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## Research Article

# LAND USE AND LAND COVER CHANGE DETECTION STUDY USING SPACE INPUT AND GIS -A CASE STUDY FOR GAJAPATI DISTRICT, ODISHA

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### ABSTRACT

Land is one of the important natural resources. A cities growth is measured not only by population but its spatial dimension. The growth of rural areas has resulted in sharp land use and land cover changes. In recent years, the significance of spatial data technologies, especially the application of remotely sensed and geographical information systems (GIS) has been widely used. The present study investigates the land use and land cover of Gajapati district, Odisha using Landsat satellite images for the year 1995, 2005& 2015. Supervised classification method is used to classify the different classes under the study area. The current study mainly focuses on built-up area in Gajapati district which reveals its expansion by more than fifty percent over the study period. A significant decrease was observed in vegetation areas, agricultural land and open fields of about thirty eight and thirteen percent respectively.

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### INTRODUCTION

Land use defines the usage of land varying from area to area. In rural areas land use mostly includes forestry and farming. In urban areas land use majors housing, commercials or industries. The type of physical and natural features present on the surface of the earth is known as land cover, e.g. Water body, forest, built-up area, etc. Land use change, including land conversion from one form to another along with land cover modification through land use management, has greatly altered a large proportion of the earth's land surface to satisfy mankind's immediate demands for natural resources. Now a days new technologies like satellite remote sensing and Geographical Information Systems (GIS) provides data to study and monitor the dynamics of natural resources for environmental management. In the present study we have used mainly two types of data. These are topographic map and remote sensing data. Rural land use land cover classification is still a challenge with medium or coarse spatial resolution remotely sensed data due to the large number of mixed pixels and spectral confusions among different land use land cover types. Generally for rural areas, higher resolution images are more appropriate as the land cover structure is complex. Prior to the pre-processing and classification of satellite imagery began, an extensive field survey was performed throughout the study area using Global Positioning System (GPS) 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 the creation of training sites. The satellite data was enhanced before classification using histogram equalization in ERDAS Imagine 9.2 to improve the image quality and to achieve better classification accuracy. In supervised classification method, spectral signatures are generated from selective locations in the image. These selective locations are given the generic name "Training sites" and are defined by the user. The training sites will help to develop spectral signatures for the outlined areas. Due to involvement of multiple data sets, we used latest technologies like remote sensing imagery, field survey, and existing study area conditions, here the study area is classified in to five categories, i.e. agriculture, built-up area, dense forest, barren land and water spread area. The study area covers 4325 sq. km and a period of 1995 to 2015 was taken for studying the land use and land cover changes.

#### Change Detection

The process of identifying differences between natural resources and human beings through observation over a period of time is called Change detection. An accurate and timely observation of changes of Earth's surface features provides the foundation for better understanding of relationships and interactions between human and natural phenomena which

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leads to better management of our resources. However, due to a shift in land use patterns and land cover changes biodiversity is greatly affected along with water and other natural processes. A detailed understanding of the impact of changes in land use/land cover pattern has become necessary for Gajapati. Therefore, present study was undertaken to analyse the extent of human induced landscape transformation in the affected areas of Gajapati district by interpreting temporal remote sensing data using geographical information system(GIS) and cover types (dense forest, agricultural land, water body and barren land) were delineated in order to achieve the above objective.

**Study Area**

The land and water area coverage of Gajapati district area of 4325 sq.km. The study area is located between 19°11'28.40"N and 84°11'8.56"E, (Fig-1). This is a district, the major part of which is hilly and with undulated topography. As per population census recorded in year 2011, the district attained a population 5, 77, 817 and the population density of the place counted 134 persons per sq. km. The district has 10.19 percent population enumerated in areas classified as urban. Due to its agriculture favourable climatic conditions, Gajapati district gains a large amount of its revenue through the agricultural sector. Agro-processing and horticulture industries contribute a major part to economic wealth of this region.

typical spectral information of the land use and land cover classes (Forest, fellow land, built up area and water body). Training pixels are carefully chosen from the lands at images once their identity is confirmed on comparison with toposheet, reference and local knowledge. After all training sites been selected, the classification was run on the image using Maximum Likelihood classifier in ERDAS Imagine 9.2 software. The overall accuracy is then calculated for each land use and land cover categories.

**RESULT AND DISCUSSION**

The land use and land cover (LULC) change detection method involves two major steps.

1. Independently classifying multi-data image.
2. Comparing individual LULC classes taking corresponding pixels in the multi date images.

Major changes were observed in built up and forest area during the period 1995 to 2015. Figure -5 represents the changing pattern of land use and land cover of Gajapati district of study period. LULC of Gajapati district has undergone significant changes during the study period. In the year 1995 built up area covered 6.87 percent of the total area, this has increased to 28.19 percent in 2005 and to 38.45 percent in 2015. Here forest lands and agricultural areas are converted to built up areas.

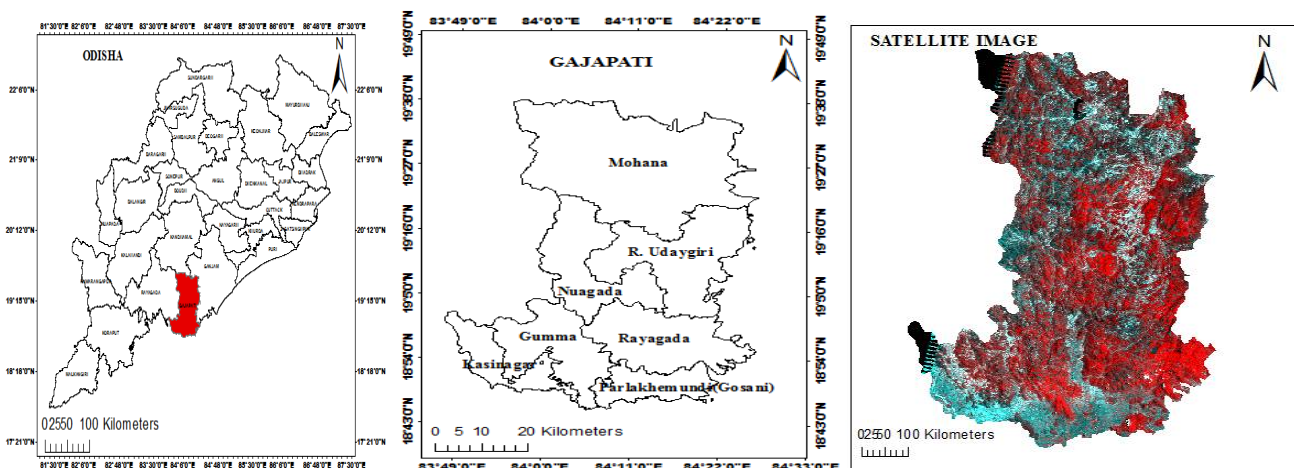


Fig 1B Location Map Depicting Satellite Image of Study Area

**MATERIALS AND METHODOLOGY**

Firstly, the ortho-rectified landsat satellite data for Gajapati district was collected as per availability from United States Geological Survey (USGS) website <http://www.earthexplorer.usgs.gov>. Satellite images used in project were acquired from the sensors Landsat TM (Thematic Mapper), ETM+ (Enhanced Thematic Mapper+) on board Landsat 7 for this study. Gajapati district falls under path row 140/47 of Landsat. A detailed portion of satellite data used in this study is specified in Table 1. Erdas Imagine 9.2 software was used for major part of project to process the satellite images. Supervised classification is the technique most often used for the quantitative analysis of remote sensing image data, so was used for mapping vegetation and land cover of the study area. In supervised classification method, selective samples of known identity are used to classify pixels of unknown identity. Training sites in the images are generated to represent the

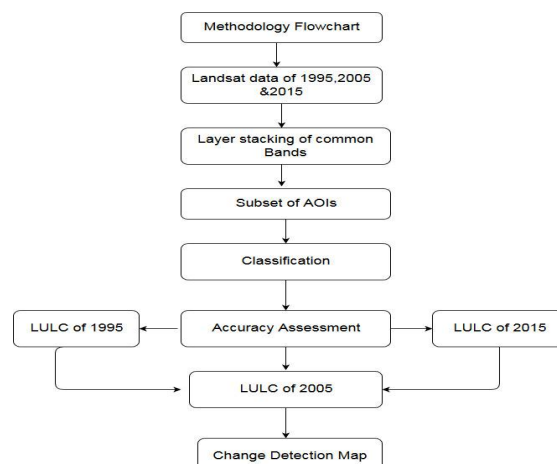


Fig 2 Methodology Flowchart

**Table 1** Satellite data used for the study

Used Data	Band	Date	Spatial Resolution
Landsat TM	7 Band	11-02-1995	240m
Landsat ETM+	7 Band+ Pan Band	13-05-2005	240m
Landsat ETM+	7 Band+ Pan Band	16-05-2015	240m

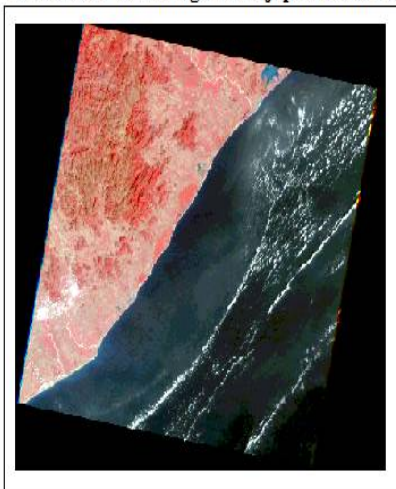
The forest covered 40.65 percent in 1995 and decrease of 26.25 percent in 2005 and 12.23 percent in 2015. The gradually decrease of forest may be the cause of increase in built up area and lake of rainfall. Water bodies covered only 1.05 percent of the study area in 1995 and increased to 3.02 percent in 2005 but decreased to 1.29 percent in 2015. This fluctuation may be due to the rainfall in the month of May, even water logged areas in the study area might have got classified under water body.

Agricultural land and open fields with 75471.2hectares (17.45%) and vegetation class, 113531.25 hectares (26.25%) occupied second and third position respectively in terms of total area coverage. Figure-5 represent the changing pattern of land use and land cover of Gajapati district of study period. LULC of Gajapati district has undergone significant changes during the study period. Built up class has gained substantial area, i.e. an increase of 28.19 percent compared to the previous period.

**Graphical representation of land use and land cover in Gajapati district**

The pie charts represent the changing pattern of land use and land cover of Gajapati District of study period. Land use land cover of Gajapati district has undergone significant changes

LANDSAT TM image of Gajapati District



Subset image of Gajapati District,1995

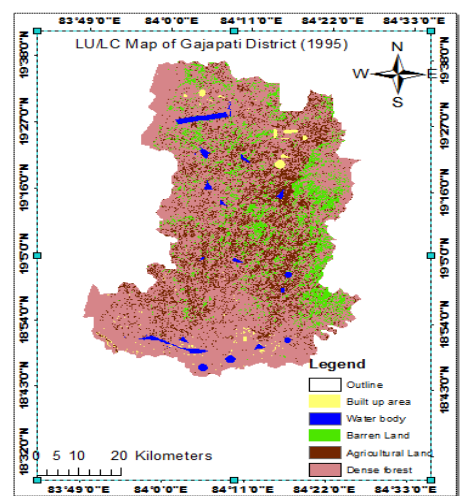
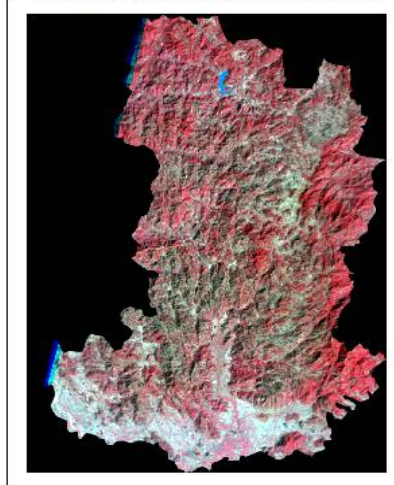
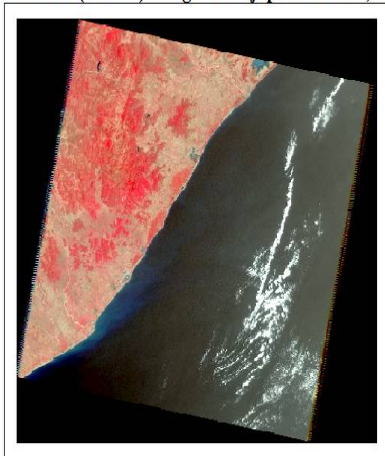


Fig 3 LULC of 1995 of Gajapati district

LANDSAT (ETM+) image of Gajapati District,2005



Subset image of Gajapati District,2005

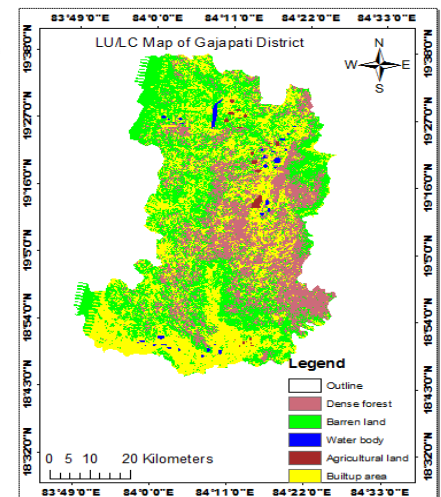
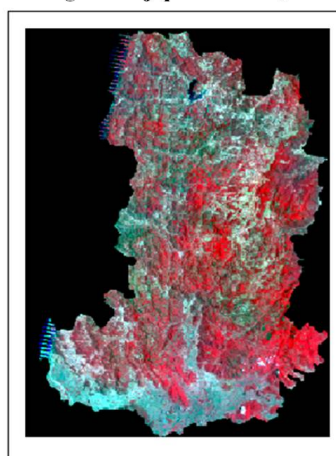


Fig 4 LULC of 2005 of Gajapati district

**Land Use and Land Cover of Gajapati District**

In 1995, vegetation class constituted the largest category with spatial coverage of 175811.25 hectares, i.e. 40.65% of the total study area. Built up area with 29712.75 hectares (6.87%) and agricultural land and open fields, 99475.01hectares (23.01%) of total area coverage. In the second time period, 2005 built-up areas constituted the largest category with spatial coverage of 151634.05hectares, i.e. 35.06% of the total study area.

The changes in land use land cover over the past decade show an accelerated growth rate urban/built-up areas with increases of more than 15% in the year 1995 & 28% in 2015, representative of the population increases for this area. Agricultural areas and barren land have shown the greatest amount of decrease in this area, with dense forest decreasing by slightly more than 20%.

**Accuracy Assessment Classification**

In this study classification accuracy assessment was conducted with the reference of the raw satellite images. In maximum likelihood classification, often many pixels remain misclassified because of the uneven distribution of data.

Classification accuracy should be done by ground trothing, or by physical appearance in the study site. But in these case time is one of the major resistant because you can't measure the past with the present.

LANDSAT (ETM+) image of Gajapati District,2015 Subset image of Gaianati District.2015

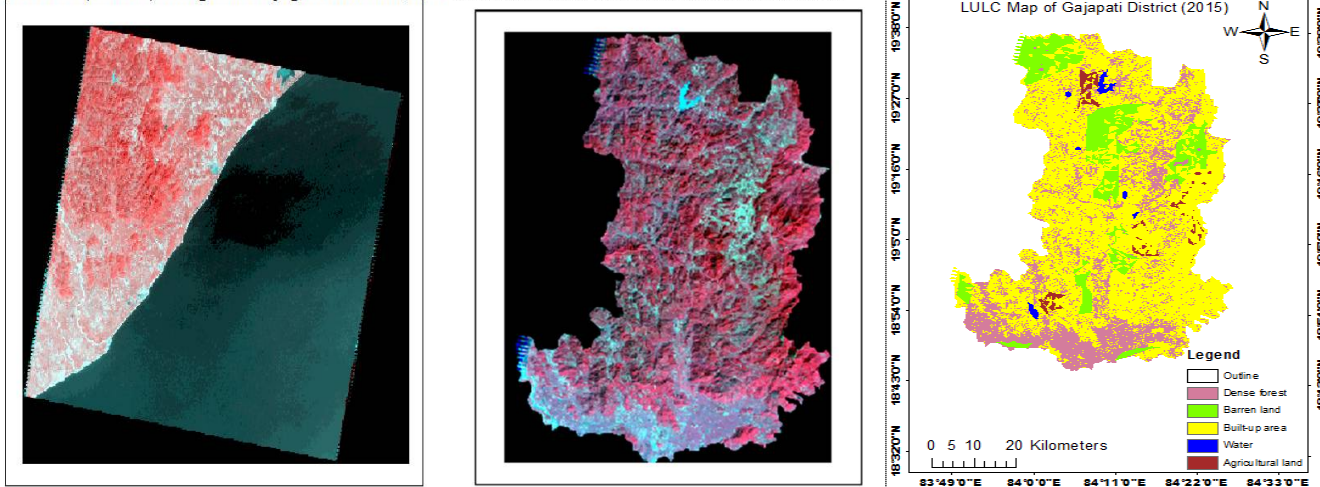


Fig 5 LULC of 2015 of Gajapati district

Table 2 Percentage change in land use /land cover of Gajapati district

Land use Categories	1995		2005		2015		Remark
	Total area	Percentage	Total area	Percentage	Total area	Percentage	
Water Body	6487.05	1.50	13061.05	3.02	5579.25	1.29	During the study period all the categories showed both positive and negative growth in area coverage, where the vegetation areas, agricultural land and open fields were converted into built up.
Dense forest	175811.25	40.65	113531.25	26.25	52894.75	12.23	
Agricultural land	99475.01	23.00	75471.24	17.45	24090.24	5.57	
Barren land	121013.05	27.98	78801.05	18.22	32048.25	7.41	
Built up area	29712.75	6.87	151634.05	35.06	317887.5	73.50	

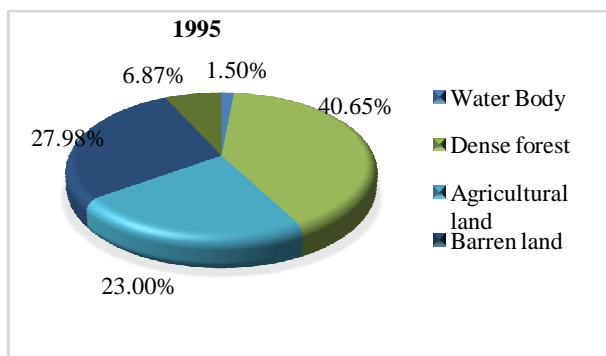


Figure 6a LULC class percentages for 1995

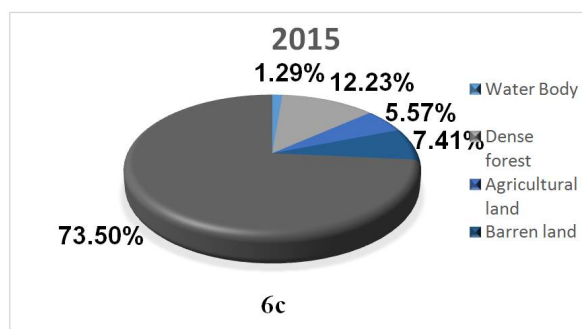
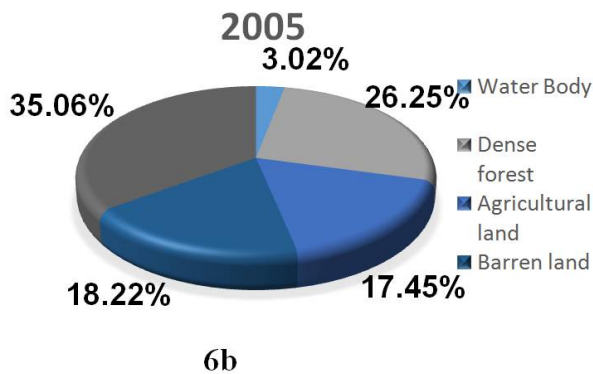
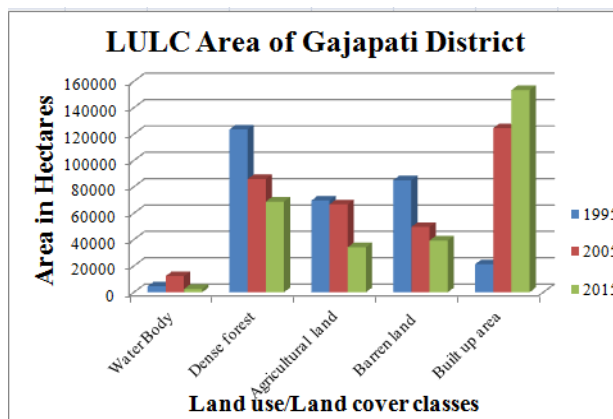


Figure 6b and c LULC class percentages for 2005 and 2015



6b



So, to acquire better accuracy of the classification both infield and outfield accuracy assessment is necessary. In this study outfield assessment was done by random sampling of the reference image. The total process was done by comparing the reference image with the classified image with some random points stratified random sampling was adopted to calculate the classification accuracy of each land cover image. The logic to use this sampling method is each land cover class found equal probability to be observed 50 random points were used for accuracy assessment of every classified image. Some observation show '0' class values, which are neglected. The data is summarized and qualified by using error matrix. Three different accuracy results- user accuracy, producer accuracy, total accuracy was produced from the overall assessment which help to understand the accuracy of the classification. The calculated assessment result of each classified satellite image from 1995 to 2005 was shown in Table-3. Calculated total accuracy result for each satellite image (1995, 2005, 2015) given as 86.25%, 95.65% and 91.43%.

**Table 3** Accuracy assessment result

CLASS	1995		2005		2015	
	Prod. Acc.	User Acc.	Prod. Acc.	User Acc.	Prod. Acc.	User Acc.
Water Body	100	78.95	95.51	100	100	100
Dense forest	62.5	100	92.31	100	98.81	99.63
Agricultural land	100	69.23	99.95	100	100	90.91
Barren land	75.15	100	100	92.41	99.37	98.23
Built up area	83.33	100	100	90.91	83.8	96.2
Overall Accuracy	86.25%		95.65%		91.43%	

## CONCLUSION

This paper focuses on LU/LC changes in a rural area, Gajapati, India using remote sensing data and GIS technology. Our results clearly show that LU/LC changes were quite visible throughout the period from 1995 to 2015. There is significant expansion of built-up area noticed. On the other hand a decrease was observed in water spread area, agricultural area and forest areas. This study clearly indicates the impact of population and its development activities on LU/LC change. This study proves that how the integration of GIS and remote sensing technologies is effective tool for urban planning and management. The quantification of LU/LC changes of Gajapati area is very useful for environmental management groups, policy makers and for public to better understand the surrounding.

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