Evaluation of Land Cover Changes In Coastal Forest Of Rajula Using GIS And RS Technology

Dr. Vibhuti B. Raval[1] and Dr. Rahul S. Gohel[2]

Biology Department, Shree M. & N. Virani Science College, Rajkot-360005

ABSTRACT

As the time plays an important role in leading the life processes and its surroundings, this research work presented about the Land use/Land cover changes in coastal forest of Rajula, Gujarat State in India between the year 1996 and 2017. Remote sensing and GIS have been used to describe different features of the study area. The data are obtained from the two types of satellite images in the study LANDSAT 5 by using the sensor TM+ for the year 1996 and LANDSAT 8 by using the sensor ETM+ for the year 2017 to depict the changes that happened in last 20 years. This work carried out to get understanding of Asiatic Lions dispersion and settling in the coastal forest areas with reference to land-cover changes in recent years. As change detection analysis is a major part of this study, it shows that some areas are increasing more than other classes Agriculture and water bodies along with industrial areas while barren-land and salt affected areas decreases. This habitat changes leads to settle down in these new areas permanently by lions.

***Keywords*: Remote sensing, Land-use/Land-cover, GIS, Change detection, Accuracy Resolution.**

1. INTRODUCTION:

A better understanding of Land use/Land cover Change is a crucial importance to the study of Global Environment change (Srivastava et al. 2010; Srivastava et al. 2012a). The land use/land cover classification was performed based on the Survey of India toposheets and Satellite imageries. GIS software is used to prepare the thematic maps and ground truth observations were also performed to check the accuracy of the classification (Pandian. M et al. 2014).

Land cover refers to the physical characteristics of Earth's surface, captured in the distribution of vegetation, water, soil and other physical features. Land use refers to the way in which land has been used by humans and their habitats (Hiroshima and Ingle, 2012). While land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable (Chaudhary et al., 2008).

In general land cover includes all the physical along with biological cover over the earth's surface together with water bodies, vegetation cover, bare soil and all sorts of man-made structures. Ellis, E. (2013) explained two different views of land use in a logical way. According to him natural scientists define land use in terms of syndromes of human activities such as agriculture, forestry and building construction that modify land surface processes including biogeochemistry, hydrology and biodiversity. On other hand the Social scientists describe land use from the perspectives of socio-economic rationale aspects.

The study of land use/land cover (LU/LC) changes is very important to have proper planning and utilization of natural resources and their management (N. E. M. Asselman and H. Middelkoop, 1995). Change detection in land use and land cover is the effective measure of the distinguishable data layout and noticeable change in order that can lead to more visible insight into subtle process enclosing land cover and land use changes than the data observed from the usual change (Singh et al., 2013).

Singh in 1989 said that change detection is the method of identifying differences in the state of an object or phenomenon by observing it at different times. Digital change detection techniques by using multi-temporal satellite imagery helps in understanding landscape dynamics (J.S. Rawat and Manish kumar, 2015).

There are mainly unsupervised classification and supervised classification methodology for LULC detection. The unsupervised classification method used for the totally unknown area while supervised classification used with known area features to get better accuracy.

2. STUDY AREA:

The present study carried out in the eastern part of Gir which includes the areas close to Jafrabad and Rajula coast of Rajula sub districts of Amreli district located in the Gujarat State of India. It is located in the eastern part of the Gir protected area and occupies the vast areas of the coastal habitats. It comprises around 120 Km² within the Rajula Tehsil of Amreli district. It lies between the parallels of latitude North 21° and meridians of longitude East 71°. It comprises around seventy two villages.

- **Topography and climate of Coastal Forest- Rajula**

The whole study area mainly comprises the scattered shrubs with different elevation and habitat ranges. It consist coastal areas of Arabian Sea with salty pan at several sites. The area is flat but little undulating at some villages. It occupies Gauchar lands, agro-pastoral lands, industrial zones and forest areas. The Agariyas are one of the Scheduled Tribes of India which also reside around, Chanch Bander, Pipavav and Devaka.

There are three seasons namely winter from November to February, summer from March to June and monsoon from July to October. The maximum temperature in summer ranges 30- 37°c whereas minimum temperature around 20-25°c found. The annual rainfall ranges around 350 mm. Due to coastal land the temperature ranges intermediate in all around year neither too cool nor hot.

- **Flora and fauna of Coastal Forest- Rajula**

The area comprises mainly sparse patches of *Prosopis juliflora* species and *Salvadora persica* with other shrub. The other includes Ziziphus, cactus and scattered tree species. It harbors the diverse faunal species within mammals, reptiles, amphibian and aves. There are Asiatic lion, striped hyenas, Jackals, Bluebull, chinkara, Sambar, Spotted deer etc inhabitant the area. There are many species of owls, owlets, and other birds found to occur.

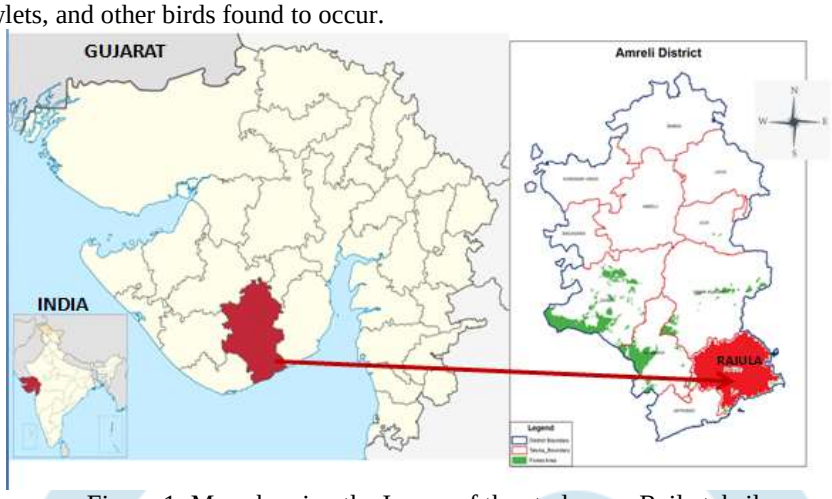

Figure 1: Map showing the Image of the study area Rajla tehsil.

3. METHODOLOGY:

There are two main methods for capturing information on land cover: field survey and analysis of remotely sensed imagery. For the most part 2 types of data that we have to handle in Remote Sensing GIS are Raster and Vector. Raster data are mostly with spatial information (Pixels) which can display us meaningful Ground surface information, while vector files are geometrical shapes like point, line Polygon, which provide us proper idea of feature existing on earth surface. By Remote sensing and GIS method we can map whole taluka area with its particular Land use/Land cover pattern. We can identify and classify particular area with the Supervised Classification method and subsequently by Change Detection method we can confer particular changes which happened between 21 years. Before the pre-processing and classification of satellite imagery began, an extensive field survey was performed throughout in the study area using Global Positioning System (GPS) Garmin – eTrex equipment. This survey was performed in order to obtain accurate location point data for each land use and land cover class included in the classification scheme as well as for signature generation.

- **Satellite image acquisition and pre-processing:**

Two types of satellite images used in the study LANDSAT 5 by using the sensor TM+ (1996), LANDSAT 8 by using the sensor ETM+ (2017). The LANDSAT images had been obtained from the global land cover facility (GLCF; www.glcf.org) through earth science data interface (ESDI) and Resourcesat-1 data had been obtained from BHUVAN platform of ISRO (http://bhuvan-noed.nrsc.gov.in). Before going into analysis the satellite images had been pre-processed with the aim of enhance the efficiency, synchronize data and to reduce the error (Jensen 1996).

Data had been procured from two platforms and map to image geo-rectification had been made with the help of toposheets of particular area having a scale of 1:50000. Then all images had been geo-referenced, layer stacking made in ERDAS 9.2 with all bands of imageries. The satellite images had been stacked to produce a multi-spectral image from each of the panchromatic bands provided per image. After that the images had been clipped to represent the individual study areas by using the vector file. Then interpretation and classification had been done.

- **Preparation of supervised classification images**

Supervised classification of all images of the study area had been carried out using the maximum likelihood classifier (MLC) technique in ERDAS Imagine. This method is widely preferred as it takes the most variables into consideration by using covariance matrix (Hord, 1982).

Supervised classification using all spectral bands can separate accurately, the different land use classes, which involves the following three steps: acquisition of ground truth, calculation of the statistics of training area and classification using maximum likely hood algorithm. After the supervised classification of the images, the change detection method had been used to identify particular changes, which happened between twenty one years after for all 2 imageries with a image processing tool of ERDAS Imagine. The MLC tool considers both the variances and co-variances of the class signatures and is based on Bayes' theorem of decision making wherever the cells in each class sample in the multidimensional space are normally distributed (Abhinav et al., 2014; Foody et al., 1992).

A class can be characterized by the mean vector and the covariance matrix with the assumption that the distribution of a class sample is normal (Banerjee and Srivastava, 2013). Given these two characteristics for each cell value, the statistical probability is computed for each class to determine the membership of the cells to the class. When a priority option is specified (equal weighting), each cell is classified to the class to which it has the highest probability of being a member (Richards and Jila, 2006; Lillesand, et al., 2004).

The satellite data was enhanced before classification using histogram equalization in ERDAS Imagine 8.7 to improve the image quality and to achieve better classification accuracy. In supervised classification, spectral signatures are developed from specified

locations in the image. Generally a vector layer is digitized over the raster scene. The vector layer consists of various polygons overlaying different land use types. The land use maps pertaining of two different periods were used for post classification comparison, which facilitated the estimation of changes in the land use category and dynamism with the changes. Post classification comparison is the most commonly used quantitative method of change detection (J. F. Mas, 1999; J. R. Jensen, 1996) with fairly good results. All data transferred into a worksheet and then overlaid on the satellite images for ground truth verification and accuracy assessment.

4. RESULTS AND DISCUSSION:

Maximum Likelihood Classification technique is used by ERDAS Imagine software for better and accurate result of particular study area. The 1996 and 2017 classified images are shown through Fig. 3 and 4.

Change detection study is made for 21 years gap with the help of satellite imageries and classification process. The Maximum Likelihood Classification tool considers both the Variance and covariance of the class signatures when assigning each cell to one of the classes represented in the signature file with the assumption that the distribution of a class sample is normal, a class can be characterized by the mean vector and the covariance matrix. Specified these two characteristics for each cell value, the statistical probability is computed for each class to detect the membership of the cells to the class. When the default equal a prior option is specified, each cell is classified to the class to which it has the highest probability of being a member. This study area is occupied by 5 major classes e.g. Agriculture, Other Vegetation (Shrub), Barren Land, Salt Affected Region, Water-Bodies (Table 1).

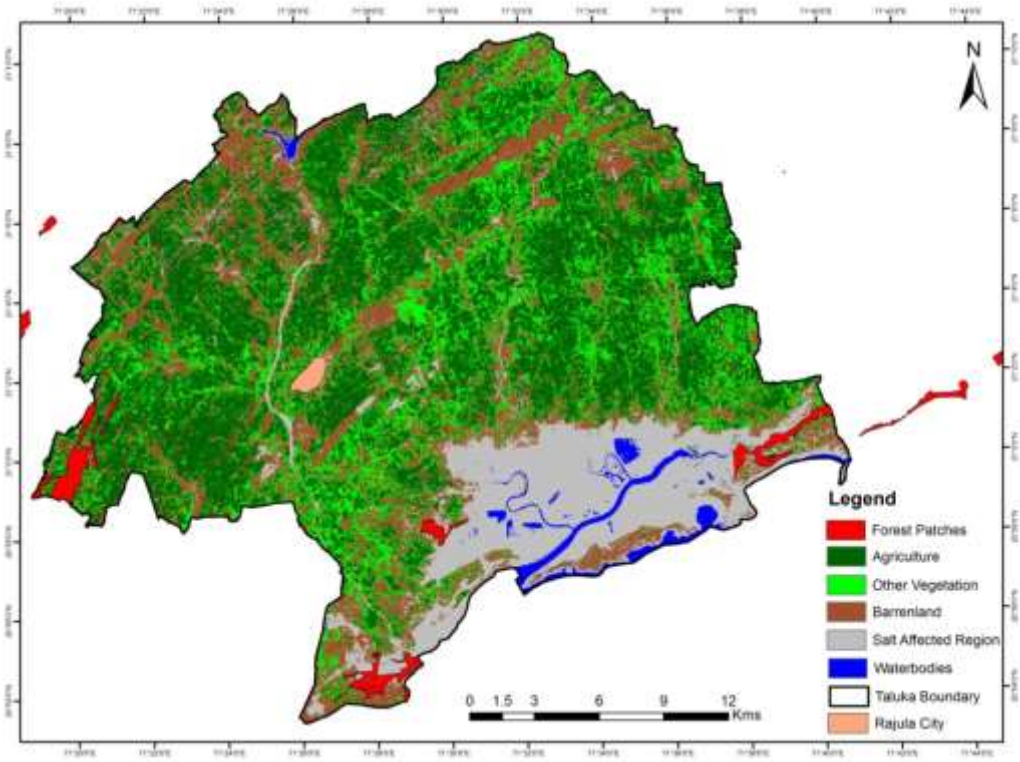

Figure 2: LULC image of Coastal forest-Rajula in the year 1996.

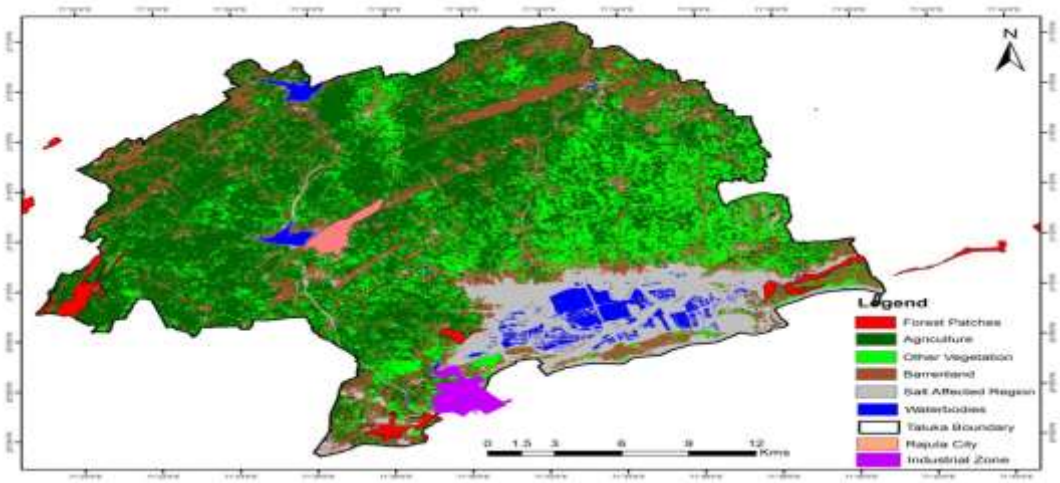

Figure 3: LULC image of Coastal Forest-Rajula in the year 2017.

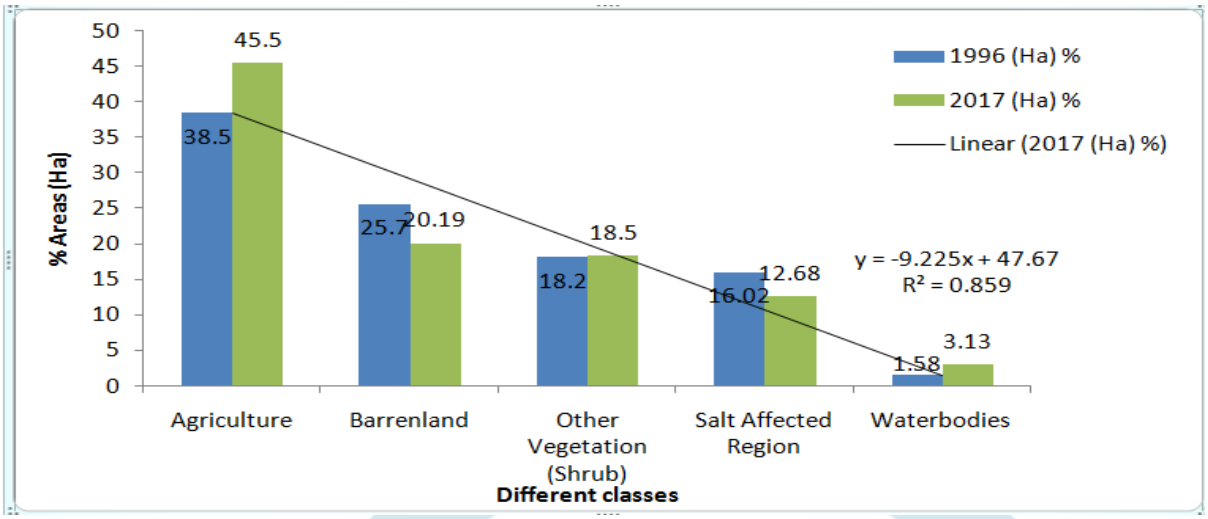

Figure 4: Areas of different class (%) in Coastal Forest-Rajula.

In the recent study Coastal forest of Rajula, the agricultural area had been increased around 7% in the recent year (38.5 to 45.5), followed by 1.5 % increased in water bodies (1.58 to 3.13), followed by slight increase in the shrub land around 0.3% (18.2 to 18.5). On other hand barren-land notably decreased around 5% (25.7 to 25.19), followed by decreased in salt affected area around 4% (16.02 to 12.68) in the year 2017 (Figure 4). In the coastal forest there had been considerable increased the industrial areas also in recent times (Fig. 2 &3).

ACCURACY ASSESSMENT

Producer's Accuracy:

The producer's accuracy measures how well a certain area has been classified. It includes the error of omission which refers to the proportion of observed features on the ground that is not classified in the map. The more errors of omission exist, the lower the producer's accuracy (Morisette And Khorram, 2000).

Producer's Accuracy (%) = 100% - errors of omission (%)

User's Accuracy:

The correctly classified pixels in a class are divided by the total number of pixels that were classified in that class which known as User's accuracy measures. It reflects the accuracy measure of map representation along with the real ground details (Abhinav et al., 2014). Each class of the map can have two types of classes on the ground. The 'right' class refers to the same land-cover class in map and on the ground where as the 'wrong' classes show a different land-cover in both map and on ground which referred as errors of commission. More the errors lower the accuracy.

User's Accuracy (%) = 100% - errors of commission (%)

Overall Accuracy:

It is calculated by dividing the number of pixels correctly classified (i.e. sum of the diagonal axis of the matrix) with the total number of pixels included in the evaluation process (Congalton, 1991).

Kappa Coefficient:

Kappa indicates the accuracy level achieved by the user. It illustrates correctly classified pixels after overall classification accuracy had been achieved. Following table shows Accuracy Assessment for each and every class of particular year in the study area.

Table 1: Accuracy assessment for 1996 and 2017 Satellite Imageries for Coastal Forest- Rajula

YEAR	1996		2017	
	Producer's Accuracy	User's Accuracy	Producer's Accuracy	User's Accuracy
Agriculture	87.50%	77.78%	100.00%	76.92%
Other Vegetation (Shrub)	75.00%	100.00%	66.67%	100.00%
Barren Land	71.43%	100.00%	85.71%	100.00%
Salt Affected Region	100.00%	80.00%	100.00%	100.00%
Water-Bodies	100.00%	100.00%	100.00%	100.00%
Overall Accuracy	86.67%		88.89%	
Overall Kappa Statistics accuracy	0.83%		0.8451	

The different accuracy of the map indices reflects the maximum viability features matched with that of ground. The kappa coefficient value for coastal forest of Rajula study area found to be 0.8 which suggested it's very much accurate (Table 1).

5. CONCLUSION:

The GIS study in coastal forest of Rajula revealed that the agriculture land along with the industrial area expanded in recent years which found to be suitable for lions as it provide food source and less disturbances. The different accuracy of the map indices reflects the maximum viability features matched with that of ground. The kappa coefficient value for the study area found to be 0.8 for coastal forest of Rajula suggested it's very much accurate (Table 1). So, in recent time due to population increase and forest cover changes lion found to visit frequently in surrounding villages. It is important mainly for the management authorities and land use planners to study about habitat change and its impacts on the surrounding fauna and its long term conservation.

Study shows changes of Land use/Land cover pattern along with climatic parameters like rainfall, temperature, etc. Classification shows major 5 parameters to be measured for monitoring like Agriculture, Barren land, Forest, Grassland, Water bodies, etc. Change analysis study shows that mainly Agriculture, Water bodies and Industrial areas are showing positive change caused by anthropogenic and climatic factors of the study area. Once LULC pattern has been understood, post work can be done easily with the help of different remote sensing and field interpretation methods. Change analysis is helpful in predict future changes with the average of different meteorological parameters and other spectral signatures.

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