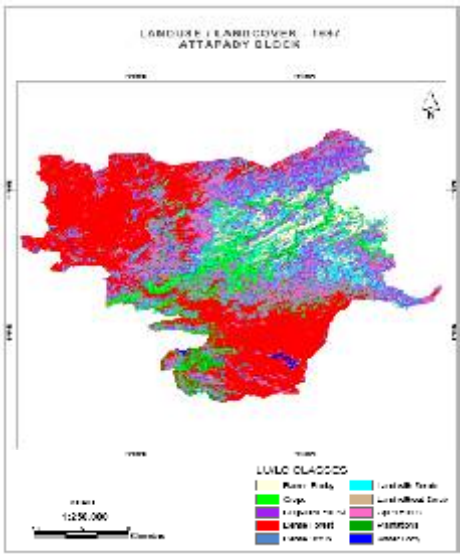


Figure 2



Open forests (10-40 % canopy cover) are seen in isolated patches along the moderately sloped areas of Attapady block near to human settlements. In the open forest area vegetation density is less compared to dense forest. Chart 5 graphically represent the trend of change of area of open forest from 1992-2005 and it was observed that the extent is decreasing.

Dense scrubs areas are characterized with scrub vegetation, which are seen in the certain area only and that is by the side notified area and in the eastern part of the Attapady block receiving lesser rainfall .The areal extents are graphically represented in Chart 6.

Chart 5: Dense Scrub (1992 -2005) Attapady Blcok

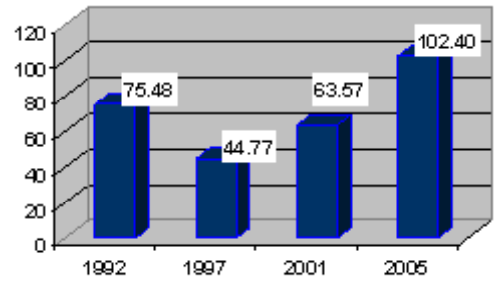
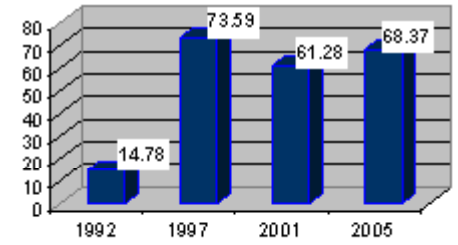


Chart 6: Degraded Forest (1992-2005) - Attapady Block



Degraded forests (< 10% canopy cover) are the land that comes under the forest area. Degraded forests are found near to private land holding and at proximity to open forest. These lands are formed due to intensive felling of trees because of human greed. There are tremendous efforts going on to regenerate degraded forest by planting trees with fencing, by Forest Department and AHADS a social organization. Chart 7 graphically represents the degraded forests which exhibits slight increase in 2005 as compared to 2001.

Scrub Land : Scrub land (10-40% canopy) are mostly seen in the private holding at the eastern

Attapady, this land may be formed due to harsh climate conditions, poor soil and water management practices; more over eastern Attapady is an extension of Deccan plateau. Land without scrub cane be brought under cultivation area if slope is moderate. But in most cases people left these lands as fallow. Chart 8 graphically represents the trend in the extent of land without scrub and land with scrub which are increasing. In the case of barren land there is a notable changes occurred, approximately 2.14 % barren land reduced in 2005 compared to 2001.

Chart 7: Land With Scrub (1992-2005) - Attapady Block

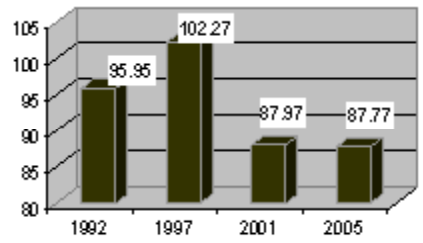


Chart 8: Barren Land (1992-2005) - Attapady Block

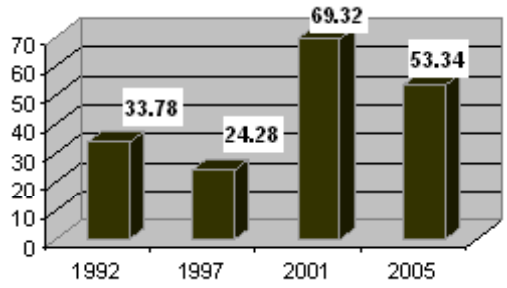


Chart 9 graphically represent the, in the case of barren land there is a notable changes occurred, approximately 2.14 % barren land reduced in 2005 compared to 2001.

A comparative analysis of land use/land cover from 2001-2005 is as follows: The extent of barren land is decreased from 9.3 % to 7.16 % in

Figure 3

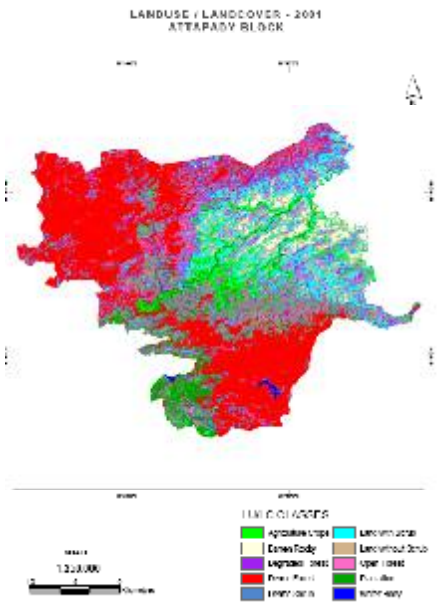
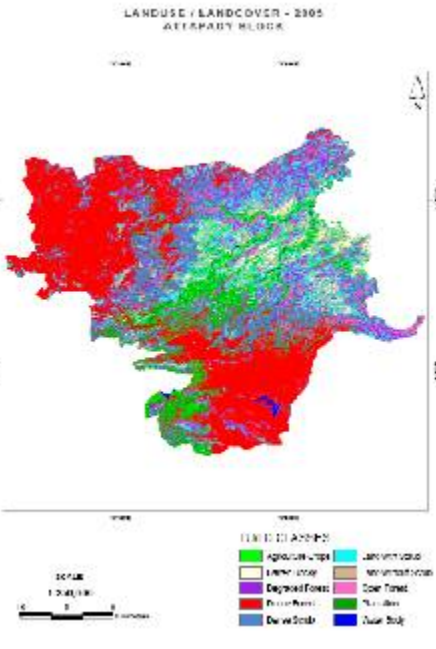


Figure 4



2005, and extent of the land without scrub is increased 6.88 % to 8.76 % in 2005 from 2001.There is slight decrease in the area of dense forest is seen. Crop is showing a negative growth where as plantation showing positive growth. A

Table 2: Land Use/Land Cover (1992 -2005) Attapady Block (% of Total Area)

S. No.	Class Name	Class Code	% of Area			
			1992	1997	2001	2005
1	Barren Land	BR	4.53	3.26	9.30	7.16
2	Crops	CR	3.25	9.21	3.14	2.75
3	Degraded Forest	DGF	1.98	9.88	8.22	9.18
4	Dense Forest	DF	37.22	33.41	33.03	31.47
5	Dense Scrub	DS	10.13	6.01	8.53	13.75
6	Land with Scrub	LWS	12.88	13.73	11.81	11.78
7	Land without Scrub	LWOS	6.21	4.99	6.88	8.76
8	Open Forest	OF	19.13	16.04	12.61	7.19
9	Plantations	PL	4.17	2.76	5.95	7.41
10	Water Body	WT	0.49	0.72	0.53	0.56
			100.00	100.00	100.00	100.00

marginal increase in the case of extent of dense scrub is noticed. Water body also witnessed slight increase.

Though the details of deforestation in the Attapady block is not worked out, statistics of forest and non forest land derived from SOI Toposheet surveyed during 1970s are given below (Table 3).

It is noticed that areas where no clear demarcation of forest boundary exists, there deforestation activities like encroachments are going on. So that establishment of surveyed and visible forest boundary signs is necessary for arresting deforestation. Methods of deforestation are varied from places to place, some of them encouraging forest fire annually and others removing bark of tree with sharp equipments, so that tree is unable to fulfill its water and other nutritional needs and ultimately die.

Table 3: Forest of Attapady Block in 1970s

S. No.	Land Use/ Land Cover	Area (SqKm)	Area (%)
1	Reserved Forest	533.56	63.90
2	Silent Valley National Park	89.50	10.78
3	Scrubs	12.00	1.44
4	Non Forest Land	199.44	23.89
	Total	834.50	100.00

Vegetation Density Mapping: Vegetation density mapping is carried by using the vegetation indices such as NDVI and RVI. Vegetation indices widely employed for determination of density of vegetation, water stress, and crop health monitoring. Vegetation density mapping was carried out for Attapady block. Common classification techniques employed for NDVI was derived from IRS images, and different Landsat TM images. The classification was carried out based on assigned land use classes. Results displayed in the form of maps.

Figure 5: Normalised Difference Vegetation Index Image of Attapady 2001

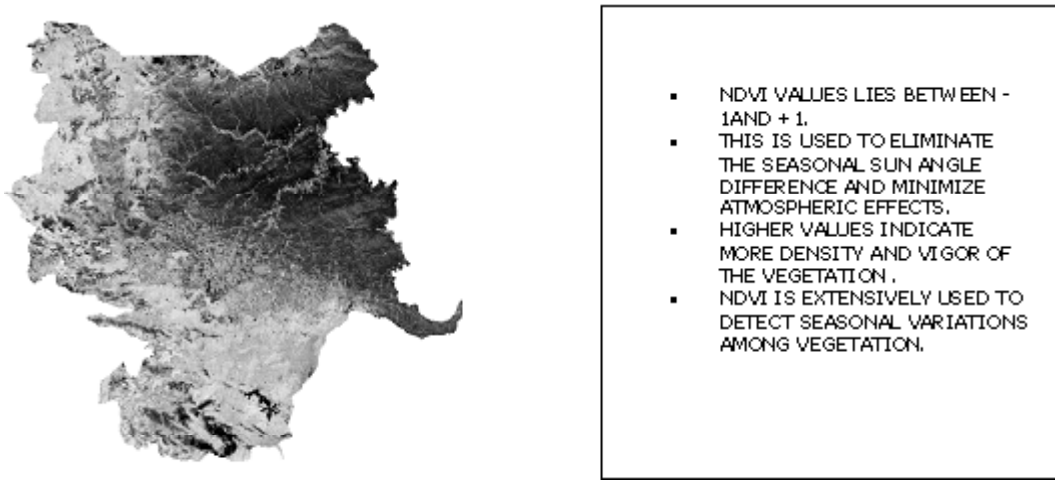
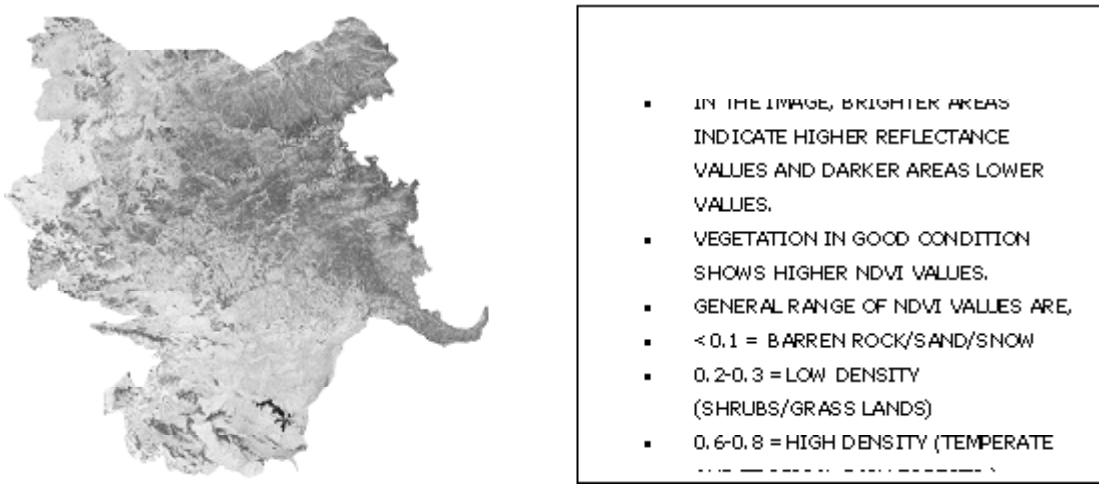


Figure 6: NDVI Image of Attapady 2005



Attapady Block is divided into three Biosphere zones according to the human interference and Degradation. Manipulation zone is for the utilization of resources in a sustainable manner. Restoration zone has the direct and indirect interferences by human. This is meant for restoration activities. Reserve zone is the least disturbed zone having diverse flora and fauna. The study was done specifically to study the impact in these three zones and the results were tabulated.

The entire Study was divided in to different river basins and development units to study at microlevel changes occurring in the environment

Figure 7: Normalised Differencial Vegetation Index (1992-2005) Attapady Block

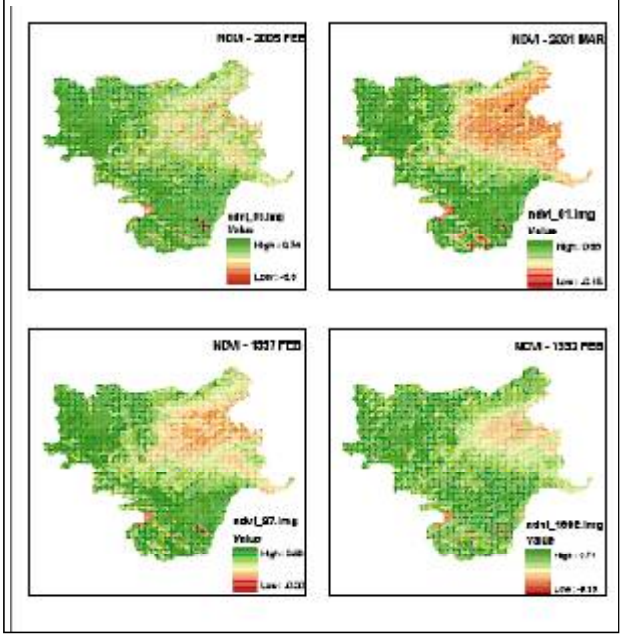


Figure 8: Ratio Vegetation Index (1992-2005) Attapady Block

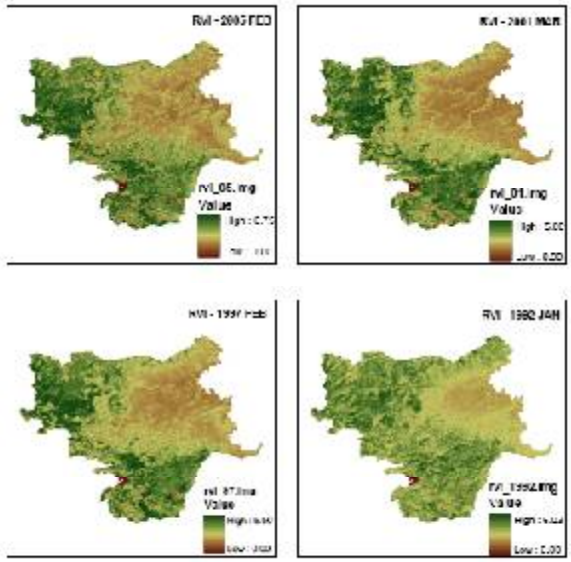


Figure 9: Matrix Layer

- the change layer or the matrix layer is shown here.
- the saffron color is the area that has showed the change temporally.
- the change can be in all classes of the classified image of 1992-2005

Figure 10: Matrix Layer Overlayed on 2001 FCC

- matrix is used to identify the change between two classified imagery.
- in the image,all the saffron color indicates the area which has chanched from 2001 to 2005.
- the remaining portion is the original 2001 image.

Figure 11: Attapady Biospere Zones

Figure 12: Restoration Zone of Attapady 2001

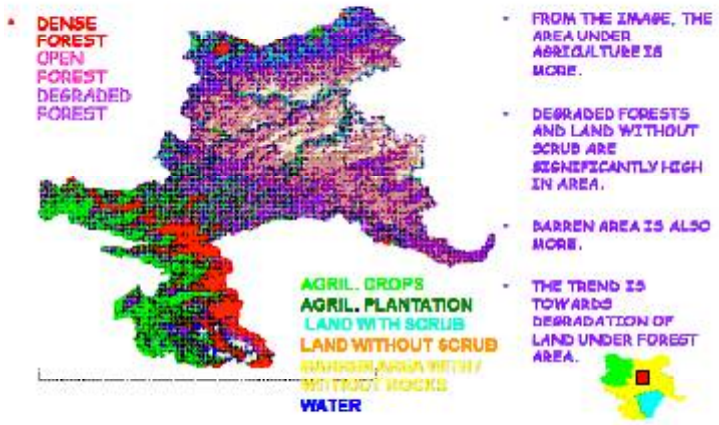


Figure 13: Restoration Zone of Attapady 2005

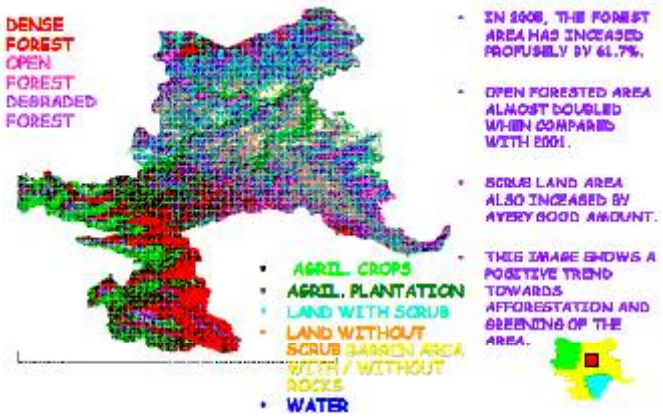


Table 4: Restoration Zone of Attapaddy			
Feature	**2001 Area in sq.km**	**2005 Area in sq.km**	**Change**
Dense Forest	44.27	71.59	–27.32
Open Forest	48.79	99.45	–50.66
Degraded Forest	102.93	31.58	–71.35
Agri.Crops	60.01	53.37	–6.64
Agri.Plantation	29.19	16.4	–12.79
Land with Scrub	41.18	118.04	–76.86
Land without Scrub	119.85	69.83	–50.02
Barren Lands	57.19	43.07	–14.12
Water	2.34	2.49	–0.15

Figure 14: Classified NDVI Image of Manipulation Zone

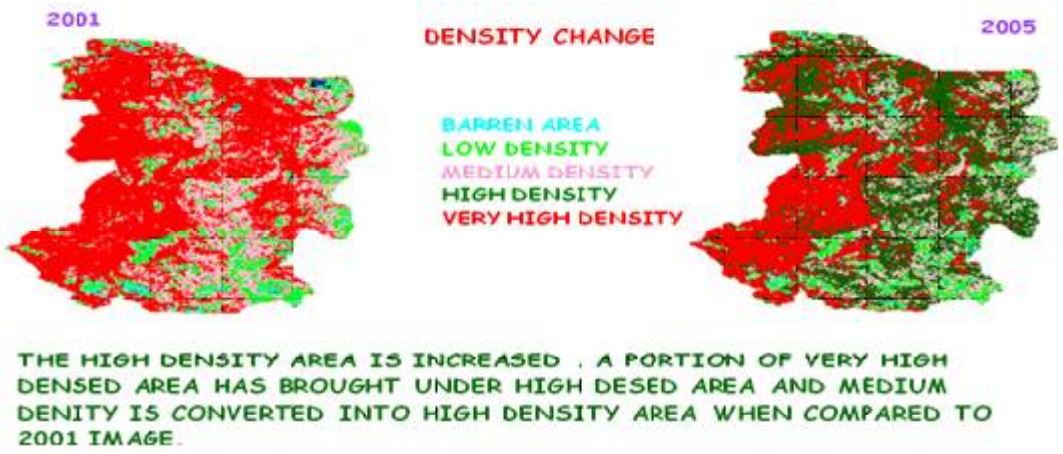


Table 5: Manipulation Zone of Attapaddy			
Feature	**2001 Area in sq.km**	**2005 Area in sq.km**	**Change**
Dense Forest	76.5	84.62	+8.12
Open Forest	36.85	39.8	+2.95
Degraded Forest	20.97	17.2	–3.77
Agri.Crops	18.58	10.96	–7.62
Agri.Plantation	6.8	1.61	–5.19
Land with Scrub	12.88	14.49	+1.61
Land without Scrub	4.14	3.14	–1
Barren Lands	0.7	5.37	+4.67
Water	0.14	0.37	+0.23

Figure 15: Classified NDVI Image of Reserve Bio Zone

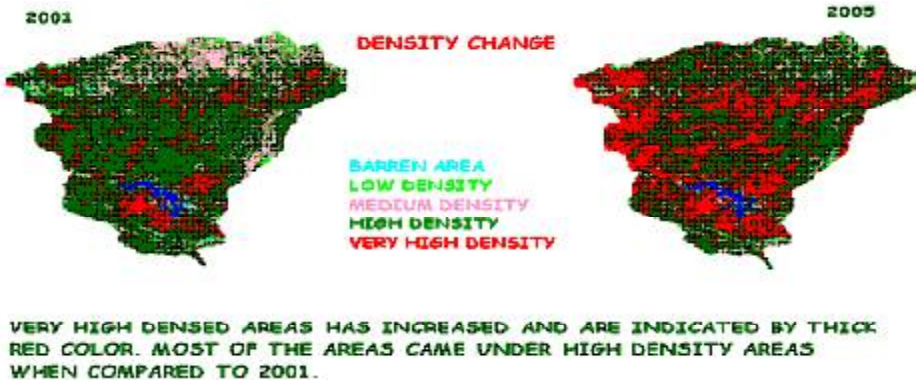


Table 6: Reserve Bio Zone of Attapaddy

Feature	2001 Area in sq.km	2005 Area in sq.km	Change
Dense Forest	69	74.73	+5.73
Open Forest	19.65	17.68	–1.97
Degraded Forest	4.18	2.29	–1.89
Agri.Crops	6.2	5.42	–0.78
Agri.Plantation	4.68	1.91	–2.77
Land with Scrub	1.62	2.73	+1.11
Land without Scrub	0.22	0.4	+0.18
Barren Lands	0.01	0.31	+0.3
Water	1.58	1.68	+0.1

and the factors responsible for the same. The entire study area is divided in five river basins namely Bhavani, Bharathapuza, suravani, kodangapallm and Lower bhavani. It was divided in to 15 developmental units to study the changes a micro level. The results of the analysis is placed in the annexure for reference.

Figure 16: Basins of Attapady Block

Figure 17: Developmental Units

OBSERVATIONS AND FINDINGS OF THE STUDY

From the study it was observed that the Vegetation cover has changed positively from 2001 to 2005. From the analysis it was observed that the dense, open and lands with scrub have increased considerably during 2001-2005. There was a considerable decrease in the degraded forest which is a positive sign. Similarly, area under agricultural crops and agricultural plantations have also decreased to a considerable extent which need ground truth for the reasons Due to the development of scrub type vegetation, barren area has decreased. It was observed from the analysis that major changes in vegetation occurred in the restoration zone. The restoration zone area was barren with less vegetation mostly with exposed rocks during the years 2000-2001. But in 2005 it was observed that more vegetation is seen in 2005 perhaps, due to afforestation programmes. It was observed that most of the vegetation is seen along the rivers- Bhavani and Kondanagappallem. The possible reason may be that sediment load along the river course from the upper slopes might have led to the rise of ground water levels. As a result most of the vegetation is seen along the river Bhavani.

The basin wise analysis clearly indicated that the Bhavani basin which covers a major part of the restoration zone showed more changes in vegetation. The major changes were observed in the development of dense, open forest and scrub type vegetation while the area under degraded forest has shown a declining trend. The micro level analyses of the different development unit wise results indicate that majority of the changes are seen in the development units which fall in restoration zone such as 2, 3,5,8,9 and 10. Among all, the development units, 5 and10 exhibit highest changes in the improvement of scrub and open forest type vegetation. There were no major changes in the dense forest area in these development units except in 5, 9 and 10 which showed minor increase in dense forest. Degraded forest in all these units showed decreasing trend while zones 5 and 10 showed highest decline. Due to the development of vegetation in this area barren area has decreased. The low density vegetated areas has become medium and high dense areas in the year 2005.

SUMMARY AND 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. Results of Land Use/Land Cover analysis of Attapady 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. The regeneration of wastelands of Attapady block need herculean efforts and the help of indigenous people. Still people of Attapady are farming with the help of oxen and plough and without having much land protection, so that losing of top soil a major seen in the farm land of Attapady. 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. 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, and hunting, incidence of forest fire and chopping of forest trees are reduced to a considerable level. Environment and resource management problems are both spatially distributed and determined by complex process and relationship involving numerous interacting elements with multiple attributes and a dynamic behavior that goes well beyond the analytical capabilities to met commercial GIS software (Fedra, 2006).

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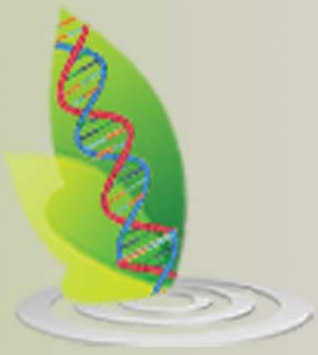

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