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Assessing land use and land cover change detection using remote sensing in Ratnagiri District of Maharashtra

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Abstract
Land Use and Land Cover (LULC) is the important source of information for the watershed development as the land use and land cover significantly affect the volume and velocity of the runoff. The information about land use and land cover plays important role in decision making land conservation, management of water resources and sustainable development. Therefore, the research was made to detect the changes in land use patterns in Ratnagiri district of Maharashtra from the year 2013 to 2018 using Landsat 8 data along with Arc GIS 10.3 and Google Earth software. The land use was classified into five categories as agricultural land, forest land, barren land, water bodies and residential area using the supervised classification method. The area under agriculture, forest land, barren land, residential area and water bodies for Ratnagiri district in the year 2013 was 38.43%, 43.93%, 12.97%, 3.70% and 0.97%, respectively. Over the considered study period of five years, in 2018, the change in the area under forest and barren land was found to be decreased by 0.22% and 2.43%, respectively. At the same time area under agriculture and residence or built-up was increased by 0.81% and 1.86%, respectively. The accuracy of the land use mapping was calculated by comparing the temporal data of 2013 and 2018 available in Google Earth software using Kappa coefficient. The results showed that the overall accuracy was 90.83% and 90% for the years 2013 and 2018, respectively.

Keywords: Arc GIS, LULC, Kappa coefficient, overall accuracy

Introduction
The Land Use and Land Cover (LULC) is the type of cover covering the surface of the Earth. Though the terms land use and land cover seems similar, there is significant difference between them. Biotic and abiotic components which covers the earth surface are called as land covers, whereas land use is the modification of the land cover for any specific purpose. Water, grassland, forest, snow, bare soil etc. comes under the land cover and agricultural land, recreation area, wildlife management are the subjects of land use (Yangchan *et al*., 2014) [18]. The land use and land cover change of an area is an outcome of natural and socio-economic aspects and interaction of human with time and space. Land use land cover (LULC) changes are mostly influenced by change in the population and physical factors including topography, slope condition, soil type, and climate. Change in land use land cover can directly affect the amount of evapotranspiration, groundwater infiltration and overland runoff. Generally, the changes in land use land cover puts adverse effects on the patterns of climate, natural hazards and socio-economic dynamics on a local and global scale Information about land use/cover and its proper management for best use is essential for the planning, sustainable land resource management and understanding the behaviour of hydrological processes to meet the increasing demands.

The detection of changes in the land use land cover is very helpful to understand, monitor and regulate cultivated area, urban expansion and landscape utilization. The understanding of landscape patterns, changes and interactions between human activities and natural phenomenon are essential for decision improvement and proper land management.

The conventional methods of land use mapping are tedious, time consuming and laborious. The modern technologies like Geographic Information Systems (GIS) and Remote Sensing (RS) are powerful and cost-effective tools for assessing the spatial and temporal change of LULC. Nowadays, satellite data with high accuracy is freely available on different web portals which can be used for land use mapping. Remote sensing data is the most common source for detection, quantification, and mapping of LULC patterns due to its repetitive data acquisition, suitable for processing, and accurate georeferencing.

In most of the developing countries like India, changes in land use patterns are closely concerned with the change in the population. Various studies have been conducted in India related to changes in land use land cover. These studies showed that the direction, pattern and degree of LULC change were different in different parts of India. These studies suggested that study of land use mapping is critical for environmental protection strategy and sustainable resource management of watersheds. India is facing serious LULC change mostly due to over use of natural resources for agriculture and human settlement.

Ratnagiri district is a district of Konkan region. It has significantly developed in past few years, primarily due to tourism. Therefore, the forest land has extensively used for agriculture and residential purpose. Thus, timely monitoring of LULC dynamics and quantify landscape patterns for Ratnagiri district is essential to evaluate and monitor changes in land use patterns. Therefore, the study was undertaken to assess the variation in land use and land cover change in Ratnagiri district of Maharashtra.

Materials and Methods

Description of the study area

Konkan region is one of the six administrative division of Maharashtra state. It is narrow strip bounded by Arabian sea on the West side and mountain range on the east side. Ratnagiri is a district of Konkan region lying from longitudes 16.49° North to 18.06° North and latitudes from 73.03° East to 73.87° East. The total area of Ratnagiri district is about 8461.5 sq. km. The study area of the research work is shown in the figure 1.

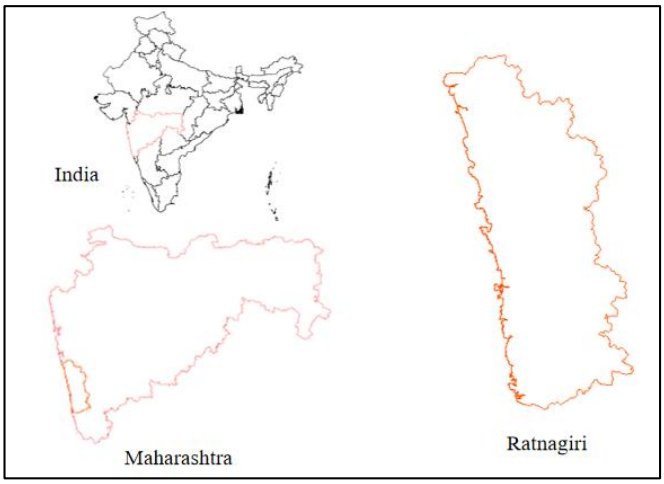

Fig 1: Location map of study area

The land use and land cover maps gives the information about the type of covering on the soil and purpose for which the land is being used. The conventional methods like ground surveying have many disadvantages when compared with the geospatial technologies. Therefore, Landsat 8 satellite images were used for the present study to carry out the land use land cover analysis. Landsat 8 satellite images has resolution of 30m x 30m and also covers very large extent, about 185 km x 185 km, which facilitate easy handling and processing of the image in the Arc GIS. The Landsat 8 images of row 147 and path 48 was used. The images will be classified into different land use land cover patterns such as water body, forest area, built-up/residential area, agriculture lands and barren lands.

There are various methods to identify different land use patterns using Arc GIS as iso cluster unsupervised classification, natural Neighbour classification, maximum likelihood classification, etc. The accuracy of different classification methods varies with type of data and the number of training samples provided. Among mentioned methods the supervised classification with maximum likelihood classification gives better accuracy.

Land use and land cover is a dynamic process. The change can be detected by making maps of land use land cover patterns for different time periods. For the current study land use land cover maps for the years 2013 and 2018 were prepared. The change in the LULC was calculated by comparing the area under each LULC pattern for the years 2013 and 2018.

Area under each LULC pattern was calculated by using equation as-

Pixel count of land use pattern × cell size of one pixel

The Landsat 8 has resolution of 30 meters. Therefore, the formula becomes-

Area (m^2) = Pixel count of particular land use pattern × 30 m × 30 m.

The percent area covered by each land use pattern was calculated as

$$\text{Area (\%)} = \frac{\text{Area under specific land use (ha)}}{\text{Total area (ha)}} \times 100$$

The land use land cover maps needs to be compared with the referenced data in order assess the accuracy of classification. The detection of the land use land cover pattern of any area can not be considered valid until its accuracy has been determined. The land use land cover maps were compared with the Google Earth images for the years 2013 and 2018. The user accuracy, producer accuracy and overall accuracy was calculated in the present study using Kappa coefficient to quantify the accuracy of land use land cover maps.

Results and Discussion

The land use land cover maps for Ratnagiri district was prepared for the years 2013 and 2018 using the Arc GIS 10.3 software. The agricultural land, barren land, water bodies, forest land and residential area are shown by light green, yellow, blue, dark green and red colors, respectively. As Ratnagiri district falls in Konkan region, it is occupied with the Western mountain ranges in the eastern part, therefore the forest area is concentrated in the east side of the district. The area covered by different land use signatures in the year 2013 and 2018 is shown in the table 1 and 2.

Table 1: Area under LULC patterns for Ratnagiri district for the year 2013

Sr. No.	Land use land cover pattern	Area (sq. km.)	Percent area
1	Agricultural land	3252.04	38.44
2	Forest land	3716.34	43.92
3	Barren land	1097.58	12.97
4	Residential area	313.12	3.70
5	Water bodies	82.36	0.97
	Total	8461.44	100

Table 2: Area under different LULC patterns for Ratnagiri district for the year 2018

Sr. No.	Land use land cover pattern	Area (sq. km.)	Percent area
1	Agricultural land	3320.48	39.24
2	Forest land	3698.37	43.71
3	Barren land	892.01	10.54
4	Residential area	470.64	5.56
5	Water bodies	79.95	0.95
	Total	8461.45	100

The land use maps prepared for Ratnagiri district are shown in the figures below.

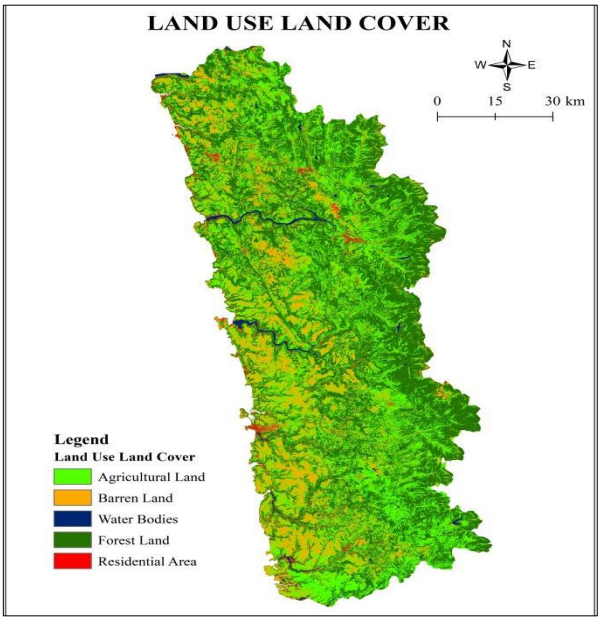

Fig 1: Land use land cover map of Ratnagiri district for the year 2018

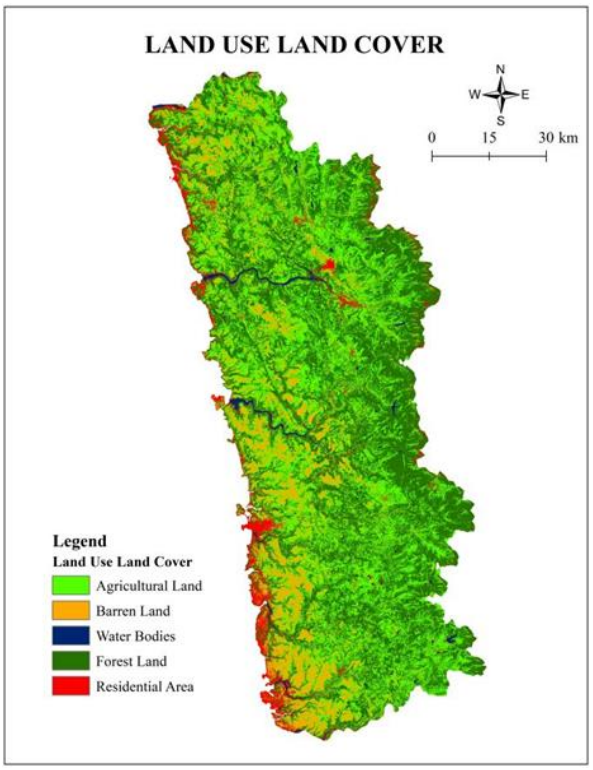

Fig 2: Land use land cover map of Ratnagiri district for the year 2018

Detection of the changes in land use patterns over the period

Land use and land cover are dynamic properties of any area. The extent of LULC changes spatially and temporally due to human needs and other climatic conditions. The changes in the land use land cover of the study area obtained from this study are discussed in the Tables below.

Table 3: Change detection in land use land cover pattern of Ratnagiri district

Sr. No.	Land use land cover pattern	Year 2013		Year 2018		Percent change
		Area in sq. km.	Percent area	Area in sq. km.	Percent area	
1	Agricultural land	3252.04	38.44	3320.48	39.24	+ 0.80
2	Forest land	3716.34	43.92	3698.37	43.71	- 0.21
3	Barren land	1097.58	12.97	892.01	10.54	- 2.43
4	Residential area	313.12	3.70	470.64	5.56	+ 1.86
5	Water bodies	82.36	0.97	79.95	0.95	- 0.02
	Total	8461.44	100	8461.45	100	--

Accuracy assessment of land use mapping

The accuracy of land use land cover for Ratnagiri district was calculated using the Kappa coefficient. The different reference points selected from the land use maps of Ratnagiri district were compared with the Google Earth image. The results obtained from the comparison of the reference points of Ratnagiri district for the year 2013 with Google Earth images are shown in the Tables below:

Table 4: Kappa coefficient values of Ratnagiri district for the year 2013

Sr. No.	Land use pattern	User accuracy (%)	Grade	Producer accuracy (%)	Grade	Overall accuracy (%)	Grade
1	Agricultural land	86.67	Excellent	86.67	Excellent	90.84	Excellent
2	Barren land	90	Excellent	87.10	Excellent		
3	Water bodies	93.75	Excellent	100	Excellent		
4	Forest land	93.55	Excellent	93.55	Excellent		
5	Residential area	91.67	Excellent	91.67	Excellent		

Table 5: Kappa coefficient values of Ratnagiri district for the year 2018

Sr. No.	Land use pattern	User accuracy (%)	Grade	Producer accuracy (%)	Grade	Overall accuracy (%)	Grade
1	Agricultural land	88.23	Excellent	83.33	Very good	90	Excellent
2	Barren land	86.11	Excellent	88.57	Excellent		
3	Water bodies	86.96	Excellent	86.96	Excellent		
4	Forest land	89.47	Excellent	94.44	Excellent		
5	Residential area	86.96	Excellent	83.33	Very good		

In this study, LULC detection of Ratnagiri district over from the year 2013 to 2018 had analyzed. The area under agriculture, forest land, barren land, residential area and water bodies for Ratnagiri district in the year 2013 was 38.43%, 43.93%, 12.97%, 3.70% and 0.97%, respectively. Over the considered study period of five years, in 2018, the change in the area under forest and barren land was found to be decreased by 0.22% and 2.43%, respectively. At the same time area under agriculture and residence or built-up was increased by 0.81% and 1.86%, respectively. The overall accuracy of land use mapping of Ratnagiri district for the year 2013 and 2018 was found to be 90.84% and 90%, respectively. The validation of land use mapping was done using Kappa coefficient. It was observed that the grade of accuracy was excellent. The overall accuracy of land use mapping for Ratnagiri district for the year 2013 and 2018 was 90.84% and 90%, respectively.

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