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Analysis of Land Use/Land Cover Changes Using Remote Sensing and GIS Techniques in Parbhani City, Maharashtra, India

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Abstract Land use and land cover is an important factor in understanding the relations of human activities with the environment and thus is necessary to be able to simulate change. The focus of this paper is to map and study the land use and land cover pattern and change among 2002 and 2013 satellite imagery. It also produces a land use land cover maps of Parbhani city in Maharashtra at two epochs in order to detect the changes that take place in the diverse natural resources. After analysis of the image, supervised maximum likelihood algorithm was used to classify the imagery into different land use categories. Five land use classes have been recognized as vegetation, fallow land, barren land, residential area, and water body. The classification of image shows major change in residential areas. The change detection analysis shows that residential area in 2002 is 7.34 % and 14.25 % in 2013, it has been enlarged by 7.11 % similarly change detection for remaining areas has been done. The information on urban growth, land use land cover change study is extremely useful to local government and urban planners for the betterment for future plans of sustainable progress of the city.
Keywords *GIS; LULC; LISS-III; LISS-IV; NRSC; Remote Sensing*

1. Introduction

The land use/land cover of a region is a conclusion of natural and socio-economic factors and their consumption by man in time and space [1].The term "land use" and "land cover" are often used simultaneously to depict maps that afford information about the types of features existing on the Earth's surface. Land cover refers to the physical individuality of Earth's surface, which is captured by vegetation, soil, water bodies and other physical features of the land. Land use refers to the way in which land has been used by humans and their habitat, usually for economic activities [2]. Land cover is an important input constraint for a number of agricultural, ecological models, which compose necessary tools for enlargement planning and management of natural resources in the area.To use land optimally, it is necessary to have information not only on existing land use/ land cover but also the capability to monitor the dynamics of land use resulting out of changing demands. If the area is small then land cover is based on ground surveillance and survey. However, if the area is large, then such

method are found to be less realistic [3]. In earlier study toposheet, censuses, demographic data may be used for reference but are not sufficient for the analysis of multi-complex environmental study. To handle multidisciplinary data set, we require new technologies like Satellite remote sensing and geographical information system [4].

Remote sensing has become an important tool appropriate to rising and understanding the global, physical processes affecting the Earth. Use of satellite data is to take advantage of increasing amounts of geographical data available in combination with GIS to aid in an interpretation. Digital change detection technique based on multi-temporal and multispectral remotely sensed data have been used to understand landscape dynamics to detect, identify, map and monitor difference in land use land cover pattern over time [5]. The basic principle in using satellite images for change detection is that changes in land cover result in changes in radiance values that can be remotely sensed. A wide variety of digital change detection techniques have been developed over the last two decades. These include mono-temporal, post classification comparison or change delineation, image differencing, image ratioing, change vector analysis, image regression, multi-temporal biomass index and back ground subtraction, digitization etc. Along all these methods, the post classification method is most widely used for change detection. This approach classifies and labels two images from different periods [2002 and 2013]. Such monitoring technique is based on multi-temporal satellite data. The area of change is considered through direct comparison of the classification results. The accuracy of the investigation depends upon accuracy of the classification of individual images [6] [7] [8].

The main objective of this paper is to notice and analyze the land use / land cover of Parbhani city between 2002 and 2013 using satellite imagery. The study also views the implementation of image processing and statistical techniques for the analysis of LULC in view of change detection changes that have taken place in LULC of study area. The paper uses remote sensing and geographic information system approach for the recognition, measurement and analysis of LULC changes in the study area.

2. Study Area

The selected study area was Parbhani city in Marathwada region of Maharashtra State of India shown in Figure 1. It is located between latitude 19.30'N and 19.50'N and longitude 76.45'E and 76.75'E. Parbhani district occupies an area about 6,511.58 km2 and has population 1,835,982 in 2011 and 1,527,715 in 2001.The Population growth rate over the decades 2001-2011 was 20.18% [09].

Figure 1: *Parbhani District: A Study Area*

3. Methodology

To recognize the change detection between LISS III image of December 2002 and LISS IV Image of December 2013. The data have been collected from the National Remote Sensing Centre (NRSC) Hyderabad. Figure 2 shows a detailed Methodology. LISS III Image has the Spatial Resolution of 23.5 m and LISS IV image having 5.8 m Spatial Resolution. The selection of the images was constrained to similar season to avoid seasonal differences. Multispectral and multi-temporal images were chosen because they enclosed the period of intended study and their resolutions are suitable for classification of images. The land cover maps are executes only for these images.

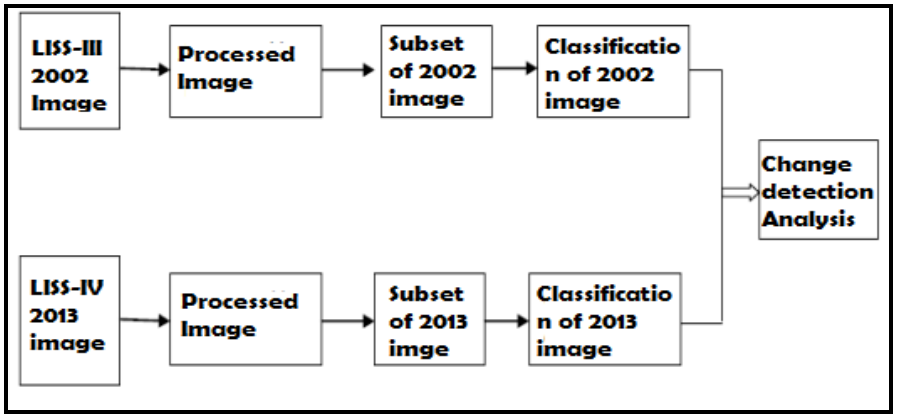

Figure 2:*Experimental Workflow for Change Detection Analysis of Study Area*

3.1. Pre-Processing of Images

In the analysis of imagery, the image pre-processing was carried out. Each pre-processing of an image consists of restoration and rectification of an image. The downloaded image LISS-IV Dec. 2013 contains image stacking, scenes mosaicking, and subsetting of the image and was done to get essential study area. The base layer so formed is used to subset of images. To position ground features of an image, image enhancement and extraction was used. Similarly LISS-III DEC. 2002 imagery contains four bands. To get composite image, image stacking is made in ENVI software.

3.1.1.*Sub Setting and Mosaicking*

Many times we do not interpret whole area of satellite image; we only interpret certain areas of the satellite image. In these cases the part we are interested in should be cut from the whole image to reduce the speed and size of an image and improve the reliability of the calculations. This cutting of an image has many names depending on the software: cut, clip (ArcGIS), extract (ArcGIS), subset (ERDAS), etc. Subset is the term used by ERDAS Imagine, satellite-image interpreting software. Sub-setting can be done in most software programs by giving coordinates, i.e. in the case of a square sub-settable part, the coordinates of two opposite corners or by drawing a polygon over the area of the image you are interested in and using that for sub-setting.

Images in the same co-ordinate system can be drawn correctly positioned to each other based on their coordinates by most GIS software's. Images of adjacent areas will appear next to each other and can be saved as one large image. This is the process of mosaicking. Mosaicking does not only mean putting the images next to each other. Mosaicking is one of the techniques of image processing which is helpful for tiling digital images. Mosaicking is blending together of several randomly balanced image so that the boundaries between original images are not seen. Any number of geo-coded images can be blended together along use specified cut lines (polygons). Mosaicking is special case of geometric correction where registration takes place in the existing image [10].

3.1.2. *Layer Stacking*

Several types of measurement may be made from the ground area enclosed by a single pixel. Each type of measurement forms an image which carries some specific information about the area. By "stacking" these images from the same area together, a multilayer image is formed. Each component image is a layer in the multilayer image. Stacking is a process of combining in layers the bands required for various types of studies into a single output file [11].

3.2. Land Cover Image Classification

Image classification is the process of assigning pixels of continuous raster image to pre-defined land cover classes. The land cover classes generated were Residential Area, Fallow land, Water bodies, Vegetation. The classification gives the land use / land cover image of the area. Table 1 show the nomenclature used for the land covers.

Table 1: *Land Covers Nomenclature*

Sr No.	LULC Classes	Colors Assign to Classes
1.	Water Bodies	Blue
2.	Vegetation	Green
3.	Barren Land	Yellow
4.	Fallow land	Red
5.	Residential	Magenta

The result of Classification affected by the values of input images, classification methods, algorithm etc. To increase classification accuracy selection of appropriate classification method is necessary. Image classification is performing to recognize and allocate real world thematic classes to the image pixels. In this study image classification was done by performing supervised maximum likelihood classification method and classified image is shown in Figure 3. The maximum likelihood classification algorithm was chosen because it has the capability to incorporate the statistics of the training samples before conveying the land covers to each pixel. The training data given by the user tells the software, that what types of pixels are to be selected for certain land cover type.

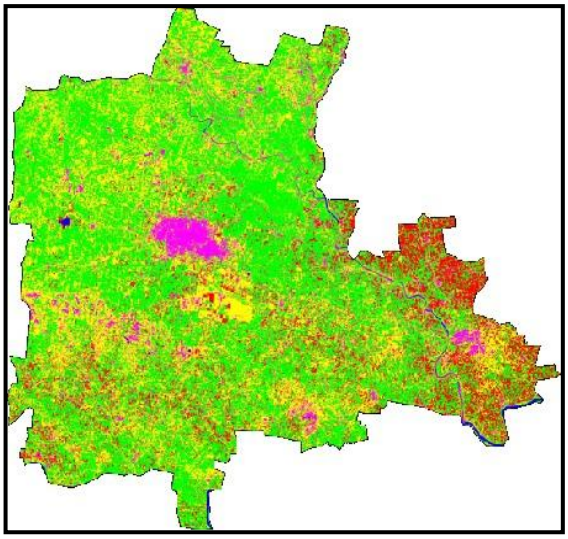

Figure 3: *LISS-III 2002 Image Classification*

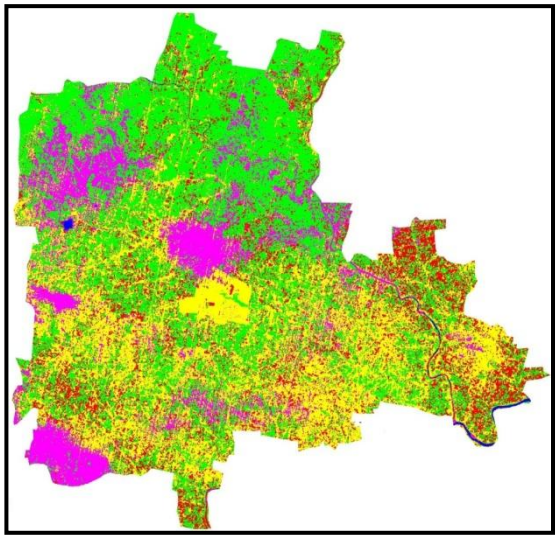

Figure 4: *LISS-IV 2013 Image Classification*

3.3. Change Detection Analysis

Change detection analysis describes and quantifies difference among imagery of the same scene at different epoch. The process of change detection depends on the phenomenon or scene at different times. The change detection process adopted for this study is the post feature under investigation. This is because the method is simple to implement and it provide thorough “from to” statistics suitable for decision making. The method was executed by using the two land cover maps generated for 2002 and 2013. The outcome was a land cover change map from 2002 and 2013. Table 2 shows the statistical analysis of change detection of both the imagery.

Table 2:*Land Covers Statistics Using Maximum Likelihood Classification*

Class Name	2002 Area in %	2013 Area in %	Change Area In %
Water Body	0.34	0.24	-0.10
Vegetation	46.94	39.26	-7.68
Barren Land	34.91	31.82	-3.09
Fallow_Land	10.47	14.23	3.76
Residential	7.34	14.45	7.11

Percentage of each class was calculated separately for each class of both the images. The statistical calculation of the classes is as follows:

Area in Percentage = Category *100 / (Sum of area of all number of points) where category assign each individual class of the image

The Table 2 shows positive and negative changes. The positive changes showed that there is increase in particular area and negative changes showed that there are decreased in particular area.

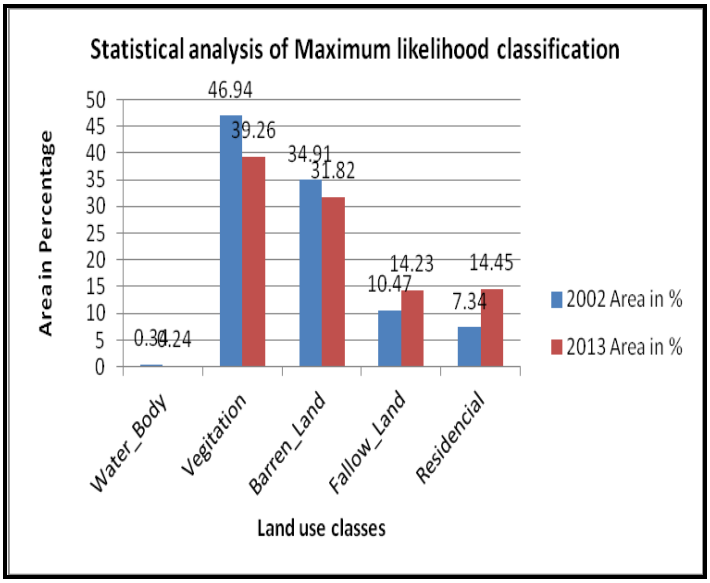

Figure 5:*Statistical Analysis of Maximum Likelihood Classification*

4. Resultsand Discussion

Land use and land cover of the study area have be analyzed for the time periods of 2002 and 2013. The results are presented in the form of maps, charts and statistical tables. The result of the land use/land cover change was analyzed using post classification approach which is based on a supervised maximum likelihood classification method. Statistical means prove that there were positive as well as negative changes in LULC classification. The post classification map indicates the city originally evolved in oval shape from the centre. An estimation area of each classified LULC type or surface was complete on the basis of the number of accessible pixels. The statistical analysis shows that water body is decrease by -0.10 %. Water body includes lakes, reservoirs, ponds, rivers and streams. Water body area in 2002 is 0.34 % and in 2013 it is 0.20 %. The area was decreased due to less rain fall and alteration of water spread area into built up area or human development area. Vegetation area was also decreased by -7.68 % during the study period. As shown in table 2 residential area was increased by 7.11 %. Such urban expansion was takes place due to expenses of barren land and vegetation. There are several factors that include directly and indirectly caused substantial changes to Parbhani LULC such as population increase is a major one. Colonization for employment and better living opportunities is another factor that has contributed in increasing urban growth. The study area is surrounded by number of small villages so that to get better educational facility many rural peoples migrate in the city place.

5. Conclusion

The current study aims to investigate land use/land cover change that occurred in Parbhani city during 2002 and 2013 using remote sensing and GIS. The study of land use and land cover classification establish the fact that the accurate land use data can be obtained from the satellite imagery more resourcefully and precisely than traditional methods. By using image processing techniques, the different land use classes are analyzed and mapped easily. The land use category compares with 2002 and 2013; it shows that there is expansion in residential area (7.11%). The increase in the area under residential land may lead to a lot of environmental and ecological problem. Water body and vegetation area were decreased due to less rain fall. The land use and land cover changes are important elements of the larger problem of global and regional environmental changes. Land use and land cover data is essential for planners, decision makers and those concerned with land resource management. Monitoring and analyzing of urban environment formulate use of up-to-date land use and land cover information for capable and sustainable management of urban areas. Change detection techniques with temporal remote sensing data provide complete information to detect and assess land use dynamics.

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