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Land use/Land Cover and Change Detection in Chikodi Taluk, Belagavi District, Karnataka using Object based Image Classification

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Abstract: ***The study examines land use land cover and change detection in Chikodi taluk, Belagavi district, Karnataka. Land use land cover plays an important role in the study of global change. Due to fast urbanization there is variation in natural resources such as water body, agriculture, wasteland land etc. These environment problems are related to land use land cover changes. And for the sustainable development it is mandatory to know the interaction of human activities with the environment and to monitor the change detection. In present study for image classification Object Based Image Analysis (OBIA) method was adapted using multi-resolution segmentation for the year 1992, 1999 and 2019 imagery and classified into four different classes such as agriculture, built-up, wasteland and water-body. Random points (200) were generated in ArcGIS environment and converted points into KML layer in order to open in Google Earth. For the accuracy assessment confusion matrix was generated and result shows that overall accuracy of land use land cover for 2019 is 83% and Kappa coefficient is 0.74 which is acceptable. These outcomes of the result can provide critical input to decision making environmental management and planning the future.***

Keywords: Chikodi, change detection, land use land cover, segmentation and OBIA.

I. INTRODUCTION

Land is important natural resources and humans, not only live, but also perform economic activities on land. For various purposes land has been used; either it may be the provision of shelter, extraction, food production and processing materials. Water and other resources culminate in the development of land use. A sequential development of land use with time results in different land utilization patterns and trends. Land is one of the major most important resources which consist of water, soil, associated with plant and animals involving the total ecosystem. With the rapid increase in population, an activity of human on land resource also has been increasing. For the need of food, energy and many others have to depend on the conservation and development of the productivity of this natural resource.

It is also important to have the capability of monitoring the dynamics of land use resulting out of both changing demands of an increasing population and forces of nature acting to shape the landscape. Due to diverse man-made and natural processes, lands are in a continuous state of transformation. In urban research, the study of spatial-temporal patterns of intra and interurban form and understanding of the evolution of urban systems are still primary objectives. Land use land cover is often related to environmental problems; therefore, for decision-making in environmental management and future planning land use land cover data are essential input. Due to increasing socio-economic necessities with increasing population creates an enormous pressure on land use/land cover. These pressure result in uncontrolled and unplanned changes in land use/land cover [1].

In recent with the time perceptive of land use/land cover has changed from simplicity to realism and complexity. In earlier studies land use land covers were concerned with the physical aspect of change. Nowadays realizes that land surface processes influence climate because of change in land use land cover. Many researchers have improved measurements of land cover changes from the last few decades. To use land in the most favourable way, it is essential to have knowledge of existing land use land cover. And for better natural resource management it is important to keep updating the land use land cover maps [2].

The identification of change in the state of an object at different period/time is one of the processes of land use land cover [3]. To monitor and manage natural resource and urban development change detection is an important process because it provides quantitative analysis of the spatial distribution of the population of interest. For monitoring natural resources there are four important aspects of change detection firstly; identification of changes that have occurred, secondly; detection of the nature of change, thirdly; measuring the area of the changes that have occurred and the fourth is assessing the spatial pattern of the changes [4].

A conventional ground method of land use mapping is labour-intensive, time-consuming and is done infrequently. With the passage of time the maps sooner became outdated in a rapidly changing environment. The data/imagery generated with the help of remote sensing gives an efficient means of acquiring information on temporal trends and spatial

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distribution of urban areas needed for understanding modelling and projecting land changes. All the characteristics of the land surface, including artificial and natural cover, the remote sensing records it and the interpreter uses the eight elements, i.e., tone, texture, shape, size, shadow, pattern site and association to gain the information on land cover. Generation of maps with different types of sensors flown aboard different platforms at varying heights above the terrain and at different times of the day and the year does not lead to a simple classification system.

In some regions it is difficult to get the information or to visit that place, remote sensing is techniques which help us to obtain necessary information on a cost and time effective basis [5]. Like aerial photographs satellite imagery also provide more frequent data collections on a regular basis. Aerial photography is limited in respect to its extent of coverage and costs but it gives more a geometrically accurate map. Remote sensing has become an efficient technique which has proved to be of immense value for preparation of land use land cover maps and monitoring the changes a regular interval of time.

The various land use/land cover studies are carried out by the researchers using digital image processing software's like ArcGIS, Erdas, and ENVI etc. The very limited land use land cover studies are carried out using eCognition software [6] - [8]. In present study an attempt is made to understand the quantification of Land Use and Land Cover units and assessing LULC changes during 1992 to 2019 using eCognition software.

II. Study Area

Chikodi taluk is situated in the North Western part of Karnataka state. The study area is located at 16°20'0" - 16°38'0"N latitude and 74°18'0" - 74°48'0"E longitude. It has an average elevation of 683 meters and receives an average annual rainfall ~670 mm. Agro-climatologically the study area falls under "Northern transitional zone" of Karnataka state.The taluk has an area of 1263 sq. km. and is situated amidst hills and Chikodi taluk from North and West is bound by Kolhapur district of Maharashtra State, on Eastern side bound by Athani, Raibag and Gokak taluk and in Southern part Hukkeri taluk of Karnataka. The study area is predominantly underlain by basalt. The river system of the taluk consists of Krishna and its tributaries like Vedaganga, Dudhaganga and Panchaganga. Chikodi taluk boasts the presence of innumerable wind turbines that are planted on top of the hills.

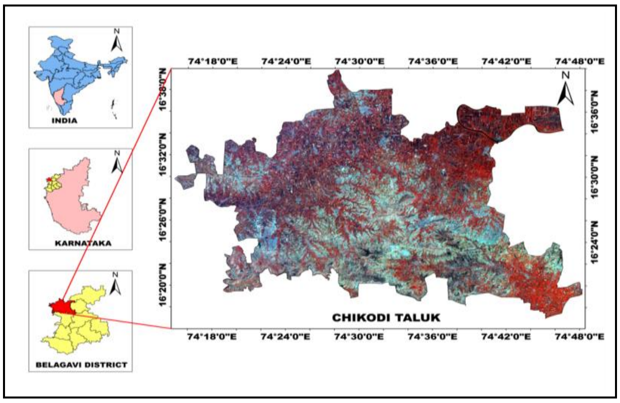

Fig. 1.Study Area

III. Data and Methodology

In ArcGIS environment SOI toposheets (E43U6, E43U7, E43U10, E43U11, E43U14 and E43U15) has geo-referenced and prepared base map of the study. Landsat-5 1992 and 1999 (TM) and Sentinel-2A 2019 have been obtained from United States Geological Survey (USGS) official website (https://earthexplorer.usgs.gov). In Erdas Imagine software, layer stacking has been done for Landsat-5 using the bands 1, 2, 3, 4, and 5 of 30m resolution and for Sentinel band 2, 3, 4 and 8 of 10m resolution. All the three images 1992, 1999 and 2019 have been uploaded in eCognition software for the preparation of land use land cover map.

A. Object Based Image Analysis (OBIA)

The methodology adapted for this study has been shown in Fig. 2. For land use/land cover classes semi-automatic Object Based Image Analysis (OBIA) method has been performed. OBIA gives the positive results with textural, structural and spectral information to make a better segmentation. Segmentation is the subdivision of image into smaller partitions. In segmentation homogenous image objects are generated [9]. For successful and accurate image analysis, defining object primitives of suitable size and shape is of utmost importance. There are different types of segmentation such as Chessboard segmentation, Quad Tree Based segmentation, Multi-resolution segmentation etc. and results varies with the type of segmentation. Chessboard is the simplest segmentation which divides the image into square object with a size predefined by the user. Quad Tree Based segmentation is similar to the chessboard segmentation but it divides the image into square of different sizes. Multi-resolution segmentation makes a group of similar pixel values into objects. And homogenous areas results in larger objects and heterogeneous area into smaller ones. First step of the analyses is to identify image objects and it has been achieved using multi-resolution segmentation in the present study. Different segmentation parameters and spectral bands tried for all the images, because quality of segmentation is decisive for outcome of subsequent classification [10].

Before the classification process, pre-processing steps has taken into consideration. Created a new project containing all the datasets required for the study and subset has done for the layer stacked image 1992, 1999 and 2019. Image 1992 and 1999, has segmented at different level-1, level-2 and level-3 with the scale 50, 10 and 5 respectively and for 2019 level-1, level-2, and level-3 with the scale 100, 50 and 10 respectively. A segmentation result of image with subset varying scale for different periods has shown in Fig. 3. With the different level realized that smaller the scale value decreases the dimensionality and dividing object into subgroup, while larger scale combines the multi-segments into one. For the present study level 3 of scale 5 for Landsat-5 1992, 1999 and scale 10 for Sentinel-2A has been selected. Image contains valuable information about land or vegetation which is not easily visible until viewed in the right way. Segmentation has been done using multi-resolution segmentation.

The shape was set to 0.02 and compactness was set to 0.98 for all the images. Shape and compactness weight-age are inter connected to each other. Higher the shape value means it has high influence on segmentation: shape must have lower value, with less influence. There will be equal amount of influence on segmentation outcome if the both parameters are equal [11]. For classification, the first task is to create the classes and to insert the nearest neighbour feature into each class. Class Hierarchy command has used in eCognition software and inserted the class and assigned the name and colour. The most fundamental of these techniques is to change the arrangement of the bands of the light used to make the image display. In order to display an image clearly image mixing layer command has been used.

Finally selected the samples for each of the four classes and merged it for final classification. All the merged results exported in ESRI shape file in order to open in ArcGIS for the further production of map.

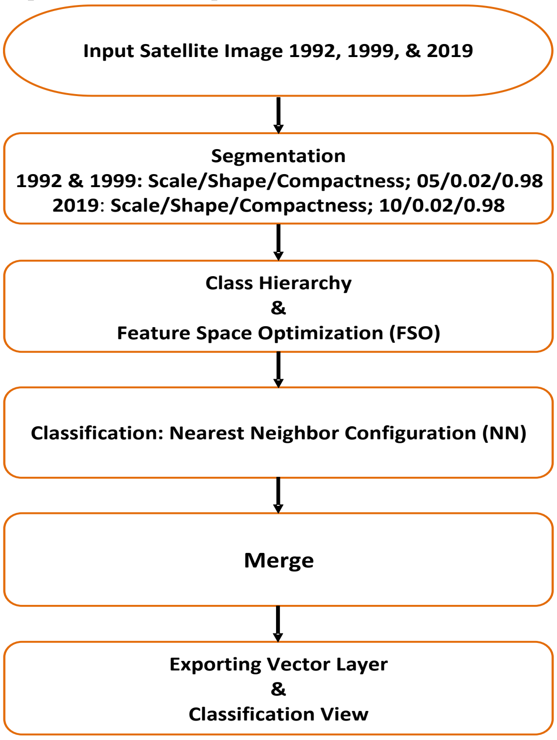

Fig. 2.Flow Chart

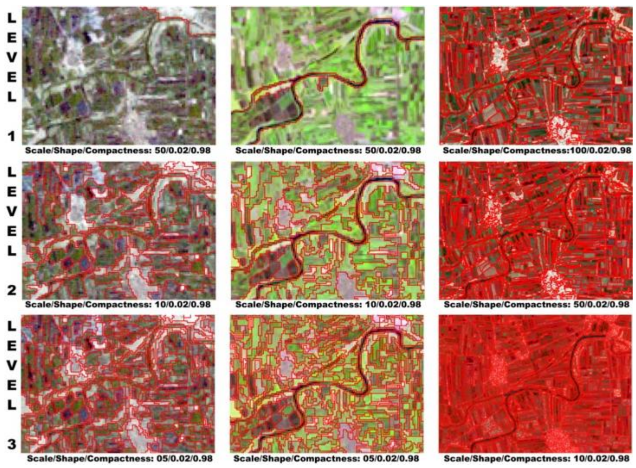

Fig. 3.Subset image of 1992,1999 and 2019 with different scale

IV. Results and Discussion

Landsat data for the period of 1992, 1999 and sentinel data of 2019 was used to analyse land use/land cover and change analysis. Object Based Image Analysis (OBIA) method was adopted for the preparation of land use land cover analysis. The land pattern was classified into four classes namely agriculture, built-up, waste land and water body.

Built-up: These are the manmade settlements which are well connected with road network for the transportation purpose. It includes urban as well as rural, in urban areas due to more population buildings, residency, industries etc will be seen more and these are well connected with street and roads. In rural areas there will be less settlements and road network due to less population.

Agriculture: It includes the cultivated and uncultivated land. Fallow lands are uncultivated land but, at present which has not been used cropping for a particular season or for a year.

Waste land: It is defined as a land which has not been used either for agriculture or built-up.

Water body: These are the surface water bodies which includes river, pond, lakes etc.

A. Land use/land cover of 1992

The land use land cover pattern of 1992 (Table I, Fig. 5), showed that majority of the area is covered with waste land (724.87 sq. km.), agriculture (523.41 sq. km.), built-up (9.43 sq. km.) and water body (5.52 sq. km.).

Table- I: Lu/Lc classes, their corresponding areas for 1992

LU/LC Categories	Area in sq. km.	Area (%)
Agriculture	523.41	41
Built-up	9.43	1
Wasteland	724.87	57
Water body	5.52	1
Total	1263	100

B. Land use/land cover of 1999

The land use land cover pattern of 1999 (Table 2, Fig. 6) showed that majority of the area is covered with agriculture (787 sq. km.), built-up (22.63 sq. km.), waste land (446.46 sq. km.) and water body (6.83 sq. km.)

Table- II: Lu/Lc classes, their corresponding areas for 1999

LU/LC Categories	Area in sq. km.	Area (%)
Agriculture	787	62
Built-up	22.63	2
Wasteland	446.46	35
Water body	6.83	1
Total	1263	100

C. Land use land cover of 2019

The land use land cover pattern of 2019 (Table III, Fig. 7) showed that majority of the area is covered with agriculture (721 sq.km.), built-up (42.81 sq.km.), waste land (493.55 sq.km.) and water body (5.49 sq.km.).

Table- III: Lu/Lc classes, their corresponding areas for 2019

LU/LC Categories	Area in sq. km.	Area (%)
Agriculture	721	57
Built-up	42.81	3
Wasteland	493.55	39
Water body	5.49	1
Total	1263	100

D. Change Detection

In present study land use land cover changes has been occurred from 1992 to 2019 (Table IV and Fig. 4). Built-up area has increased 9.43 sq. km. to 42.81 sq. km. during the period 1992-2019. Water body is almost similar i.e., 5.52 sq. km. and 5.49 sq. km. in 1992 and 2019 respectively. In agriculture and wasteland major variation has been seen during the period 1992-2019.

Table- IV: Change Detection from 1992-2019

LU/LC Categories	1992 Area (Sq.km.)	1999 Area (Sq.km.)	2019 Area (Sq.km.)	1999-1992 Area (Sq.km.)	2019-1999 Area (Sq.km.)	2019-1992 Area (Sq.km.)
Agriculture	523.18	787	721	263.82	-66	197.82
Built-up	9.43	22.63	42.81	13.2	20.18	33.38
Wasteland	724.87	446.54	493.70	-278.33	47.16	-231.17
Water body	5.52	6.83	5.49	1.31	-1.43	-0.03
Total	1263	1263	1263			

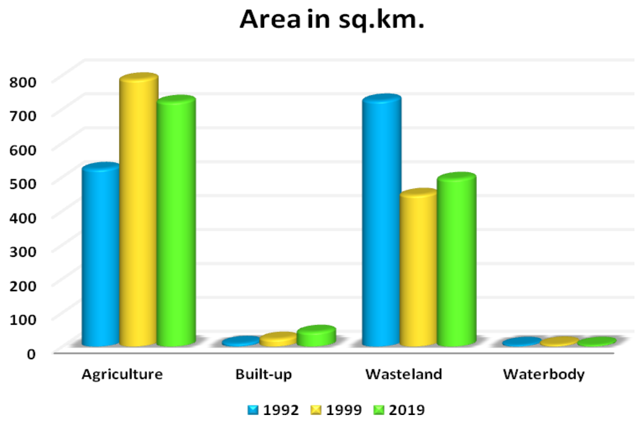

Fig. 4. Graphical representation of change detection

E. Accuracy Assessment

For accuracy assessment 2019 recent image has been taken into consideration because of availability of high resolution of Sentinel-2A and Google image. And for the year 1992 and 1999 availability of Google image resolution is very low. Random points (200 points) were created for the image 2019 in ArcGIS environment and extracted the values to point. In order to open the points in Google Earth, the random points were converted into KML layer. Google Earth is a high spatial resolution and also a free for the public domain [12]. A confusion matrix was estimated (Table V) and calculated the overall accuracy and Kappa coefficient. In general Kappa coefficient value ranges between -1 to 1 where 1 is considered as good classification and -1 considered as poor classification [13].

F. Discussion

Land use analysis was carried out at different time scales to determine land use/ land cover pattern and the causes of transition in the land cover of the area. The areal coverage of water bodies is nearly same during 1992 to 2019. The slight variation is observed during 1999, it may be due to the water storage in tanks. It is also dependable on the amount of rainfall received during the study period.

The analysis showed a decrease of wastelands from 724.87 sq. km. to 446.54 sq. km. during 1992 to 1999 and at the same time interval increase of agricultural land from 523.18 sq. km. to 787 sq. km. has been noticed. The gradual increase of areal extent of built up land 9.43 sq. km. to 42. 81 sq. km. has observed during study period. Due to impact of population growth, waste land reclamation activities and advance agricultural practices observed variation in wasteland area. With unchecked population growth and economic development in the study area, infrastructural land has expanded and encroached upon agricultural land in the last few years. For the urbanization usually the Agricultural land losses at a high rate. The decrease in the agriculture land is observed in the Chikodi taluk during 1999 to 2019. The decrease of agricultural land in any area it impacts on food production. The agricultural land showed a decrease in their areal extent from 787 sq. Km. (1999) to 721 sq. km. (2019).

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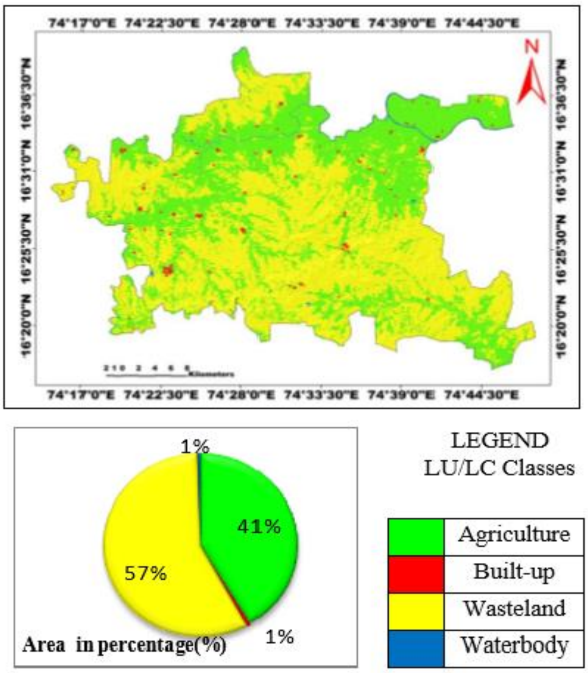

Fig. 5. Land use/Land cover of 1992

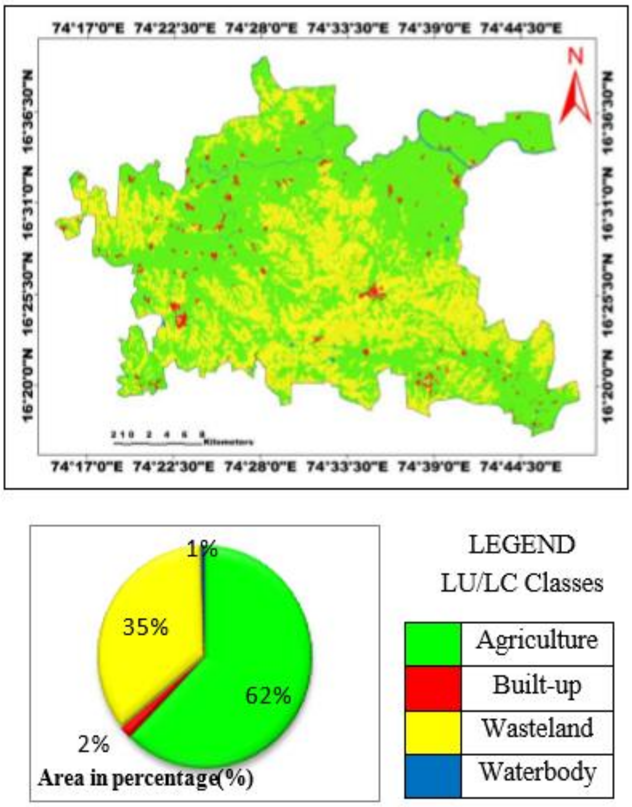

Fig. 6. Land use/Land cover of 1999

Infrastructural growth is a causes closely related to population growth. For the extra population it's need extra infrastructure [14]. The infrastructural growth includes the increase of settlements, roads, educational institutes, government offices and industries are observed in study area during last few decades. The unscientific growth of city creates lots of problems in future. Therefore, there is need of sustainable land/use land cover planning and development to reduce the undesired impacts on environment.

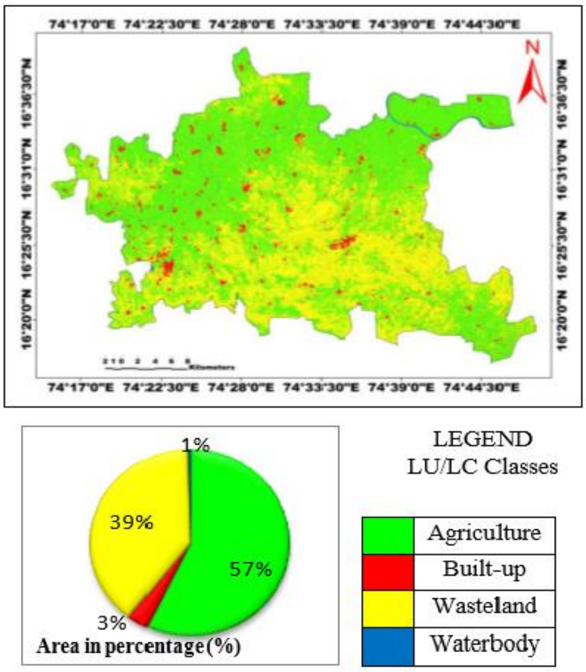

Fig. 7. Land use/Land cover of 2019

Table: V Confusion matrix: 2019

LU/LC Categories	Agriculture	Built-up	Waste land	Water body	Total
Agriculture	96	3	10	0	109
Built-up	2	10	0	0	12
Wasteland	11	2	56	0	69
Waterbody	1	0	0	9	10
Total	110	15	66	9	200
Overall Accuracy = 85.5%					
Kappa Coefficient = 0.74					

V. CONCLUSION

Land use land cover and change detection has been achieved in the present study using integrated remote sensing and GIS approach. The land use/land cover change analysis of Chikodi taluk revealed an increase in the built up land during 1992 to 2019 and decrease of agricultural land is noticed from 1999 to 2019. Accuracy assessment has performed and result shows that total (overall) accuracy is 85.5% and Kappa is 0.74 which is acceptable in both total accuracy and kappa accuracy. Based on the results it shows that object based analysis method is more effective in terms of classification accuracy. In order to reduce the negative impacts on environment in future, scientific land use/cover planning and integrated land management is required in the study area.

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