STUDIES ON LAND USE/LAND COVER AND CHANGE DETECTION OF G.MADUGULA TRIBAL MANDAL OF VISAKHAPATNAM DISTRICT, ANDHRA PRADESH, INDIA – USING REMOTE SENSING AND GIS TECHNIQUES.

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ABSTRACT

Land use/ land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to monitor and detect the changes to maintain a sustainable environment. In this paper an attempt has been made to study the changes in land use and land cover patterns in Gangaraju Madugula (G.Madugula) mandal of Visakhapatnam district, Andhra Pradesh, India. The study was carried out through Remote Sensing and GIS approach using SOI toposheets, IRS-1D-LISS-III imagery of 2002, IRS-P6-LISS-IV imagery of 2012 and with limited field checks. Digital change detection is the process that helps in determining the changes associated with land use and land cover properties with references to multi temporal remote sensing data.

The present study has brought out that the barren lands have been decreased from 35.85% to 33.87% with a net decrease of 1.97% and dry land was decreased from 23.91% to 23.26% with a net decrease of 0.65% during 2002-2012. However, forest, plantations and settlements have shown considerable increase. The areas under natural tanks have shown less change and can be considered as a negative sign for sustainable development. Though there are some changes detected in land use/land cover analysis of the period 2002-2012, it does not indicate any significant environmental impact on the study area. However, it is necessary to closely monitor the land use/land cover changes for maintaining a sustainable development.

Key Words: Land Use/ Land Cover, Remote Sensing, GIS, GPS and Sustainable Development.

I INTRODUCTION

Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). Land use/land cover (LULC) changes are major issues of global environmental change. The satellite remote sensing data with their repetitive nature have proved to be quite useful in mapping land use/land cover patterns and changes with time (Anil et al., 2011). Quantification of such changes is possible through GIS techniques even if the resultant spatial datasets are of different scales/ resolutions (Sarma et al., 2001). Such studies have helped in understanding the dynamics of human activities in space and time. Land Cover, defined as the assemblage of biotic and a biotic components on the earth's surface is one of the most crucial properties of the earth system. Land use change is the modification in the purpose and usage of the land, which is not necessarily the only change in land cover but it also includes changes in intensity and management (Verburg, et al, 2000).

Land is the most important natural resource; Land-use refers to the way in which land has been used by human's habitat and for their economic activities. Land-cover refers to the physical characteristics of earth's surface, captured in the distribution of soil, vegetation, water, and other physical features of the land, including those created solely by human activities (Mynar babu et al., 2014). Information about land use change is necessary to update land cover maps and for effective management and planning of the resources for sustainable development (Alphan 2003). Over the years, remote sensing has been used for land use/land cover mapping in different parts of India (Gautam and Narayanan, 1983: Sharma et al., 1984; Jain, 1992; Brahabhatt et al., 2000).

Accurate and up-to-date land cover change information is necessary to understand and assess the environmental consequences of such changes (Giri et al, 2005). Remote sensing and Geographic Information System (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling (Pandian et al., 2014). Remote Sensing techniques have been successful in carrying out land use/ land cover mapping (Harikrishna et al., 2013).

The present study has been taken up in order to understand the changes that have taken place in land use/land cover in G.Madugula mandal of Visakhapatnam district. This area is known for extensive forest activity in recent times. It is believed that this aggressive human activity might have influenced on the land use/land cover patterns resulting in a possible impact on the environment. This work is taken up to better understand this aspect and moreover this type of analysis provides a valuable tool to increase the efficiency of land use and land cover, and to diminish the negative environmental and societal impacts related to LULC.

An advantage of image analysis over the traditional methods to deal with the present type of problem is that only remote sensing imagery can provide a direct record on the long/short term impact of man on the environment. Therefore the present investigation has been designed in order to evaluate whether there has been any significant changes in the land use in the recent past or not.

II STUDY AREA

The area of study G.Madugula mandal is located between the 17º 45' N to 18º 10' North latitudes and 82º 20' E to 82º 45' East longitudes. The geographical area of the mandal is 720 Sq.Km and perimeter 212.9 Km, forms part of Visakhapatnam District, Andhra Pradesh, India. It is bounded on the North-East by Paderu and Madugula mandals, on the west and south-west by Chintapalli mandal, on the south by Ravikamatam mandal and on the North Pedabayulu mandal. G.Madugula is a broad picturesque and rich valley with an altitude of over 1200m above the sea level. The entire G.Madugula is inhabited by schedule tribes with different sectors and is surrounded by hill streams. The location map is shown in Fig. 1.

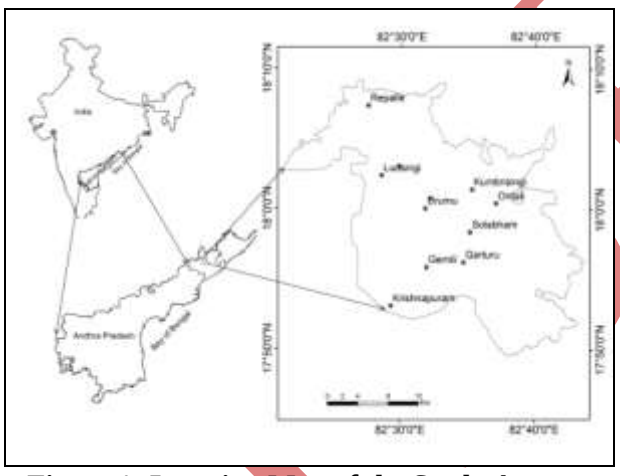

Figure 1: Location Map of the Study Area

III OBJECTIVES

The aim of this study is to produce a land use/land cover map of G.Madugula mandal in order to detect the changes that have taken place over 10 years period using change detection method.

The following specific objectives are pursued in order to achieve the aim.

• To create a land use / land cover classification scheme.

• To determine the trend, nature, rate, location and magnitude of land use / land cover change for the period of 2002 to 2012.

IV DATA USED

For monitoring the changes in land use/land cover, IRS-P6-LISS-VI digital data of 2012 (Fig.2) along with IRS 1D LISS III data of 2002 (Fig.3) have been used. The Survey of India (SOI) topographical maps of the series 65 J/8, J/12, 65 K/5, and 65 K/9 published on a scale 1:50000 have been used along with other collateral data.

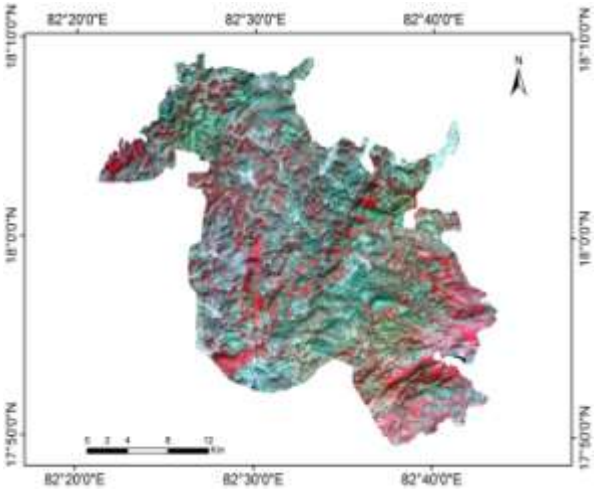

Fig.2: Satellite image of 2012

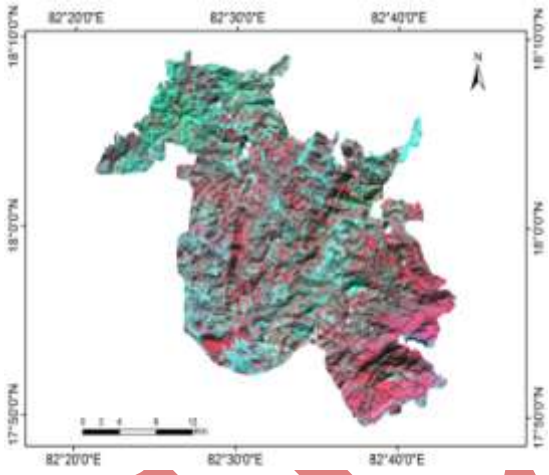

Fig.3: Satellite image of 2002

V METHODOLOGY

Present study is based on geo-referenced satellite data for the years 2002 (LISS-III) and 2012 (LISS-IV) of G.Madugula mandal of Visakhapatnam district, Andhra Pradesh, India. The goal of using these images is to identify the long term change in land use pattern. The images with resolution of 23.5m (IRS 1D LISS III) and 5.8m (LISS-IV) are enhanced using histogram equalization to increase the volume of visible information. This procedure is required to identify the various features in the image classification scheme.

Fig. 4: Flow Chart of the Methodology for LU/LC and Change Detection

Land use/land cover pattern for the year 2002 and 2012 are classified by the use of satellite imageries with different ground resolution. First off all, each satellite image is classified using unsupervised classification with maximum likelihood classifier, which is an appropriate classification method. MLC has been per-pixel classifiers which able to handle and show the spatial distribution of land uses/land cover types. Secondly, eighty land use/ land cover classes are classified which are finally converted into seven prime land use/land cover types and changes of these are investigated. The major LU/LC classes are; settlements, barren land, forest, dry land, plantation, water bodies and others. IRS 1D LISS III and LISS-IV satellite data from 2002 to 2012 could not be checked against the ground truth but the available historical evidence were used to validate the interpretation made. Field survey was performed for LISS-IV image of 2012 for each land use/land cover class included in the classification scheme throughout the study area. ERDAS 9.1 and Arc GIS 9.3 software were utilized for image processing, image classification and map layout respectively. Methodology flow chart was shown in Fig.4.

5.1 Accuracy Assessment

The number of reference pixels is an important factor in determining the accuracy of the classification. An equalized stratified random sampling approach was used to assess the accuracy of each land cover classification. Kappa analysis is a discrete multivariate technique used in accuracy assessment (Jensen, 1996). The overall accuracy and a Kappa analysis were used to perform classification accuracy assessment using ERDAS IMAGINE 9.1 software. Accuracy of the supervised classification of the satellite imagery was derived from a reference template from the margining data with 240 randomly selected samples from all the classes. Kappa statistics incorporates the diagonal elements of the error matrices. It represents the agreement which is obtained after removing the proportion that could be expected to occur by chance (Yuan et al. 2005). Those selected points were checked on the LU/LC classified map generated from classification. Producer's accuracy, User's accuracy, overall classification accuracy and kappa statistics were computed using 'accuracy report' tool of accuracy assessment module.

VI RESULTS AND DISCUSSIONS

The general land use of an area depicts an idea of overall areal utilization of resources, natural or cultural. In this paper, changes in the land use and land cover of G.Madugula mandal of Visakhapatnam district is evaluated from the differences between ten years of period i.e, 2002-2012 maps shown in Fig.5 and Fig.6. The findings of the present investigation are presented in Table 1. The IRS 1D-LISS III and IRS P6-LISS IV satellite data sets used in the current study yielded the following comparisons with respect to land use / land cover change detection. From the current study it is evident that there is considerable decrease in barren land of the study area for the period of 2002 to 2012. Based on this the changes that have taken place between the two data sets have been brought out and presented in pictorial representation (Fig. 7). The details are discussed below.

6.1 Change Detection Analysis

Change detection gives us the changes of specific features within a certain time interval and it is an important application of Remote Sensing technology. For a given research purpose, when the remotely sensed data and study areas are indentified, selection of an appropriate change detection method has considerable significance in producing a high-quality change detection product. Now after obtaining detailed land use/land cover information, change detection analysis is done by using two data sets of ten years interval to find out the changes that have taken place between the years 2002 to year 2012. Detailed attribute information of the feature classes, which has been changed between the two data sets (Table 2).

The attribute data of land use/land cover from the study area between years 2002 and 2012 with regard to various features indicated significant changes in feature classes(Fig: 7). The data indicates that the area under barren land has been reduced from 35.85% in the year 2002 to 33.87% in 2012. A decrease of 1.97% area under barren land has been indicated. This is because of the fact the people are shifting from plain areas to hilly regions for their livelihood. The area under dry land has been reduced from 23.91% in the year 2002 to 23.26% in 2012. A decrease of 0.65% area under dry land has been indicated. This reduce can be attributed to the fact that due to various social and financial reasons farmers are planting the lands without actively practicing agriculture. This trend has increased in recent times and perhaps caused this increase.

The area under forest which is around 23.76% in the year 2002 to 25.48% in 2012. An increase of 1.72% area indicated significant change and can be considered as a positive sign as far as the forest is considered. The feature classes namely plantation indicated an increase from 9.48% in the year 2002 to 9.77% in the year 2012, a net increase of 0.3%. This is an interesting observation made during this investigation. The area of investigation is traditionally known for mango, cashew, guava and banana plantation etc. In recent times farmers have been encouraged to go for mixed plantations with two or three commercial crops at a time. This has an advantage of less expenditure and more profit realization. This trend is observed in the regions like Rayalagedda, Sirasapalli, Pinajngar, Palakonda, Jirayi, Peddapalem and Sarayi. This can be attributed to the increased awareness of the farmers in the commerlisation of agriculture.

The area under settlements in the year 2002 was 2.54% where as the area has shown considerable increase to 2.86% in the year 2012 and there is a net increase of 0.32% which can be attributed to the declining trend of rural activity in the study area. All the settlements are rural areas because there is no urban area in this G.Madugula mandal. This can be due to number of problems surfaced during the last decade in the settlements fields. These include the lack of medical and transportation facilities. Illiteracy rate is very high and this has adversely affected their economic and social life. This perhaps is the reason for the less increase in the area under settlements.

Whereas the areas under water body have decreased considerably. The area recorded under the water body in the year 2002 was 0.77%, this has gone up to 0.71% in the year 2012, a net decrease of 0.06%. This is a natural consequence of increased rural settlements and resultant agriculture activity in terms of plantation. They have indicated no significant change during the study period of years 2000-2010. Where as the area under fallow land has increased from 2.31% in the year 2000 to 6.79% in the year 2010, an increase of 4.48% over a period of 10 years.

Another environment under others has shown a slight increase from 3.7% in the year 2002 to 4.04% in the year 2012, an increase of 0.34%.

VII CONCLUSIONS

The study was carried out in the area of G.Madugula mandal of Visakhapatnam district is located between the 17º 45' N to 18º 10' North latitudes and 82º 20' E to 82º 45' East longitudes. The study clearly established that the satellite remote sensing coupled with GIS can be a powerful tool for mapping and evaluation of land use/land cover changes of a given area. The significant changes in the land use/land cover during the study period between the years 2002 to 2012 recorded some interesting observations. During this time span (one decade), the significant positive observations as per development and environment is concerned are the natural systems represented by forests, plantation indicated significant change. The features namely barren land, dry land and water body indicated a decreasing trend where as the settlements indicated an increasing trend. The reasons attributed for this are due to the changes in the pattern of forest and plantation activity and increased activity of rural settlements.

In general the land use/land cover data during the study period (2002-2012) of the study area indicated certain significant changes which may not show any significant environmental impact. However, these trends need to be closely monitored for the sustainability of environment in future.

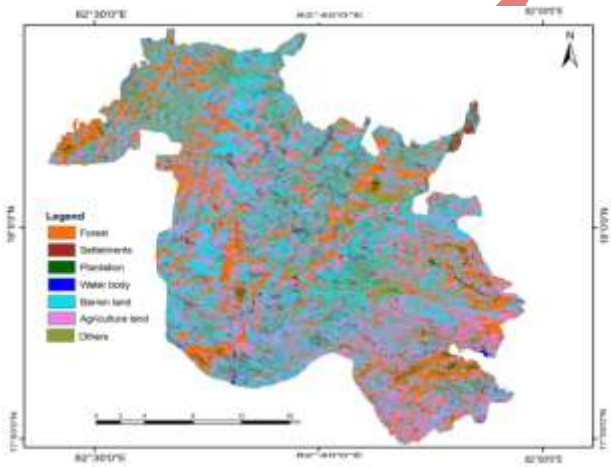

Fig.5: Land use/Land cover map of 2002

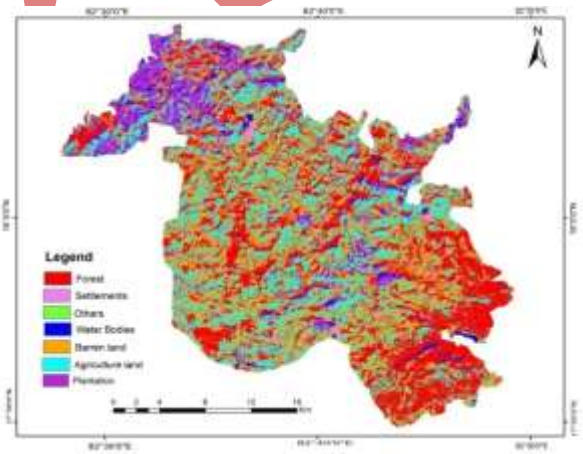

Fig.6: Land use/Land cover map of 2012

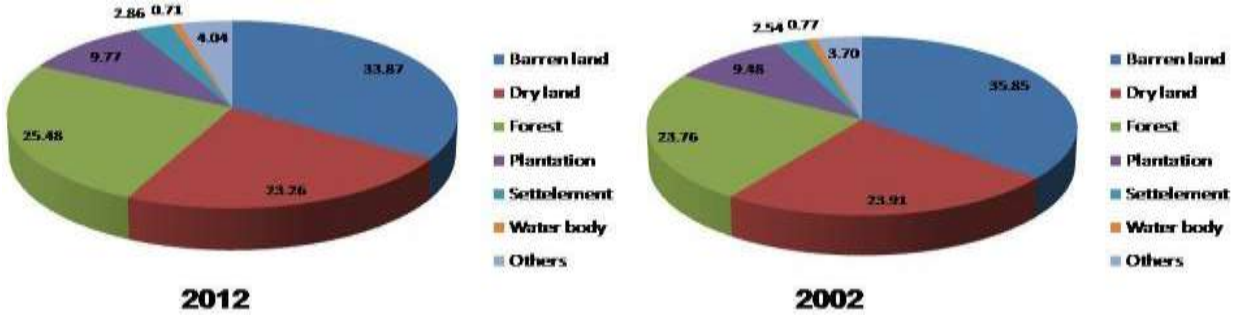

Figure 7: Pictorial representation of LU/LC classes

Table 1: Attribute data of supervised classification of images

	LISS IV - March,2012		LISS III - March, 2002	
Feature Name	**Area occupied in (sq.km)**	**% of Area occupied**	**Area occupied in (sq.km)**	**% of Area occupied**
Barren land	244.09	33.87	258.32	35.85
Dry land	167.61	23.26	172.32	23.91
Forest	183.62	25.48	171.20	23.76
Plantation	70.44	9.77	68.30	9.48
Settlements	20.64	2.86	18.32	2.54
Water body	5.15	0.71	5.55	0.77
Others	29.10	4.04	26.64	3.70
Total area	**720.65**	**100.00**	**720.65**	**100.00**

Table 2: Attribute data of change detection images

Feature Name	**Areas (%) March, 2012**	**Areas (%) March, 2002**	**% of Difference**
Barren land	33.87	35.85	-1.97
Dry land	23.26	23.91	-0.65
Forest	25.48	23.76	1.72
Plantation	9.77	9.48	0.30
Settlements	2.86	2.54	0.32
Water body	0.71	0.77	-0.06
Others	4.04	3.70	0.34

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