IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 3, Issue 6 Ver. II (Nov. - Dec. 2015), PP 55-60
www.iosrjournals.org

Application of Remote Sensing Techniques for Change Detection in Land Use/ Land Cover of Ratnagiri District, Maharashtra

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Abstract: *Remote sensing data and imageries have been used for the assessment and monitoring of land use and land cover changes, so that available resources of any region may be used properly. In the coastal areas of Maharashtra, catastrophic and human interventions are highly influencing on coastal resources. Now there is an urgent need to use the sustainable resources by reducing the rate of degradation. The present study is an attempt to analysis the change detection in the major aspects of land use and land cover in the Ratnagiri district of Maharashtra. Satellite images of the years 1989, 1999 and 2009 have been obtained from Global Land Cover Facility (GLCF) & NRSC and used for the analysis of periodic changes in LULC of Ratnagiri.*
Keywords: *LISS-III, LULC, GLCF, Change detection, Degradation,*

I. Introduction

The Ratnagiri district covers 8,16,424 hectares of the total area of the district having nine tehsils (fig 1). Most of the part is covered by forest with undulating landscape. Various resources are available in the district, but needs proper management. Therefore remote sensing techniques for monitoring the natural resources is the proper way that can also give information about the vulnerable sites of degradation from time to time.

In the past three decades, there has been a growing trend in the development of the change detection techniques using remote sensing data. Remote Sensing (RS) and Geographical Information System (GIS) are now providing new tools for ecosystem management. The data is collected by remote sensing, enables the synoptic analysis of earth system functions; also change at local, regional and global scale over times. Such data also provides an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996 ; Lillesand et al., 2008). Land use is defined as the use of land for economic purpose by human beings. The land use includes agricultural land, built-up land, recreational area, wildlife management area etc. Land cover refers to the physical characteristics of earth's surface, distribution of vegetation, water, soil and other physical features of the land including those created solely by human activities, e.g. settlement. (Anderson, 1976).

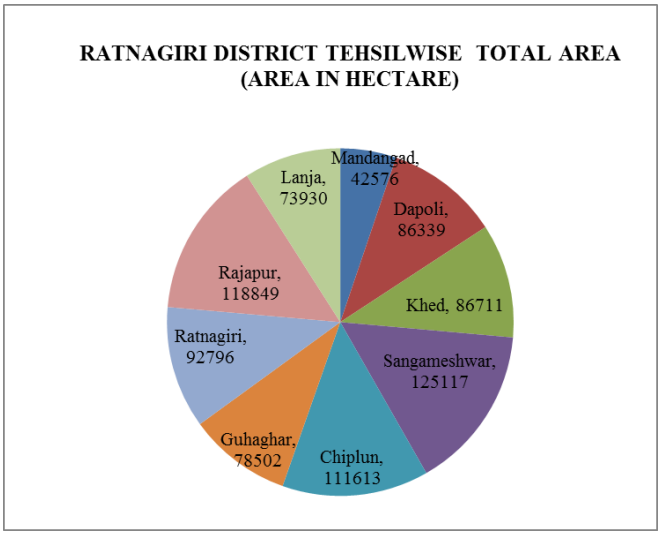


Figure : 1 Tehsil wise Area of Ratnagiri district

Land use refers to the purpose of land reserves, for example, recreation, wildlife habitat or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know the current quantity of land and the type of its usage and to identify the land use changes from year to year. Satellite remote sensing data i.e. images and soft data is the most common data source for change detection, quantification, and mapping of LULC patterns and variations can be easily detected due to its repetitive data acquisition, digital format suitable for computer processing, and accurate georeferencing procedures (Anderson, 1976; Chen, Vierling, & Deering, 2005; Jensen, 2005;). Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times. Essentially, it involves the ability to quantify temporal effects using multi-temporal data sets. One of the major applications of remotely-sensed data obtained from Earth-orbiting satellites is change detection because of repetitive coverage at short intervals and consistent image quality (Anderson, 1976). Amount of degradation can be easily accessed using these advances tools and techniques (Sapkale & Rathod, 2014; 2015).

II. Data And Methods

Land use and land cover classification through supervised classification methods by using LANDSAT, TM , Satellite image of Ratnagiri Coastal Resource for the years 1989 has been performed/ done. LANDSAT, ETM, Satellite image of Ratnagiri Coastal Resource 1999 and LISS-III Satellite image of Ratnagiri Coastal Resource 2009 were also used to carry out change detection analysis. Satellite images of the years 1989, 1999 and 2009 have been obtained from Global Land Cover Facility (GLCF) & NRSC. The resolution was 30 meters for Landsat data and 23.5 m. LISS III image. During analysis 4-5% error occurs due to variation in the resolution of the images. The Land Use/ Land Cover classification has been performed through supervised classification method using Digital Image Processing software. Erdas Imagine and ArcGIS software are powerful tools for extracting the land use and land cover layers from Ratnagiri Coastal Resource.

III. Discussions And Results

LAND USE / LAND COVER MAPPING AND CHANGE ANALYSIS: The land use and land cover classes includes agricultural land, forest/vegetation, built up area, water bodies and fallow land. It is the broad classification of the land use and land cover of study area.

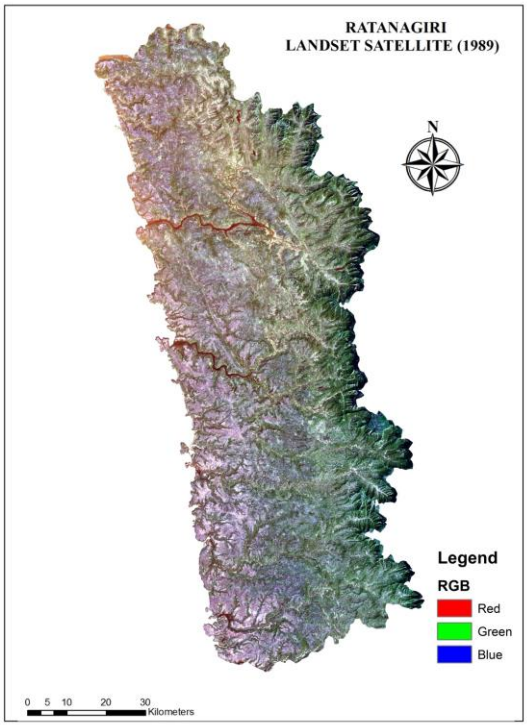
Table No. 1

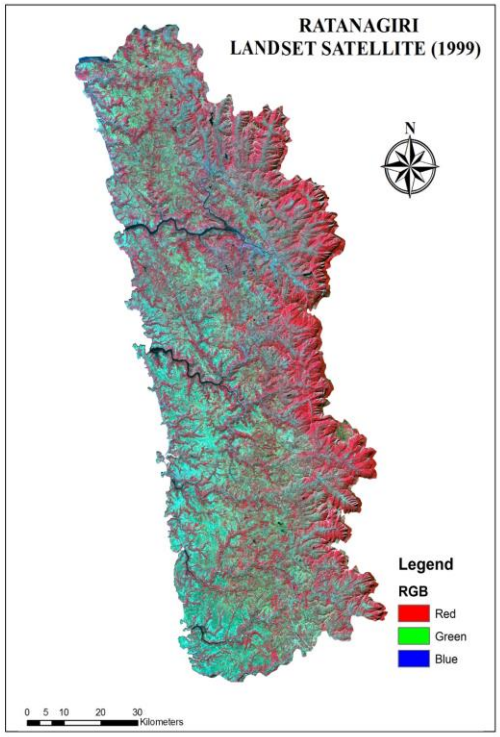
LAND USE / LAND COVER CLASSIFICATION IMAGE-YEAR-1989

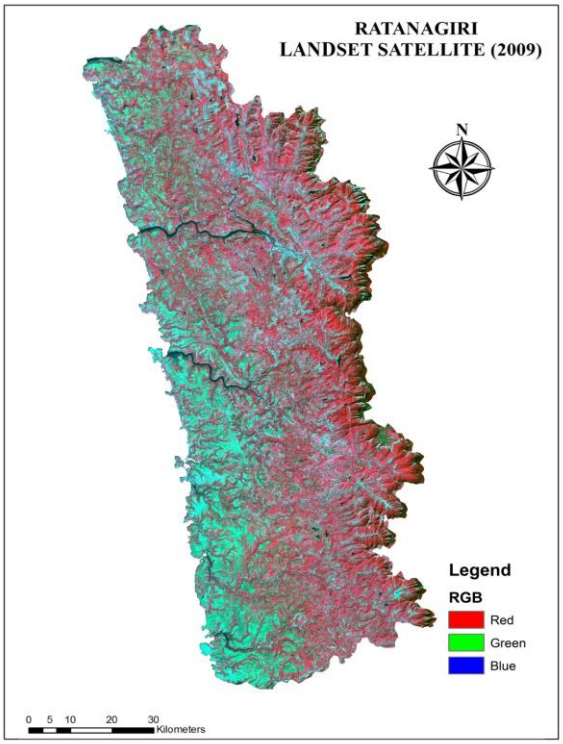
Sr. No	Class Name	Area in Hectare (Approx)	Area in Percentage%
1	**Built-up**	816.433	0.10
2	**Cropped**	58864.819	7.21
3	**Open land**	165409.325	20.26
4	**Dense forest**	26289.142	3.22
5	**Sparse forest/**trees	518598.241	63.52
6	**Water body**	16981.806	2.08
7	**Barren land**	29146.658	3.57
Total Area		**816106.424**	**100**

CROPPED AREA: The cropped land may be defined broadly as land that is used primarily for production of food and fodder. Cropped land occupies sizeable area. Rice, Vegetables are the major crops in this region. In the year 1989 the cropped land is covered by 7.21% of the total area under these categories. In 1999 about 11.65% of the total area is under cropped in the region. In 2009 about 13.47% of the total area is under cropped. In Ratnagiri district the cropped area has increased by 1.82% in 20 years from 1989 to 2009. There is a positive change in agricultural land in these 20 years (table no. 1 to 5).

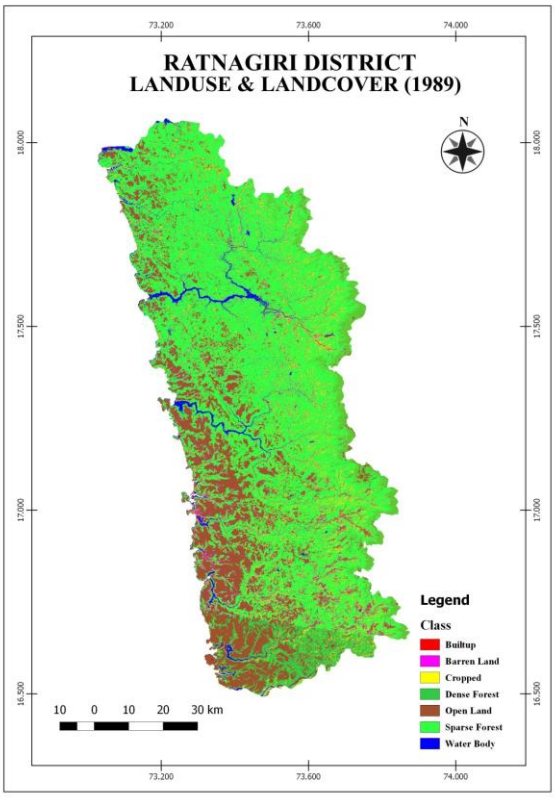
BUILTUP AREA :The built-up land cover is reported from Ratnagiri district in the year of 1989 is 0.10%. The total area covered by built-up land in the years 1999 and 2009 is 0.59% and 2.46% respectively. It can be observed that in these 20 years, from 1989 to 2009 the built-up area has increased by 1.87%. There is a positive change in built-up land in these 20 years. It has also seen that an analytical result for built-up area in the district gives the lower values, because most of the region is occupied by undulating topography, the settlements in the village areas have covered by large size trees-probably mango trees.

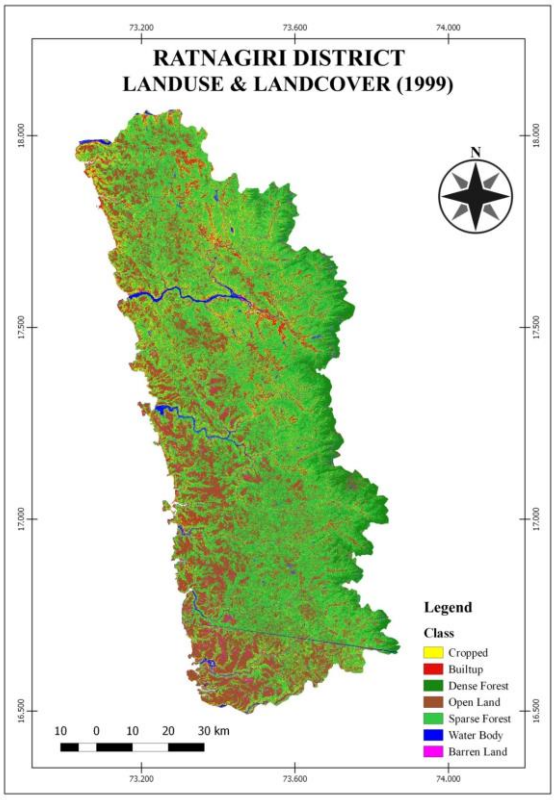






Source:- Based on Global Land Cover Facility (GLCF)


RATNAGIRI DISTRICT
LANDUSE & LANDCOVER (1989)
N
Legend
Class
Builtup
Barren Land
Cropped
Dense Forest
Open Land
Sparse Forest
Water Body
10 0 10 20 30 km
73.200
73.600
74.000
18.000
17.500
17.000
16.500


RATNAGIRI DISTRICT
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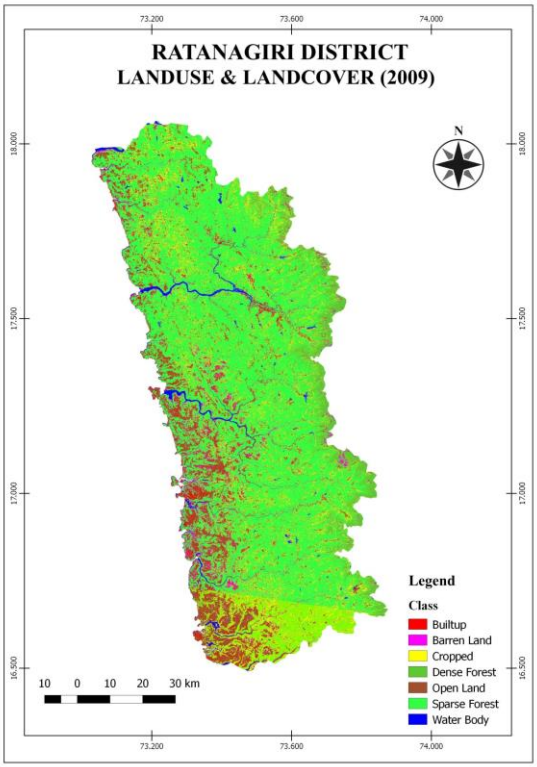
RATANAGIRI DISTRICT
LANDUSE & LANDCOVER (2009)
N
Legend
Class
Builtup
Barren Land
Cropped
Dense Forest
Open Land
Sparse Forest
Water Body
10 0 10 20 30 km
73.200
73.600
74.000
18.000
17.500
17.000
16.500

Table No. 2			
LAND USE / LAND COVER CLASSIFICATION IMAGE-YEAR-1999			
Sr. No	**Class Name**	**Area in Hectare**	**Area in Percentage%**
1	**Builtup**	4816.954	0.59
2	**Cropped**	95114.444	11.65
3	**Open land**	187126.443	22.92
4	**Dense forest**	67110.792	8.22
5	**Sparse forest/trees**	433770.852	53.13
6	**Water body**	12899.641	1.58
7	**Barren land**	15267.297	1.87
Total Area		**816106.424**	**100**

Table No. 3			
LAND USE / LAND COVER CLASSIFICATION IMAGE-YEAR-2009			
Sr. No	**Class Name**	**Area in Hectare**	**Area in Percentage%**
1	**Builtup**	20002.608	2.45
2	**Cropped**	109728.595	13.44
3	**Open land**	91032.279	11.15
4	**Dense forest**	50782.132	6.22
5	**Sparse forest/trees**	507821.326	62.20
6	**Water body**	10531.985	1.29
7	**Barren land**	26207.493	3.21
Total Area		**816106.418**	**100**

OPEN LAND AREA : In the Ratnagiri district some area covered with open land. The open land refers to the land, may be uncultivated and unused land. In the year 1989, the open land has occupied 22.92% of total area of region. From 1999 to 2009, it is 22.92% and 11.17% respectively. In Ratnagiri district the open land area has decreased by -11.75% in 20 years from 1989 to 2009. There is a negative change in open land area in these 20 years.

DENSE FOREST AREA : The area under forest includes the land classified as forest under any legal enactment dealing with forest or administrated for forest, whether state-owned or private, and whether wooded or maintained as potential forest land. The areas where crops are raised in the forests and grazing lands or areas open for grazing within the forests are included under forest area (National Commission on Agriculture, 1976). The present Ratnagiri district is located in coastal and hilly region with uneven topography covered by dense vegetation. Most of the area is under dense forests.

Table No. 4							
LAND USE/ LAND COVER CHANGE FROM 1989 TO 1999							
		Year-1989		**Year-1999**		**Difference**	**Change (1989 to 1999)**
Sr. No	**Class Name**	**Area in Hectare**	**Area in %**	**Area in Hectare**	**Area in %**	**Area in Hectare**	**Area in %**
1	**Builtup**	816.433	0.10	4816.954	0.59	4000.522	0.49
2	**Cropped**	58864.819	7.21	95114.444	11.65	36249.625	4.44
3	**Open land**	165409.325	20.26	187126.443	22.92	21717.118	2.66
4	**Dense forest**	26289.142	3.22	67110.792	8.22	40821.65	5.00
5	**Sparse forest***	518598.241	63.52	433770.852	53.13	-84827.38	-10.39
6	**Water body**	16981.806	2.08	12899.641	1.58	-4082.165	-0.5
7	**Barren land**	29146.658	3.57	15267.297	1.87	-13879.36	-1.7
Total Area		**816106.424**	**100**	**816106.424**	**100**		

* Scattered trees with different species and bushes/shrubs are included.

Table No. 5							
LAND USE/ LAND COVER CHANGE FROM 1999 TO 2009							
		Year-1999		Year-2009		Difference	Change (1999 to 2009)
Sr. No	Class Name	Area in Hectare	Area in %	Area in Hectare	Area in %	Area in Hectare	Area in %
1	Builtup	4816.954	0.59	20002.608	2.46	15185.654	1.87
2	Cropped	95114.444	11.65	109728.595	13.47	14614.151	1.82
3	Open land	187126.443	22.92	91032.279	11.17	-96094.164	-11.75
4	Dense forest	67110.792	8.22	50782.132	6.23	-16328.66	-1.99
5	Sparse forest	433770.852	53.13	507821.326	62.13	74050.474	9.00
6	Water body	12899.641	1.58	10531.985	1.50	-2367.656	-0.08
7	Barren land	15267.297	1.87	26207.493	3.01	10940.196	1.14
Total Area		816106.424	100	816106.418	100		

In 1989, the dense forest area was 3.22% of the total area in study region. In 1999 and 2009 the area of Ratnagiri district under dense forest area was 8.22% and 6.23% respectively. It can be observed that in these 20 years, almost 1.99% dense forest area cover has decreased in the study region. There is a negative change in dense forest area in two decades.

SPARSE FOREST AREA: The Ratnagiri district is located in coastal and hilly region with uneven topography covered by sparse vegetation. Most of the area is under sparse forests with scattered trees of different species like mango and coconut, also accounted with bushes and shrubs. In 1989, the sparse forests cover was 63.52% of the total area in the study region. In 1999 and 2009 the area of Ratnagiri district under sparse forests was 53.13% and 62.13% respectively. It is observed that in these 20 years, almost 9.00% sparse forests area cover has increased in the study region. There is a positive change in sparse forests area cover in last two decades. Mango plantations on the slope of the hills are also one of the reasons for increasing the area of this category.

WATER BODY: Water bodies include estuary, wells, lakes, ponds, river and stream. The percentage of water bodies in the region is 2.08% of the total area in the year 1989. The total area covered by water bodies in the years 1999 and 2009 was 1.58% and 1.50% respectively. The area under water bodies in Ratnagiri district has decreased from 1989 to 2009 by -0.08%.

BARREN LAND: The Barren land is reported 3.57% in the year 1989. The total area covered by barren land in the years 1999 and 2009 is 1.87% and 3.01% respectively. In Ratnagiri district the area under barren land has increased by 1.14% in 20 years i.e. from 1989 to 2009. There is a positive change in barren land area in these 20 years.

IV. Conclusion

Updated information about land use and land cover of the present study area will help to overcome the problems in connection with the agricultural systems, forest cover, various infrastructures etc. Therefore it has suggested that, Remote sensing, GIS, GPS techniques should be used continuously for the management and development in the study area. The analytical results of the present research work, using TM and LISS III images have provided the major categories of the Land use and land cover of Ratnagiri district, still with reducing the errors, micro level study with analyzing sub categories of LULC may be suggested for accurate results.

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