International Journal of Remote Sensing & Geoscience (IJRSG)
www.ijrsg.com

CHANGE DETECTION MAPPING: USING REMOTE SENSING AND GIS TECHNOLOGY – A CASE STUDY OF ACHANAKMAR-AMARKANTAK BIOSPHERE RESERVE, CENTRAL INDIA

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Abstract

The present study aims to find out the land use/land cover change detection between the year 2005 and 2010 in Achanakmar-Amarkantak Biosphere Reserve. The study has made use of Landsat TM satellite imageries for the years 2005 and 2010 to identify the land use/land cover categories in Achanakmar-Amarkantak Biosphere Reserve. ERDAS image processing and ArcGIS software were used to demarcate the land use/land cover divisions in Achanakmar-Amarkantak Biosphere Reserve. Remote Sensing and GIS provide consistent and accurate base line information than many of the conventional surveys employed for such tasks. The land use and land cover analysis has been attempted based on thematic features of the area consisting of forest, agriculture land, water bodies, built-up land, and waste land.

The land use and land cover map clearly shows that area of Forest land is higher than others. Many change detection techniques have been developed. This paper summarizes and reviews these techniques. This paper is a comprehensive exploration of all the major change detection approaches implemented as found in the literature.

Keywords

Change detection, Satellite imagery, Land use, Land cover, Forest, Biosphere reserve, unsupervised classification technique. Remote sensing and GIS.

Introduction

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh 1989). Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental change. The rapid development of the concept of vegetation mapping has lead to increased studies of land use and land cover change worldwide. Although the terms 'Land Use' and 'Land Cover' are often used interchangeably, their actual meanings are quite distinct. 'Land Use' refers to human activities that take place on the earth's surface. (How the land is being used; such as residential housing or agricultural cropping.) 'Land Cover' refers to the natural or manmade physical properties of the land surface.

To prepare a land use map using satellite data, image classification is a powerful method of informationextraction (Karteris,1990).Successful use of satellite remote sensing for land use/land cover change detection depends upon an adequate understanding of landscape features, imaging systems and information extraction methodology employed with relevant to the aim of analysis. The information may be obtained by visiting sites on the ground and / or extracting it from remotely sensed data. Change detected from different temporal images usually reflects natural and human activity impacts. Many studies have demonstrated the effectiveness of using remotely sensed data as a powerful tool to detect land use change for critical environmental areas, vegetation dynamics and urban expansion. Remote sensing makes a major technological breakthrough in the method of acquiring information on land resources, agriculture, forestry, ocean resources and other studies (Rao, 1991).

Study area

The Achanakmar Amarkantak biosphere reserve lies between lat. 22 ^{o} 15' to 22 ^{o} 58' N and long. 81 ^{o} 25' to 82 ^{o} 5' E , having an area 3835.51 sq. km., partly falling in Madhya Pradesh and partly in Chhattisgarh state . The area falls in almost northern part of Biogeographic zone of 6 and Biogeographic province 6a (Deccan peninsula, central highlands). Out of the total area, 68.10 % lies in Bilaspur district followed by Anuppur (16.20 %) and Dindori (15.70 %). The protected area, Achanakmar Sanctuary is located in Bilaspur district, within the area of the Biosphere Reserve. The sanctuary has a total geographical area of 551.15 sq. km.

Presently the Achanakmar-Amarkantak biosphere reserve has been divided into core and buffer zones area only. The entire area of 551.15 sq. km of Achanakmar sanctuary has been designated as core zone and remaining area of 3284.36 sq. km serves as buffer zone. Out of this an area of 1224.98 sq. km. falls in Madhya Pradesh and the rest of the area of 2059.38 sq. km. fall in Chhattisgarh state. Fig -1shown the details of the study area.

Material Used

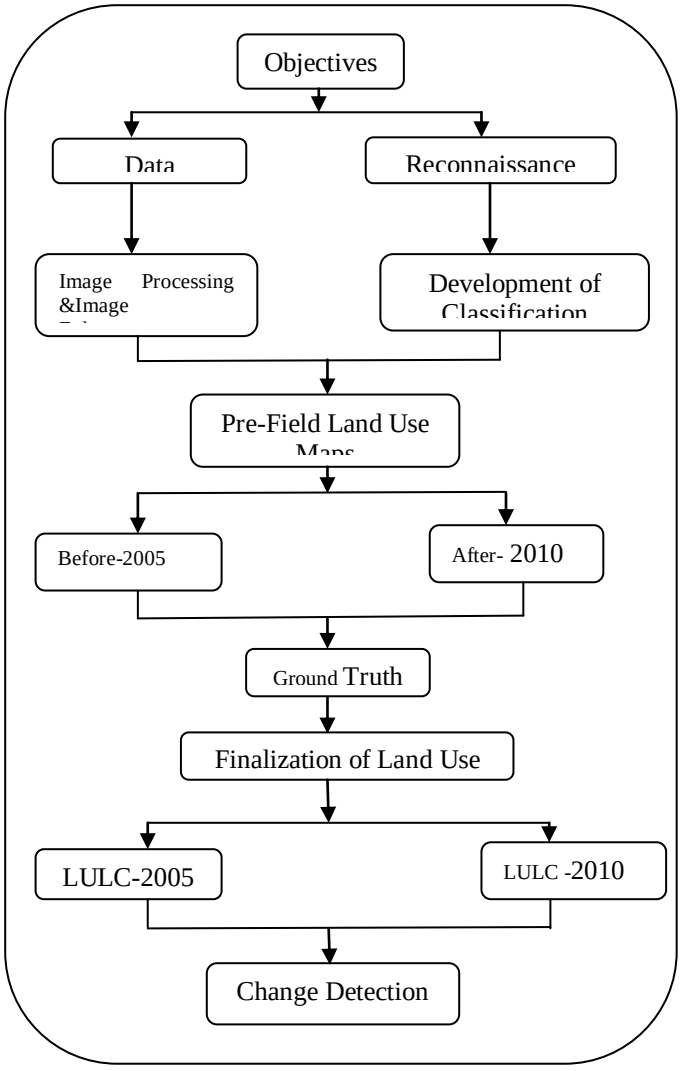
The study has made use of various primary and secondary data. These include Survey of India (SOI) topographic sheets

(64- F5,6,7,9,10,11,1314,15;64- J1,andJ3) of 1:50,000 scale; and satellite images Landsat TM(for the year 2005) and Landsat TM (geocoded data (for the year 2010). These (Landsat) data were visually and digitally interpreted by using the ERDAS (for classifying the image) and ArcGIS software (for processing, analysis and integration of spatial data) to reach the objectives of the study. Adequate field checks were made before finalization of the thematic maps. The main goal of this study is to extract land use/land cover changes using multi- temporal satellite data.

Methodology

As follows, there are general change detection processes between multi-temporal observations.

1. Make sure the content of change detection
2. Select data
3. Preprocess data/ unsupervised classification
4. Extract the temporal features of detected objects
5. Change detection
6. Evaluate accuracy



Flow chart shown the methodology of Change detection

Field Survey

In the present investigation stratified random sampling has been done. Satellite data has been classified through visual interpretation as per the classification scheme based on the reconnaissance survey and land cover/ land use classes in the area. Sampling was done on homogeneous units. Samples plots were laid along the gradient and reference to North direction has been provided. For structural analysis normally 32.5 x 32.5 m plots are laid for woody vegetation and 5 x 5 m for shrubs and 1x1 m for grasslands and same has been followed here. As far as possible representative sites were selected for this purpose and marked on SOI maps. Fig-2 showed the details of plots.

Result and Discussion

The land use/land cover categories of the study area were mapped using Landsat TM data year 2005 and 2010 (FCC of bands 2, 3 and 4) of 1:50,000 scale. The satellite data was visually interpreted and after making thorough field check, the map was finalized. The various land use/land cover classes interpreted in the study area include, forest (dense, moderate and open forest), agricultural land (crop land, open land and agricultural plantation) built-up land, waste lands, (land with scrub, land without scrub and barren rocky areas) and water bodies.

From the current study it is evident that there is considerable increase in the forest cover (dense, moderate and open forest) for the period of 2005 to 2010. Built-up land, waste lands, and water bodies class is showing an decreasing trend and thereby resulting to the inference that the population decrease pressure is playing a very active role towards increasing forest cover. This is very much evident from the Table1& 2 and Figure 3,4 and figure5 depicting the overall trend in the land use / land covers change for the period 2005 – 2010 years.

Accuracy Assessment

The classification accuracy is most important aspect to assess the reliability of maps, especially when comparing different classification techniques. During this study the accuracy assessment method were used. Accuracy assessment, automatic random point to be selected by software. This method shows above 90% or more than accuracy of map.

Conclusion

Current common methods of change detection are discussed, particularly analysis and comparison of image change detection after classification. This paper proceed form the principles of them, achieving them with ERDAS software, analyzing their results and comparing their advantages and disadvantages. Remote sensing and GIS together can

supply timely and accurate information needed for forest planning and management. Remotely sensed data provide striking spatial detail about the earth surface, which serve as a better data source for environmental change studies such as forest land cover transition. This research shows that visual elements in image interpretation can be used for forest/ non-forest change detection very effectively.

It has been found that vast changes occurred due to migration of the people to cities due to endangered species and forest. This has resulted in the formation of huge forest areas and surrounding endangered species. The rate of growth of forest density in Achanakmar-Amarkantak Biosphere Reserve (AABR) is also increasing and is much higher as compared to that of total density of the forest. Therefore it can be observed that the impact of forest mapping in AABR has increased during the last five years of change detection mapping , and this impact and pace of forest mapping is increasing year by year.

Acknowledgement

The authors are thankful to Remote Sensing and GIS lab, MGCGV Chitrakoot for providing the lab facility and encouragement for the present study.

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Table: 1 Land use / Land Cover Classification (2005-2010)

Land Use /Land Cover Class	Year-2005		Year-2010	
	Area(Km^2)	Area %	Area(km^2)	Area %
A- Forest				
Dense Forest	59.65	1.69	78.42	2.04
Moderate Forest	1872.15	48.81	2085.27	54.37
Open Forest/Shrubs	199.87	5.21	274.09	7.15
B-Non-Forest				
Water bodies	59.76	1.56	45.64	1.19
Wasteland	53.79	1.40	25.96	0.68
Agriculture/ Open land	1578.89	41.17	1316.19	34.32
Built-up Land	11.39	0.30	9.94	0.26
Total	3835.51	100	3835.51	100

Table 2: Area under Different Land Use/Land Cover Categories Changes 2005-2010

Land Use /Land Cover Class	Year-2005	Year-2010	Changes Area	
	Area%	Area%	Area%	Area(km^2)
A- Forest				
Dense Forest	1.69	2.04	0.35	18.77
Moderate Forest	48.81	54.37	5.56	213.12
Open Forest/ Shrubs	5.21	7.15	1.94	74.22
B-Non-Forest				
Water bodies	1.56	1.19	-0.37	-14.12
Wasteland	1.40	0.68	-0.72	-27.83
Agriculture/ Open land	41.17	34.32	-6.85	-262.7
Built-up Land	0.30	0.26	-0.04	-1.45
Total	100	100	-	-

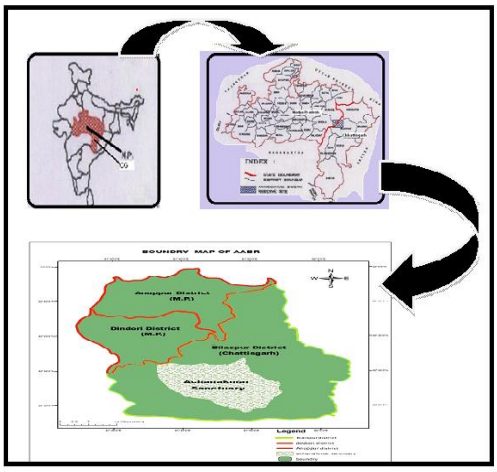

Figure 1: Location Map

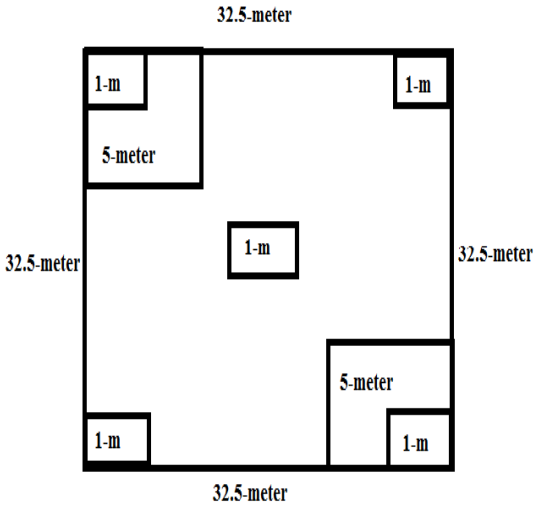

Figure 2: Sample of laying Plots

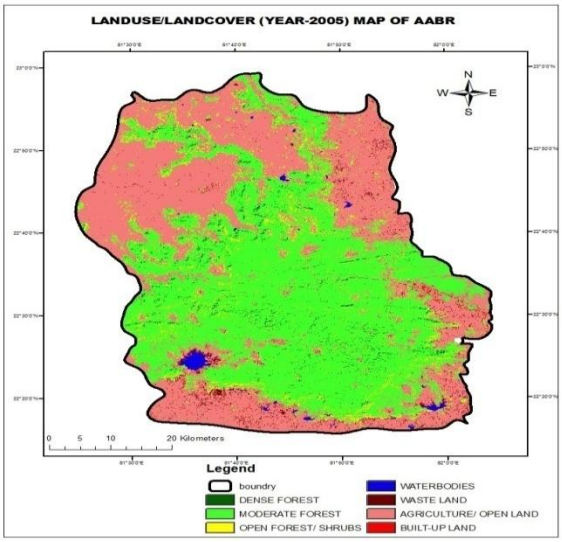

Figure3:Year 2005 Map(Before Data)

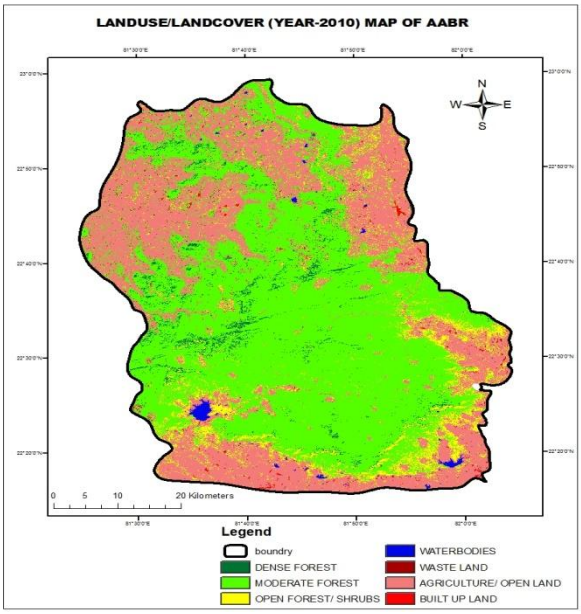

Figure 4: Year 2010 Map(After Data)

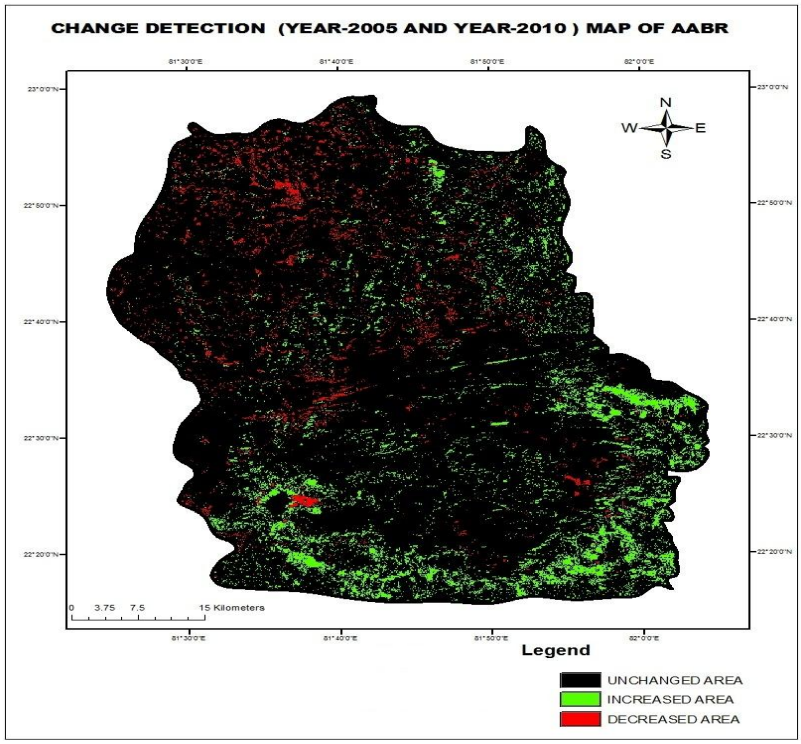

Figure 5: Change Detection Map of AABR