Volume 3, Issue 10, October 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Assessment of Deforestation, Land Use and Land Change Detection of Erode District for Two Decades (1990-2000) Using GIS Techniques and Image Processing

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Abstract: Deforestation is a contributor to global warming and is often cited as one of the major causes of the enhanced greenhouse effect. Tropical deforestation is responsible for approximately 20% of the world greenhouse gas emissions. Deforestation has been one of the first and main reasons for climatic change and global warming. The accuracy of change detection on the earth's surface is important for understanding the relationships and interactions between human and natural phenomena. Remote Sensing and Geographic Information Systems (GIS) have the potential to provide accurate information regarding land use and land cover changes. In this paper, we examine the major techniques that are utilized to detect land use and land cover changes and deforestation. Image differencing and image rationing are easy to implement, but at times they do not provide accurate results. Hybrid change detection is a useful technique that makes full use of the benefits of many techniques, but it is complex and depends on the characteristics of the other techniques such as supervised and unsupervised classifications. Change vector analysis is complicated to implement, but it is useful for providing the direction and magnitude of change. Recently, artificial neural networks, chi-square, decision tree and image fusion have been frequently used in change detection. Research on integrating remote sensing data and GIS into change detection has also increased. Here we have analyzed one decade land use and land cover status of Erode District is analyzed. For analysis, high resolution satellite imagery is used. The land use change detections for the period from 1990 to 2000 are analyzed under GIS environment and images are processed using ERDAS software.

Keywords: Change Detection Techniques, Remote Sensing, GIS, Land Use and Land Cover Change.

I. INTRODUCTION

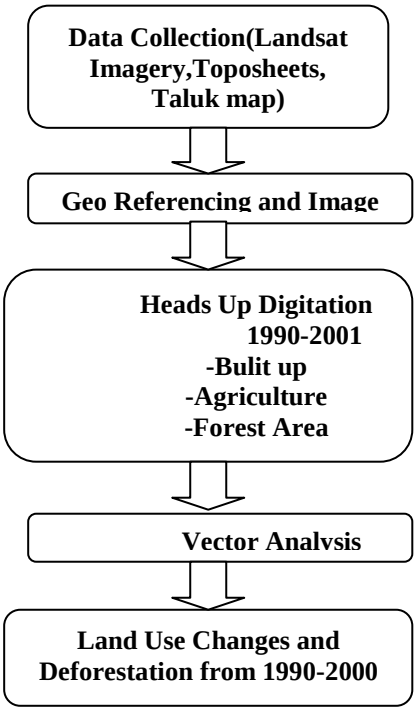
Land use and land cover is dynamic in nature and require regular monitoring to understand areas of rapid change. Land use/ Land cover change encompass some of the most important human alteration affecting the surface of the earth. Changes in land cover through cropping, forestry and urbanization represent the most substantial alternative through their interaction with most components of global environmental changes. Land use and land cover information are important for several planning and management activities concerned with the surface of the earth because it constitutes key environmental information for many scientific, resource management and policy purposes and a range of human activities. An accurate knowledge of land use and land cover features represents the foundation for land classification and management. Therefore a wide range of scientists and practitioners, land and water managers as well as urban planners seek information on the location, distribution, type and magnitude of land use and land cover change.

Erode District is one of the industrialized districts located in the western part (Kongu Nadu) of the state of TamilNadu, India. The district comprises a long undulating plain, sloping gently towards the Kaveri River in the south-east. Erode District is landlocked and is situated at between 10 36" and 11 58" North latitude and between 76 49" and 77 58" East longitude. Western Ghats traverses across the district giving rise to small hill locks. Erode district had a population of 22,59,608 as of 2011. It is 46.25% urbanized as per Census 2000.

S.No	Type of Map	Resolution/ Scale	Date/Year of Acquisition	Source
1	Toposheet	1:50,000	58E/09,58A/14, 58E/03,58E/02, 58E/06,58E/07, 58E/08,58E/10,58E/11, 58E/12 & 58E/16	SOI
2	Landsat TM	1:50,000	21-11-1990 17-4-2000 9-10 2010	GLCF
3	NR census Atlas	1:50,000	2008	NRSC

4	**District and village maps**	**1:75,000**	**-**	**TN maps .gov.in**

II. METHODOLOGY



III. SOFTWARE USED

In this study, satellite images are converted into vector analysis using GIS Arc. In ERDAS 9.1, images are classified on the basis of visual interpretation and the statistical attributes are analyzed using supervised Algorithm.

IV. DATA AND IMAGERY USED

Landsat TM 11-4-1990 and Landsat TM 21-4-2000 satellite images have been downloaded from USGS website .Study areas are covered by 11 Toposheets (58E/09,58A/14, 58E/03,58E/02, 58E/06, 58E/07, 58E/08,58E/10, 58E/11, 58E/12 and 58E/16) have been bought from Survey of India ,Chennai.

V. LAND USE AND LAND COVER CLASSIFICATION

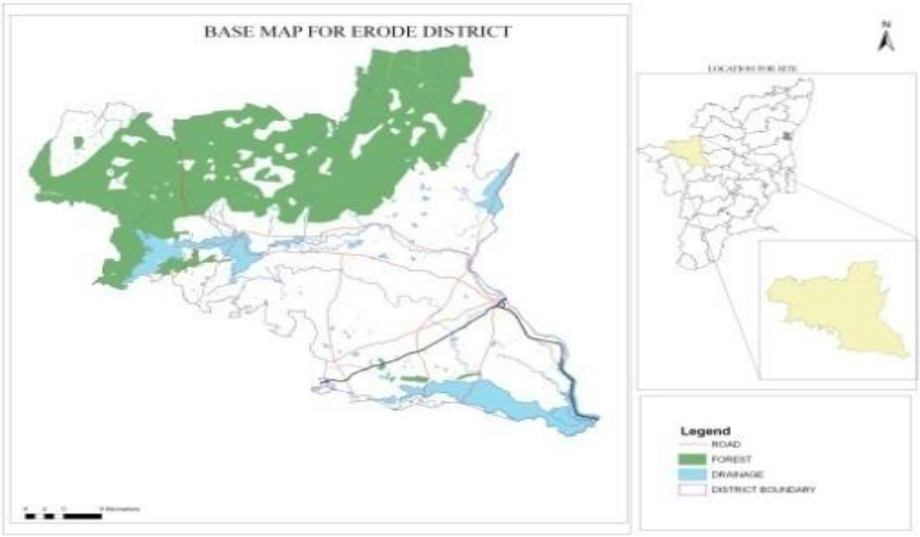


Figure 1 Base Map

Land use and Land cover map of study area was generated from Landsat Multi thematic Mapper data for the years 1990 and 2000 respectively are shown in figures 2 and 3. Therefore, one decade datasets with different time series information covering a 10 year periods have been used. Land use and land cover map was classified based on NR

CENSUS classification scheme given in Table 1. LULC is classified using visual image interpretation and these classes are built up, Agricultural, wasteland, forest grazing land and water body . Figures-4 and 5 show the land use and land cover map pertaining to years 1990 and 2000. Forest layer has been extracted from 1990 and 2000 shown in figures 6 and 7. Land use and land cover change map statistics are shown in table 2

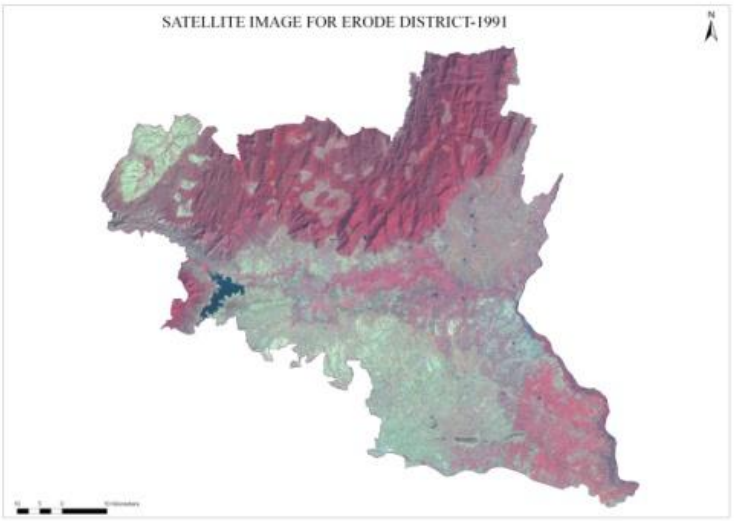


FIGURE 2 LANDSAT TM SATELLITE IMAGE -1990

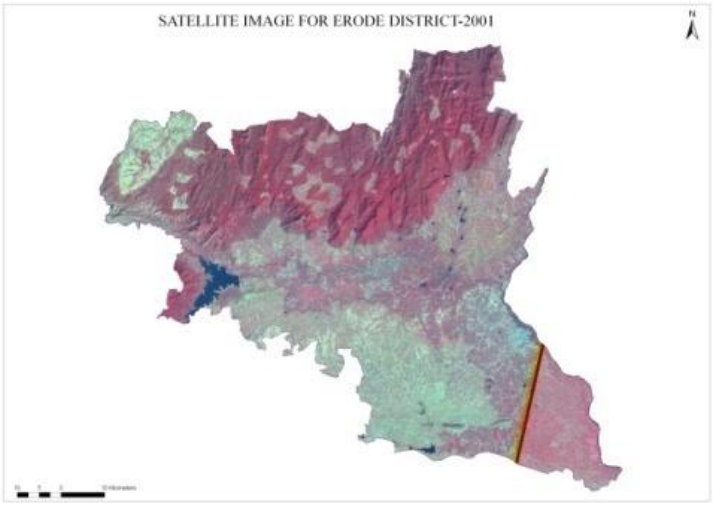
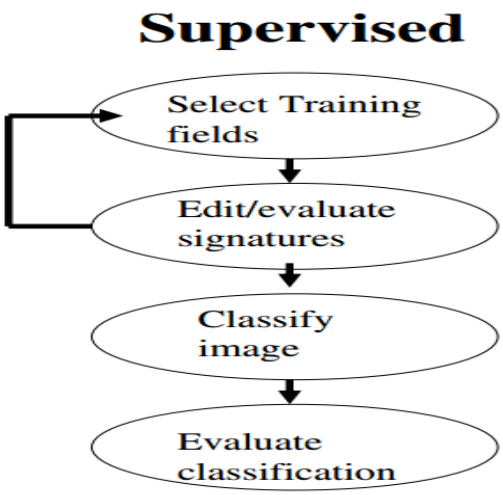


FIGURE 3 LANDSAT TM SATELLITE IMAGE -2000

VI. METHODS



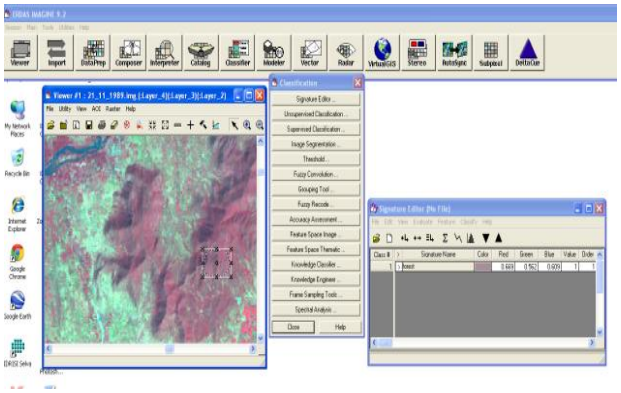
- **TRAINING SET**

Training set=>training vector

Training: The process of defining criteria by which patterns or features are recognized.
Signature: Result of training that defines a training sample or cluster parametric based on statistical parameters that assume a normal distribution (e.g., mean, covariance matrix) and non parametric are not based on statistics but on discrete objects (polygons) in feature space.

- **SUPERVISED TRAINING SET SELECTION**

- Objective: Selecting a homogenous (unimodal) area for each apparent cluster.
- Digitized polygons: High degree of user control often results in overestimate of cluster variability.
- Seed pixel: Region growing technique are used to reduce within class variability; works by analyst setting threshold of acceptable variance, total #pixels, adjacency criteria (horizontal or vertical diagonal).



SUPERVISED TRAINING SET SELECTION FIGURE SHOWS HOW TO EDIT SIGNATURE FROM SATELLITE IMAGE IN ERDAS

The analyst should select multiple training sites to identify the digitized polygon or seed pixel technique, the many possible clusters in each class of interest.

TRAINING STAGE

• Training/Test Area classification: look for misclassification between classes; training areas can be biased; better to use independent test areas
• Quick alarm classification: on-screen evaluation of all pixels that fall within the training decision region (e.g. parallelepiped)

VII. SPATIAL DISTRIBUTION OF LAND USE CATEGORIES-1990

Landsat TM imagery of 11 April 1990 was visually analyzed and classified different kinds of land use in Erode District. The spatial distribution of land use was assessed geographically and their aerial extent quantified and shown in the Table 1. The histogram of land use spatial distribution are shown in Figure 4 and the different categories of land use and land cover features are classified under level I and II .

TABLE 1: LAND USE/ LAND COVER STATISTICS OF 1990

S.No	Level I	Level II	Area in HA	Area in %
1	Built up	Urban Built Up	4438.83	0.74
		Rural Built Up	15966.70	2.65
		Industry	404.89	0.07
2	Agriculture	Crop Land	169801.00	28.20
		Fallow Land	24734.00	4.11
		Plantation	111119.00	18.46
3	Forest	Evergreen forest	116506.79	19.35
		Deciduous forest	71896.99	11.94
		Forest Plantation	116.45	0.02

		Degraded Forest	38245.46	6.35
4	Grazing land	Grazing land	5849.36	0.97
5	Waste land	Dense scrub	12561.80	2.09
		Open scrub	15589.50	2.59
		Salinity	199.11	0.03
6	water body	Tank/Reservoir	8708.61	1.45
		River/ Stream	5909.67	0.98
			602048.2	**100.00**

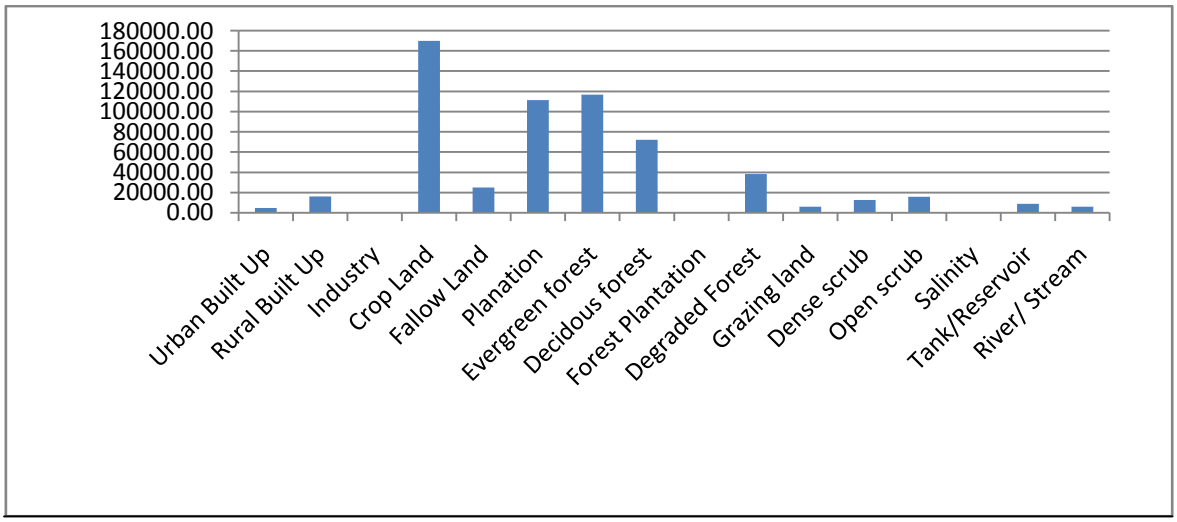


FIGURE 4 HISTOGRAM OF LAND/LAND COVER CLASSIFICATION OF 1990

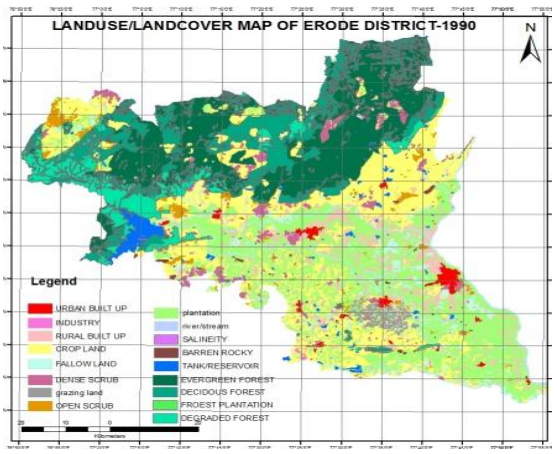


FIGURE 5: LAND USE AND LAND COVER MAP

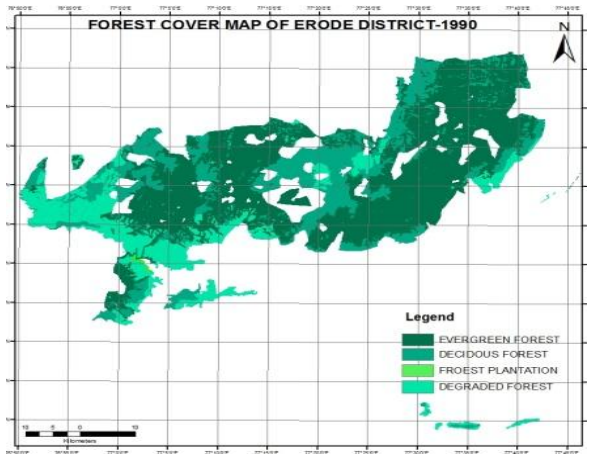


FIGURE 6 FOREST COVER MAP OF ERODE -1990

VIII. SPATIAL DISTRIBUTION OF LAND USE CATEGORIES-2000

Landsat TM 17 April 2000 satellite image downloaded from USGS website was visually analyzed and classified different kinds of land use in Erode District. The spatial distribution of land use was assessed geographically and their aerial extent quantified and shown in the Table 2. The histogram of land use spatial distribution are shown in figure 7 .The different categories of land use and land cover features are classified under level I and II .

TABLE 2 LAND USE/ LAND COVER STATISTICS OF 2000

S.No	Level I	Level II	Area in Hectare	Area in %
1	Built up	UrbanBuilt Up	6362.13	1.11
		Rural Built Up	15966.70	2.77
		Industry	1205.66	0.21

2	Agriculture	Crop Land	203036.00	35.27
		Fallow Land	24734.00	4.30
		Plantation	53542.20	9.30
3	Forest	Evergreen forest	73113.66	12.70
		Deciduous forest	108972.97	18.93
		Forest Plantation	116.45	0.02
		Degraded Forest	44562.60	7.74
4	Grazing land	Grazing land	6803.43	1.18
5	Waste land	Dense scrub	12561.80	2.18
		Open scrub	10659.90	1.85
		Salinity	260.08	0.05
6	water body	Tank/Reservoir	8708.61	1.51
		River/ Stream	5109.67	0.89
			575715.9	**100**

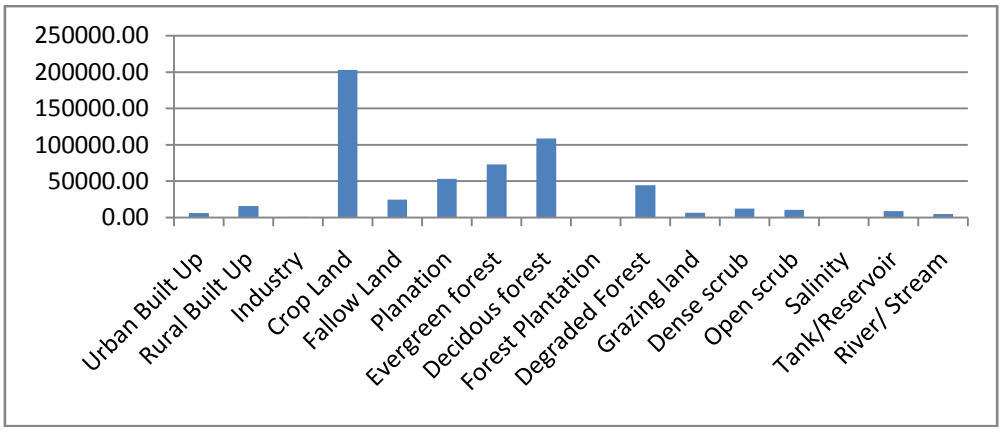


FIGURE 7 HISTOGRAM OF LAND USE/ LAND COVER CLASSIFICATION 1990

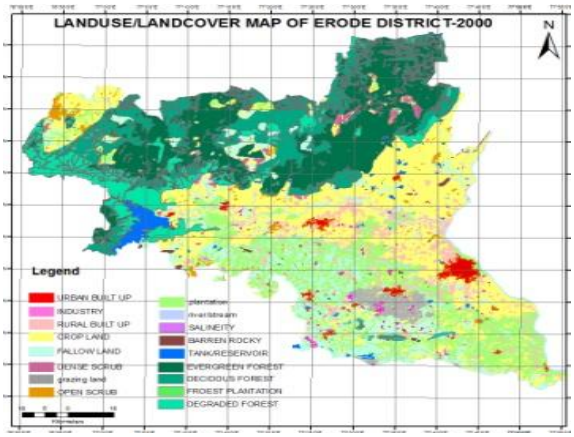


FIGURE 8 LAND USE/ LAND COVER -2000

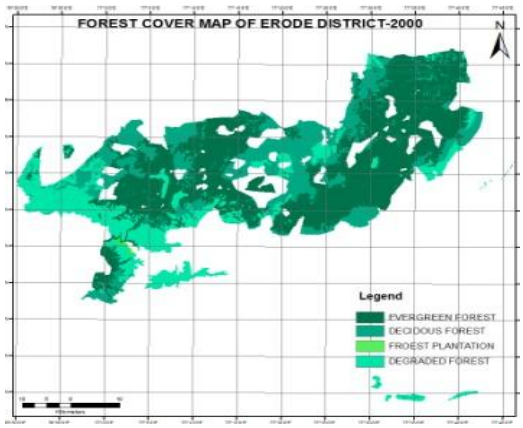
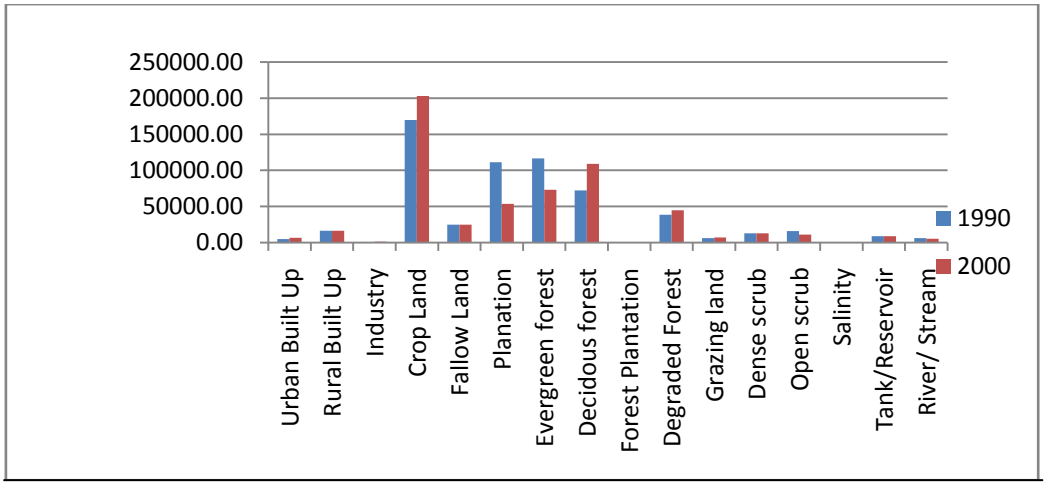


FIGURE 9 FOREST COVER MAP – 2000

IX. LAND USE CHANGE DETECTION (1990-2000)

The land use change detections from 1990 to 2000 reflect that changes especially in the crops has increased 19.57% and plantation crops has decreased -51.81%. Cultivation practices has increased mainly due to human population growth who exerted in agriculture actives for their survival, increasing number of irrigation wells and free electricity for agriculturalist announced by the Government of TamilNadu , in July 1989. Built-up land has increased 43.32% due to high growth rate of human population. Decreasing trend of land use is also due to industry increased

197.77% It was observed that the -37.24% of Evergreen forest and Deciduous forest to 51.56% has increased in the reserved forest and open scrub has decreased to -31.62. Salinity land is found to occur in and around land. It was observed that the 97.40% affected the useful land. Spatial distribution of land use and land use change detection between 1990 and 2000 was furnished in Table 3.



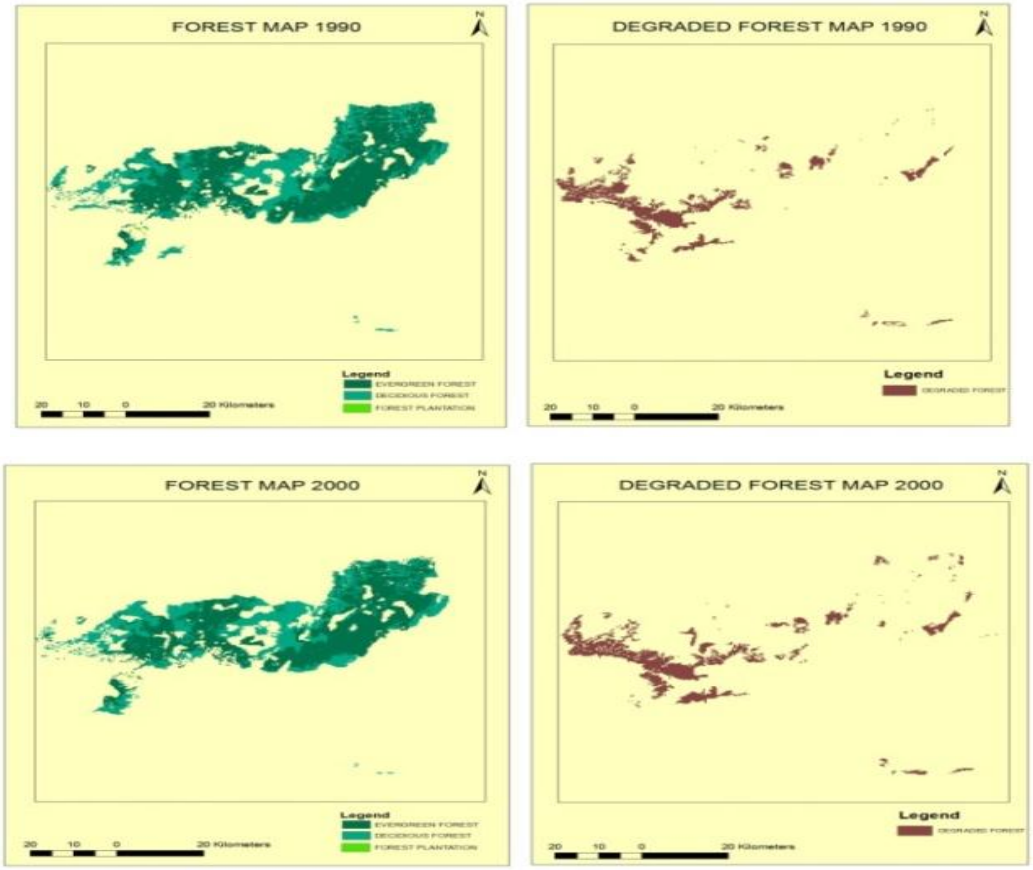
HISTOGRAM OF LAND USE CHANGE FOR 1990 AND 2000

TABLE 3 CHANGE IN LAND USE BETWEEN 1990-2000

Sno	Level I	Level II	LULC 1990(ha)	LULC 2000(ha)	Gain in Sq.Km	Loss in Sq.Km
1	Built up	UrbanBuilt Up	4438.83	6362.13	1923.30	-
		Rural Built Up	15966.70	15966.70	0.00	-
		Industry	404.89	1205.66	800.78	-
2	Agriculture	Crop Land	169801.00	203036.00	33235.00	-
		Fallow Land	24734.00	24734.00	0.00	-
		Plantation	111119.00	53542.20	–	-57576.80
3	Forest	Evergreen forest	116506.79	73113.66	–	-43393.13
		Deciduous forest	71896.99	108972.97	37075.98	-
		Forest Plantation	116.45	116.45	0.00	-
		Degraded Forest	38245.46	44562.60	6317.14	-
4	Grazing land	Grazing land	5849.36	6803.43	954.07	-
5	Waste land	Dense scrub	12561.80	12561.80	0.00	-
		Open scrub	15589.50	10659.90	–	-4929.60
		Salinity	199.11	260.08	60.97	-
6	water body	Tank/Reservoir	8708.61	8708.61	0.00	-

X. DEFORESTATION MAP OF 1990-2000

From the analysation , we found that the variations of deforestation for 1990-2000 is deforested into 37%.The Figures below show the degradation of forest.



XI. CONCLUSION

Overall changes in the landscape has shown an increased trend for urban development (43.32%) and growth of industry to 198% and forest to 52% . Such development is guided or often times constricted by various environmentally sensitive or protected areas (e.g. Reserve Forests.) and existing high-density development. The study has revealed that satellite data has the unique capability to detect the changes in land use quickly. From the analysis it is found that the satellite data is very useful and effective for getting the results of temporal changes. With this effective data it is found that the agriculture land is decreasing at the rate of increasing the settlements.

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