Use of Cartosat Stereo Data for Effective Study of Land Use Change Detection in Radhanagari Wild Life Sanctuary Region in Maharashtra

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Abstract

To carry out study of Land Use change detection for a period of more than 15 years period is very difficult due to variations in spectral, radiometric and spatial characteristics of satellite image data available. In spite of common vegetation AOIs for Land Use, vegetation classes do not match as desired due to spatial variations especially for smaller land use patches / areas. Thus where it is essential to study Land Use changes for micro areas such as for Grassland patches or Karvi patches in other mixed vegetation, locational accuracies play crucial role in estimationof Grassland patches or specific shrub patchesof interest. Cartosat Stereo images with capability of creation of DEM and as well as fusion capability with other images for creation of uniform spatial data helps in having better accurate estimation of Grassland patches or Karvi patches along with other Land Use Class area estimation.

1.0 INTRODUCTION

The forestry or vegetation science is one of the established and well developed branches of science. We have tradition of more than 100 years of forestry management records. In the last few decades there are many studies in various facets of ecology using conventional methods except few in the recent years. However these conventional methods stand alone had several limitations. They were not spatially explicit and also there was lot of difficulty in revising those observations as well as there was no surrogate available to model them for different scenarios or for different specific conditions. Here came the advantages of remote sensing technology. With the mapping and stratification through remote sensing, the area coverage could be very large with even low intensity sampling by taking the advantage of stratification.

Also the temporal revisit of the satellites has made it possible to assess and analyse changed scenario with better accuracy and precision. Land use change detection for comparatively large Land use change detection often involves comparing aerial photographs or satellite imagery of the area taken at different times (Petit, 2001). The process is most frequently associated with environmental monitoring, natural resource management, or measuring urban development.

Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement (Prakasam*et al.*, 2010).

Land use/cover Change detection is very essential for better understanding of landscape dynamics during a known period of time having sustainable management. Land use and land cover change has been recognized as an important driver of environmental change on all spatial and temporal scales (Tansey *et al.*, 2006), as well as emerging as a key environmental issue & on a regional scale is one of the major research endeavours in global change studies.

The study of vegetation is necessary in present situation, because the increasing population is changing the vegetation lands into the barren and built-up lands. there are

several methods have been used by the researchers to find out the vegetation cover on the earth surface, among the various method NDVI is popular method, since it gives the higher accuracy of result, which also reduce the cost, time and human power. After the invention of remote sensing and GIS technology the spatial analysis have been improved rapidly.

2.0 STUDY AREA

2.1 Study Area

Radhanagari Wild Life Sanctuary is in Kolhapur District, Maharashtra, India.

Location:

73.83° E to 74.05° E
16.20° N to 16.49° N

Area:351.45 Sq. km.

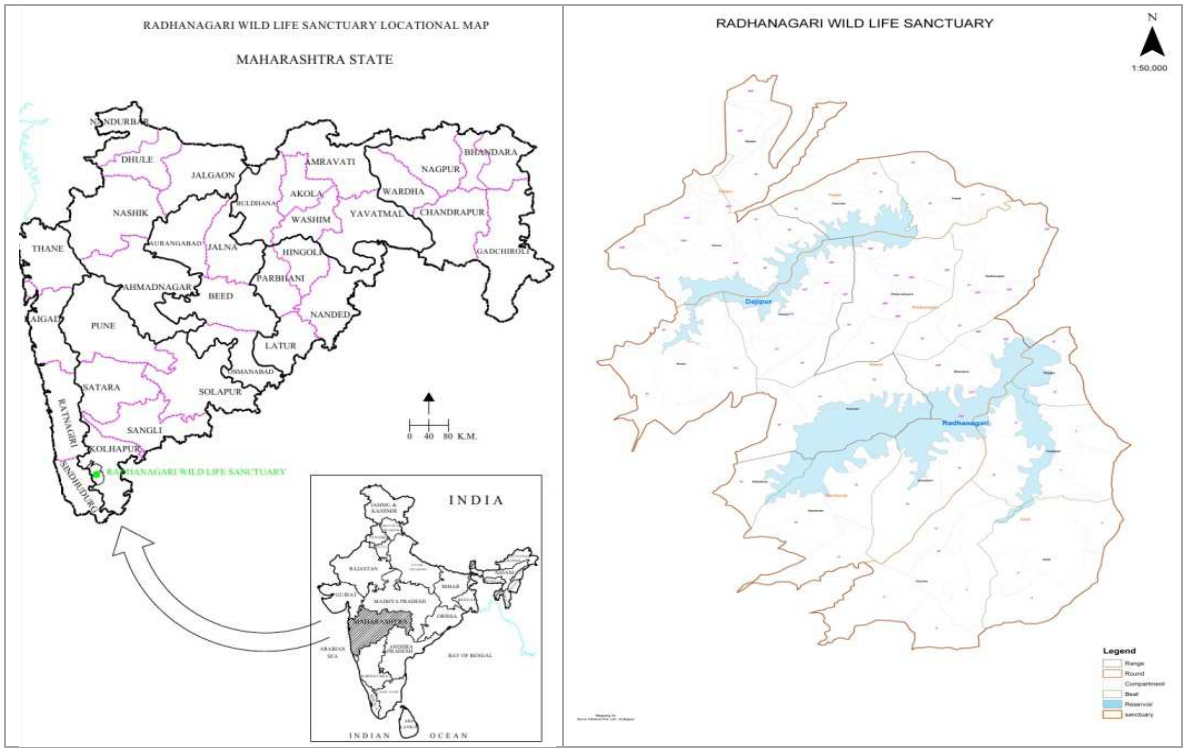


Figure 2.1 Study Area

The Radhanagari Wild Life Sanctuary stretched along the crest of the North Sahyadri range of Western Ghats, lies within 16 12 00 N to 16 29 24 and 73 49 48 E to 74 03 00 E and spread over area of 351.45 sq. km.

The Bhogavati and Dudhgagnga rivers pass through the protected area and reservoirs viz Laxmi Talao and Shahu Sagar is created after construction of a dam on it. The reservoir restricted the free movement of wild animals; however, it plays an important role in providing effective natural protection to the remaining area of forests by isolating them from human interference. Besides Bhogavati and Dudhgagnga rivers, there are many other perennial and seasonal natural water sources inside the protected area.

The topography of Radhanagari Wild Life Sanctuary is undulating, with exposed rocks. A distinct feature of the area is the presence of numerous barren rocky lateritic

plateaus, locally called the sada. There is a rugged terrain along the main ridge of the Western Ghat which is also western part of the sanctuary and it gets gradually flattened towards east. Geological foundation is Deccan trap. Soil in the west is predominantly is Lateritic while red and yellowish soil occurs in the east. Greyish green loam and murrum soil are found on gentler slopes. The elevation ranges from 559 msl to 1033 msl (SOI). The Radhanagari Wild Life Sanctuary experiences moderate climate with maximum temperature of 41 C in summer and a minimum of 4 C in winter. Mean annual rainfall ranges from 6000 mm in the western ridge and 4000 mm on the gentler slopes of the east. According to Champion and Seth (1968) the forest types 270 include, western tropical hill forests, semi evergreen forests, and southern moist mixed deciduous forests.

3.0 DATA USED

The following IRS data and Survey of Indian topo sheets are used in this analysis.

1. Cloud free digital data of IRS – 1C, LISS-III of path 93 and Row 48 acquired on 11th February 1998.
2. Cloud free digital data of IRS – 1D, LISS-III of path 93 and Row 48 acquired on 6th January 2003.
3. Cloud free digital data of IRS – RESOURCESAT 2, LISS-IV of path 93 and Row 48 acquired on 26th January 2013.
4. Cloud free digital data of IRS – 1C, LISS-III of path 93 and Row 48 acquired on 11th February 1998.
5. Cloud free digital data of CARTOSAT 1 P5 &P6 – Stereo pair data of path 93 and Row 48 acquired on 20th and 31st January 2013.
6. Survey of India Topo sheet No. 47H15NE, 47H15NW, 47H15SE, 47H15SW, 47H16NE, 47L3NW, 47L3SW, 47L4NW on 1:25000 scale (Surveyed during 1987-88).

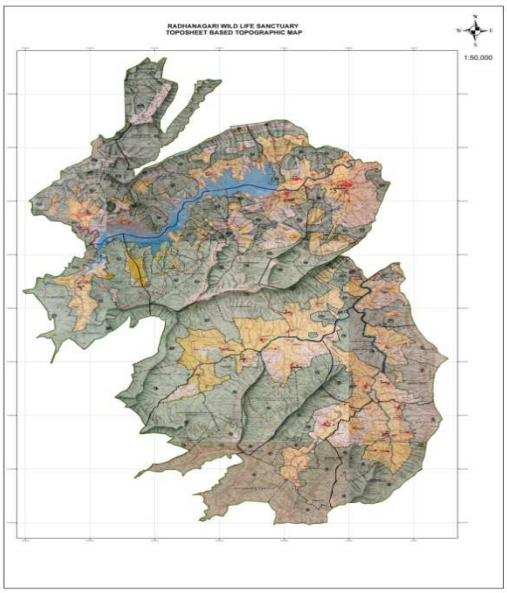


Figure 3.1 Map showing Topographic details of Study Area

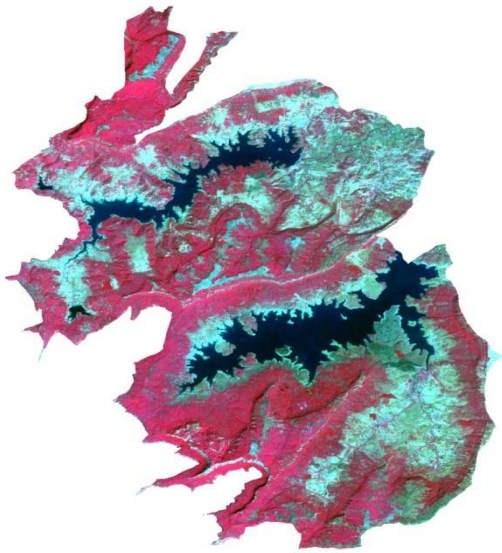


Figure 3.2 Radhanagari Wild Life Sanctuary LISS III FCC Satellite Image

Source : Survey of India Topo sheets (1987-88)

4.0 METHODOLOGY

In the present study OrthorectifiedCartosat-1 data is used to rectify LISS-III and LISS-IV data to overcome difficulties in estimation of areas due to variations in spectral, radiometric and spatial characteristics of temporal satellite data spanning over 15 years from 1998 to 2013.

I. DEM Generation and Ortho rectification of Cartosat-1 data

Cartosat-1 stereo pair data of IRS P5 / P6 was acquired and image processing is carried out using ERDAS LPS software. Block files were generated using Rational Polynomial Coefficients as geometric model with Cartosat RPC. Projections to UTM with Zone 43 North and WGS84 as Datum were carried out. All band A & F image were integrated using respective RPC data. Block triangulation is first done by using auto tie point generation tool and then refining the same with 16 points till error reduction of less than 0.5 pixels is achieved. DEM is then generated using DTM option of ERDAS LPS Project Manager. Ortho rectification of the above is carried out for output pixel size of 2.5 m.

CARTOSAT DEM

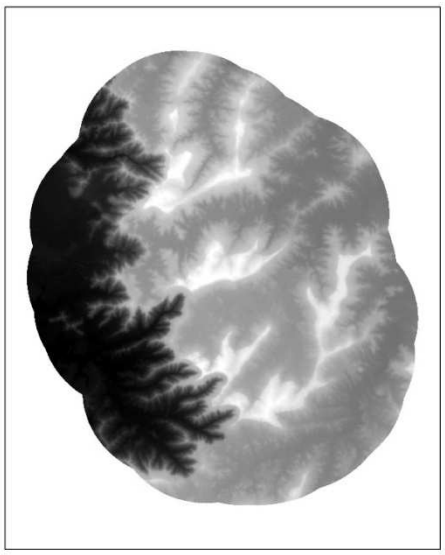


Figure 4.1.

CARTOSAT ORTHORECTIFIED IMAGE

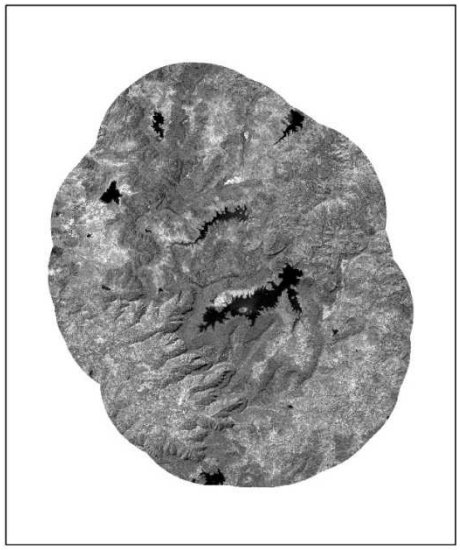


Figure 4.2

II. Geo-referencing and Resampling of LISS-III, LISS-IV data

Geo-referencing of LISS-III and LISS-IV image is carried out using SOI Topo sheets of 1:25000 scale in ArcGIS 9.2. Resampling of LISS-III, LISS-IV data was done for respective pixel sizes of 24 m and 5 m.

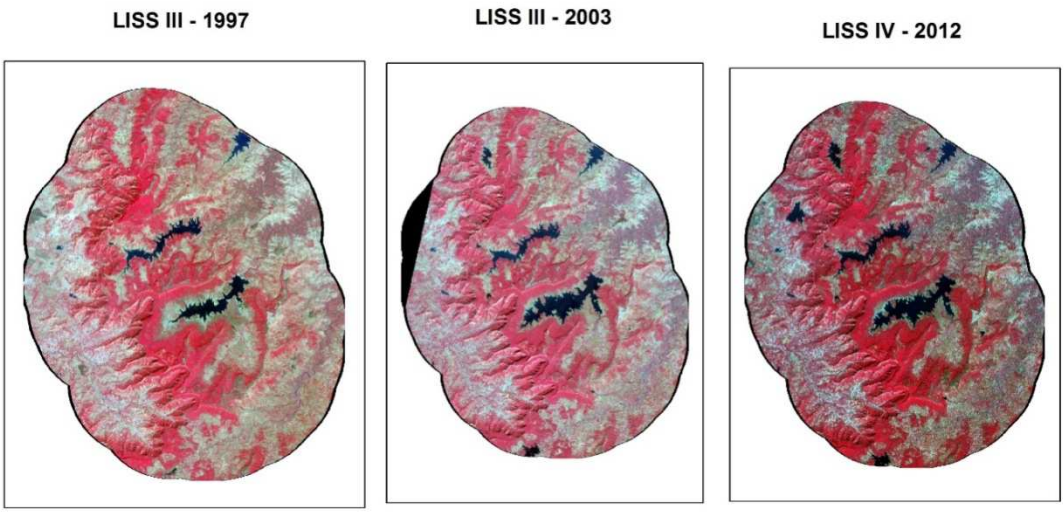


Figure 4.5

III. Ortho rectification of LISS-III, LISS-IV data using ortho rectified Cartosat-1 data

Ortho rectification of LISS-III, LISS-IV data is carried out using DEM generated from the Cartosat-1 stereo pairs and ortho rectified output of banda.tif using projective transformation. This process is carried out using ERDAS Software.

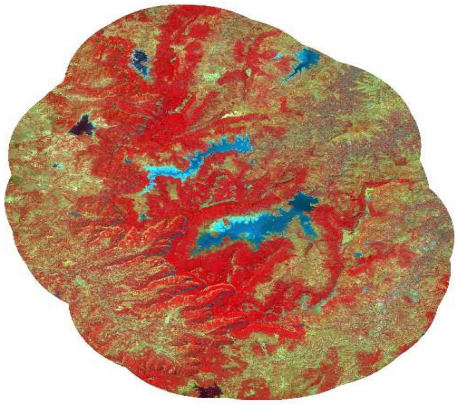


Figure 4.6

IV. Vegetation Classification of LISS-III, LISS-IV data

For supervised classification ground AOIs were collected for the required LULC of first level classification. In ERDAS Imagine software signature polygons were generated using signature editor tool. Supervised classification is then carried using Maximum Likelihood as parametric rule. Recoding is the done for combining same type of land use in to single one. Appropriate colours are then assigned to each land use type as required.

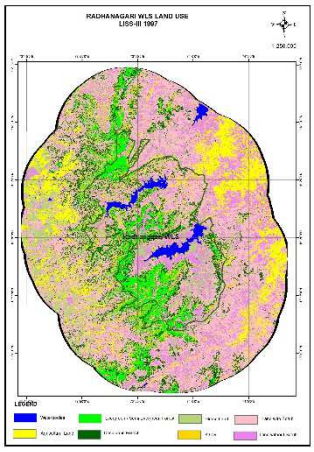


Figure 4.6.

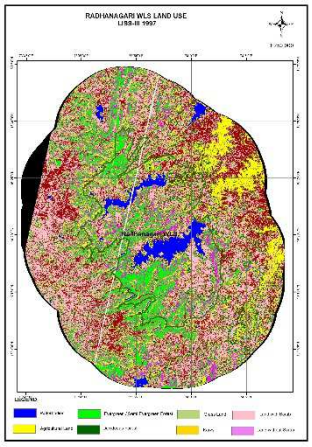


Figure 4.7

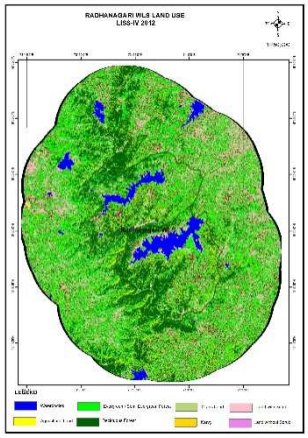


Figure 4.8

V. Estimation of Grassland areas and Karvy cover areas in 1997, 2003 and 2013

From the data above area for each land use is available. This information is then taken in to MS EXCEL for further area estimation / analysis as desired.

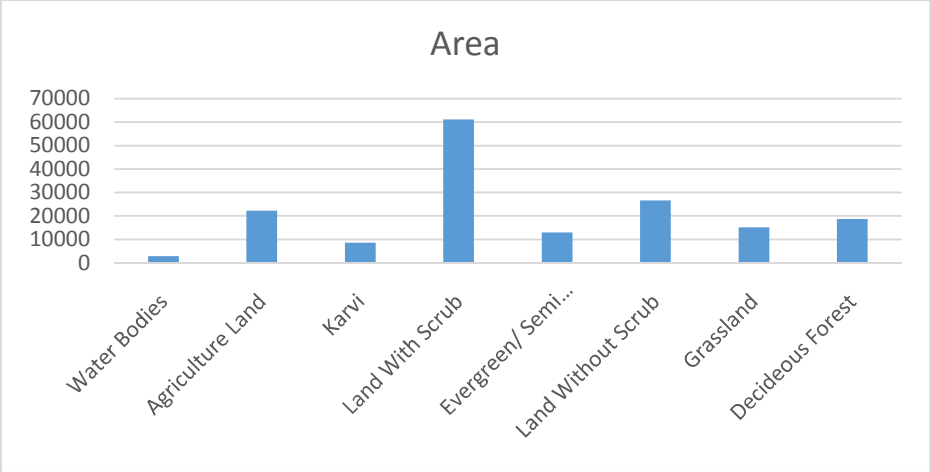
Table 4.1 VEGETATION AOI DETAILS

SR. NO	FOREST TYPE	LONGITUDE	LATTITUDE	ALTITUDE	AREA	REMARK
1	GRASSLAND	73.98242	16.40682	1970	10X10	
2	GRASSLAND	73.98175	16.40328	2054	25X25	
3	DECIDUOUS	73.98231	16.40778	2011	5X5	Sevri Tree Canopy
4	EVERGREEN	73.98933	16.39991	2127	5X5	Cashew Nut Plantation 10 Acres
5	GRASSLAND	73.98903	16.40032	2090	10X10	
6	EVERGREEN	73.98998	16.39949	2147	10X10	Mango Tree Canopy
7	GRASSLAND	73.98967	16.39614	2250	30X30	
8	EVERGREEN	73.98989	16.3964	2256	5X5	Arjun Tree Canopy
9	SHRUB(KARVI)	73.97285	16.37567	2765	5X5	
10	KARVI CONTOUR			2742		Karvi vegetation above 2742 m
11	GRASSLAND	73.97286	16.38625	2549	8X8	
12	DECIDUOUS	73.97286	16.38625	2549		Acasia Tree plantation
13	GRASSLAND	73.9721	16.38995	2444	5X5	
14	GRASSLAND	73.97065	16.39128	2380	20X20	
15	GRASSLAND	73.94968	16.39463	2258		
16	GRASSLAND	73.94025	16.3931	2500		
17	KARVI CONTOUR			2700		Karvi vegetation above 2700 m
18	GRASSLAND	73.93513	16.38437	2694	10X10	
19	SHRUB(KARVI)	73.93563	16.38423	2704	10X10	
20	EVERGREEN	73.93515	16.38396	2722	10X10	Ain Tree Canopy
21	EVERGREEN	73.8624	16.35454	1979	10X10	Mango Tree Canopy
22	KARVI CONTOUR			2220		Karvi vegetation above 2220 m
23	SHRUB(KARVI)	73.883	16.33278	2600	3X3	
24	GRASSLAND	73.88287	16.332	2574	5X5	
25	SHRUB(KARVI)	73.89945	16.34517	2536	3X3	
26	SHRUB(KARVI)	73.90484	16.34966	2566	3X3	
27	SHRUB(KARVI)	73.90488	16.34933	2574	3X2	
28	SHRUB(KARVI)	73.90496	16.3492	2572	3X3	
29	GRASSLAND	73.90484	16.349	2567	5X5	
30	SHRUB(KARVI)	73.92123	16.36526	2637	4X4	
31	SHRUB(KARVI)	73.92116	16.36556	2632	4X4	
32	SHRUB(OTHER)	73.92105	16.36532	2633	5X5	Ranmodi Shrub
33	DECIDUOUS	74.0107	16.41497	2048	10X10	Teak Tree Plantation

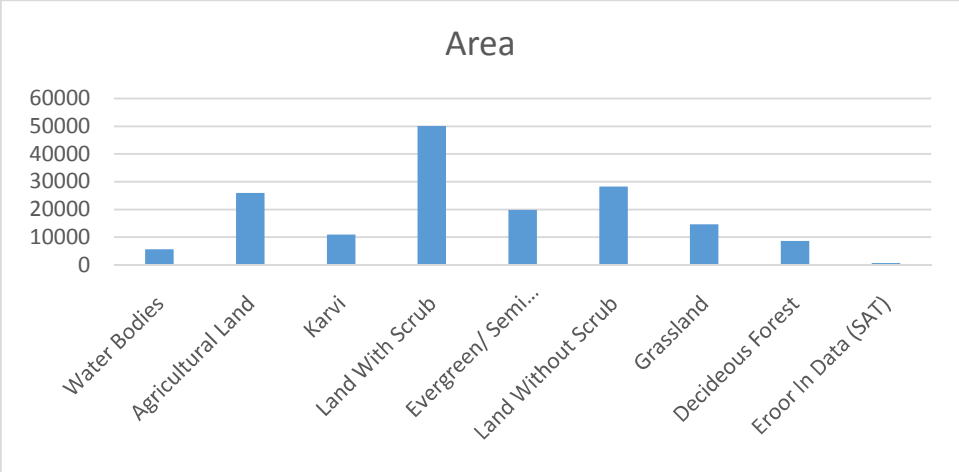
TEMPORAL GROWTH /REDUCTION OF KARVY AND GRASS LAND PATCHES IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2013
Karvy	8553.6576	10974.23336	12518.89492
Grassland	15152.6016	14681.46484	13565.42573

5.0 RESULTS AND DISCUSSIONS

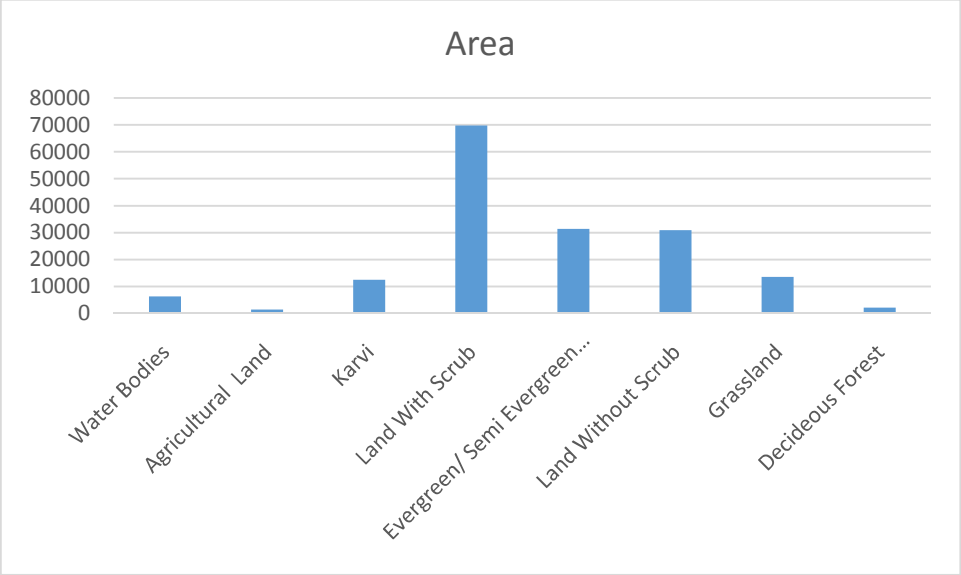
The land use/land cover types are classified as follows and details of Land use/Land cover statistics of study area for year 1997, 2003 and 2013 respectively is given in the figure, and Area under major land use/land cover categories was calculated for the year 11997, 2003 and 2013. Land use/Land cover has been categorised into 8 different classes that are water bodies, Agriculture land, Karvi –shrub, Land with scrub, Evergreen / Semi evergreen Forest, Land without scrub, Grassland and Deciduous Forest.



Graph - 5.1



Graph - 5.2



Graph - 5.3

Change in Forest Area:

Forest the most important part of land cover in study area seems to fluctuating in the period of study. In this study, Evergreen and Semi evergreen forest cover is clubbed together as it is very difficult to identify evergreen forest patches from semi evergreen vegetation as they are mixed with each other. It was found that there is approximately53% increase of Evergreen / Semi evergreen forest cover from 1997 to 2003 and approx. 58 % increase from 2003 to 2012. But for the same period there seems to be decrease in deciduous forest cover.

TEMPORAL GROWTH /REDUCTION OF FOREST LAND IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2012
Evergreen/ Semi Evergreen Forest	12948.7104	19903.0026	31377.93449
Deciduous Forest	18679.7952	8654.998039	2142.176431

Table - 5.1

Change in Water Bodies:

The reservoirs, Lakes, tanks, waterholes etc. is considered under this category. The prominent water bodies are easily detected on satellite imagery by their black and dark blue tones. The changing rate of water bodies of this area is also showing increasing trend. There is approximately 2.2 % decrease of water bodies since last 12 years (from year 1997 to 2009).

TEMPORAL GROWTH /REDUCTION OF WATERBODIES IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2012
Water bodies	2908.8576	5607.841139	6312.56725

Table - 5.2

Change in Agricultural Land:

From the classification the study area is predominantly seems to come under poor to medium cultivation. There is approx. 17 % increase of agricultural land usage from 1997 to2003. In image of 2012 it seems that Agricultural and is mixed up with other LU class.

TEMPORAL GROWTH /REDUCTION OF AGRICULTURAL LAND IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2012
Agriculture Land	22175.1936	25923.95823	1373.639505

Table - 5.3

Change in Scrub Land:

Scrub land which plays critical role in better mix of species is found to be of increasing trend.

TEMPORAL GROWTH /REDUCTION OF SCRUB LAND PATCHES IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2012
Land with scrub	61102.656	50125.74962	69770.70092
Land without scrub	26624.2752	28281.77175	30954.01868

Table - 5.4

Change in Karvi vegetation and Grass Land patches:

There clearly seems to be increase in Karvi vegetation. There is approx. 28 % increase if Karvi from 1997 to 2003 and 14 % from 2003 to 2012. Simultaneously there is decrease of Grass land area of approx. 3 % from 1997 to 2003 and 9 % from 2003 to 2012. This also substantiates the information received from the villagers in the area that Karvi has encroached large area of grass land patches.

TEMPORAL GROWTH /REDUCTION OF KARVY AND GRASS LAND PATCHES IN RADHANAGARI WLS			
VEG TYPE	1997	2003	2012
Karvi	8553.6576	10974.23336	12519.88492
Grassland	15152.6016	14681.46484	13566.32573

Table - 5.5

6.0 CONCLUSION

Vegetation changes over the period of 15 years from 1997 to 2012 have definitely taken place in the study area i.e. Radhanagari Wild Life Sanctuary. Forest areas have increased especially Evergreen / Semi evergreen forests area has increased could be due to plantation in some of the area by Forest department. While there is increase in Forest area there seem to be decline in the Grass land patches encroached by Karvi shrub. This has impact on Gaur feeding habits and ranging behaviour. Favourable growth in forest area seems to have supported increased population of the Gaur in Radhanagari WLS. But encroachment by Karvi on grasslands together with agricultural growth adjoining sanctuary has also raised the Man animal conflicts due to change in ranging by Gaur to outside sanctuary areas.

Thus it has been possible to overcome the difficulties of relating land use classes of low resolution satellite data with higher resolution data with the help of CARTOSAT data with utilisation CARTSAT DEM froth rectification of the temporal data with desired accuracy.

7.0 REFERENCE

- Petit C., Quantifying processes of land-cover by remote sensing, resettlement and rapid land-cover change in south-eastern Zimbabwe Remote sensing, 2001, vol. 22.no.17, 3435-3456.
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- Tansey K.T., Millington A.C. Land use/land cover change detection in Metropolitan Lagos (Nigeria): 1984-2000.ASPRS 2006 Annual Conference Reno, Nevada, May 1-5, 2006.