iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: I Month of publication: January 2018

DOI: http://doi.org/10.22214/ijraset.2018.1134

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

Application of Space-Born Remote Sensing To Analyze Forest Cover in Chittoor (India) Area

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Abstract: Forests are renewable resources and sources for the existence of human beings and their livelihood, especially people living in rural areas is closely linked to the forests. The rich diversity of the forest resources that yield fuel, fodder, timber and edible products should be studied so that the requirement of dependent communities is met. Many of the species are not commercially viable, but they are part of the forest ecosystem performing their role in nature. Monitoring the distribution and locations of land cover changes is important for regulatory actions and subsequent land-use activities. The emergence of imaging sensors and geospatial technologies has created a need for image processing techniques that can integrate observations from a variety of different sensors and datasets to monitor forest resources. The overall objective of this study is to map out and analyze the changes of forest cover in Chittoor district, which is having 4805 km^2 area using IRS-P6 LISSIII imageries. An unsupervised classification was performed using satellite imageries and a total of five major land cover classes were identified and mapped. By using post-classification techniques from 2008 to 2012, the forest cover has decreased by an area of 2629.24 ha.
Keywords: Land use, Unsupervised classification, LISSIII, Forest, Remote sensing.

I. INTRODUCTION

As we are aware of the fact that the hills are known for its natural beauty. Forests are the green blankets that are naturally protecting the hill environment and preserving the natural resources. It is evident that the reported forest cover in our country including dense forest, open forest and mangroves are 67.83 Mha, which is 19.39% of India's geographical area (Adepoju et al., 2006). It is essential to assess the forest cover and understand the reason for the decrease in forest cover. Land use/cover is two separate terminologies which are often used interchangeably (Dimyati et al., 1996). The recent researchers show that the overwhelming population pressure, practicing of unscientific agricultural methods and the lack of awareness about the importance of forests among the populace in general and tribal folk in particular are the prime causes of deforestation/degradation of forests. The rates of depletion, reason for the deterioration and remedial measures to restore it are the essential factors to assess the forest cover in any terrain. The inventory of forest resources and forest cover assessment/change detection in the rugged topography or hill sector is not an easy task and it is a time-consuming process.

Remote sensing and geographical information systems (GIS) are well-established information technologies, whose applications in land and natural resources management are widely recognized (Adamala et al., 2016). Current technologies such as remote sensing and GIS provide a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi-spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics to detect, identify, map, and monitor differences in land use and land cover patterns over time, irrespective of the causal factors. In pressured environmentally sensitive and ecologically important regions, there is a continuing need for up-to-date and accurate land cover information that can be utilized in the production of sustainable land use policies. Operational systems for monitoring and updating forest maps are thus needed for many applications such as forest management, carbon budgeting and habitat monitoring (Wasseige et al., 2004).The importance of vegetation in the environment is underscored by the role it plays as a major carbon sink. Land use affects land cover and changes in land cover affect land use. Changes in land cover by land use do not necessarily imply a degradation of the land. With the invent of Remote sensing and GIS techniques, land cover mapping has given a useful and detailed way to improve the selection of areas designed to agricultural, urban and/or industrial areas of a region.

Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy in association with GIS that provides a suitable platform for data analysis, update and retrieval (Chilar et al., 2000). The advent of high spatial resolution satellite imagery and more advanced image processing and GIS technologies, has resulted in a switch to more routine and consistent monitoring and modeling of land cover patterns. Remote sensing has been widely used in updating land use/cover maps and land use/cover mapping has become one of the most important applications of remote sensing (Sader et al., 2001). A post-classification approach was adopted with a maximum likelihood classifier algorithm (Adepoju et al., 2006). El Bastawesy (2015) have used several LISS images of different time period (2008 to 2012) and processed these images in ERDAS and ARC-GIS software's to analyze the changes. Bhagawat (2011) presented the change analysis based on the statistics extracted from the four land use/land cover maps of the Kathmandu Metropolitan city by using GIS. According to him, land use statistics and transition matrices are important information to analyze the changes of land cover. In India, studies on land use/land cover have been done by various scholars, especially by using remote sensing data. The analysis also showed that changes in land use pattern that have resulted in the loss of forest area, open spaces, etc.

II. STUDY AREA

The geographical area of Chittoor is 15468 km^2. The study area Chittoor(Fig. 1)is having 4805km^2 of forest. It lies in the southern part of Andhra Pradesh and North-Eastern part of Chittoor district and South-Eastern part of Kadapa district between latitudes 13^o 36' 18'' and 13^o 56' 55'' N and longitudes 79^{o}07' 51'' and 79^{o}30' 18" E. The climate is generally dry with temperatures ranging from 16-45^{o}C and the average annual rainfall is about 934 mm, received mainly from northeast monsoons. As per Champion and Seth's classification, the Forest fall under Dry tropical South Indian, dry mixed deciduous forests, dry deciduous, Southern cutch thorn forest groups and Tropical dry evergreen forest types. Its most important species is the famous Pterocaropussantalinus.

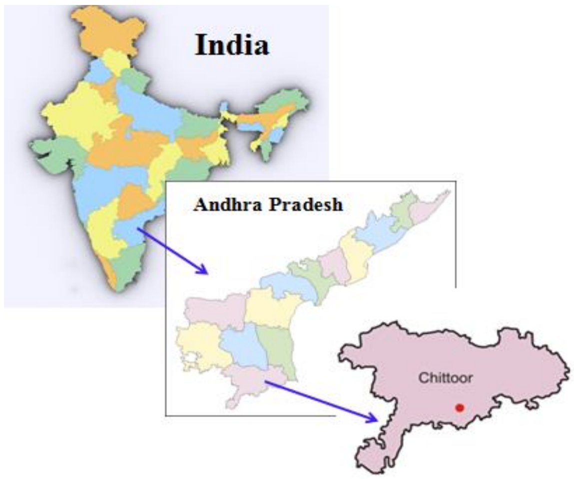

Figure1. Study area

III. MATERIALS AND METHODS

In the current study, for assessing the changes in the forest cover using Indian Remote Sensing (IRS)P6 Satellites, Linear Imaging Self Scanning (LISS)SensorIII geo-coded 2008 and 2012data were used(Table1). The study area (Chittoor) map was prepared from Survey of India (SOI) topographical sheets on 1:50,000 scale. The reason for using LISS III images is that they provide 23.5 m resolution, 141 km ground swath with 24 day repeat cycle and 4 spectral bands (3 Visible-Near Infrared and one Short Wave Infrared). As a pre processing of scene,the Geometric corrections and radiometric normalization were done. The detailed methodology in doing land use land cover analysis of Chittoor forest cover is shown in Fig. 2. Before performing classification, the classes were identified as 6 classes using satellite data.The identified classes are very dense forest, moderate dense forest, dense forest, scrub, open forest and water bodies. The unsupervised classification technique was used in this study to get desired classes. It is generalized such that>60% canopy coverage was assigned as very dense forest, 60-40% as moderate dense forest, 40-10% as open forest, <10% as scrub forest and 0% as nonforest.

Table1.Data sets used for land cover changes

Name	Description
RESOURCESAT-1 Images	Chittoor LISSIII images acquired from National Remote Sensing Center
SOI Toposheets 1:50000	Acquired from Survey of India

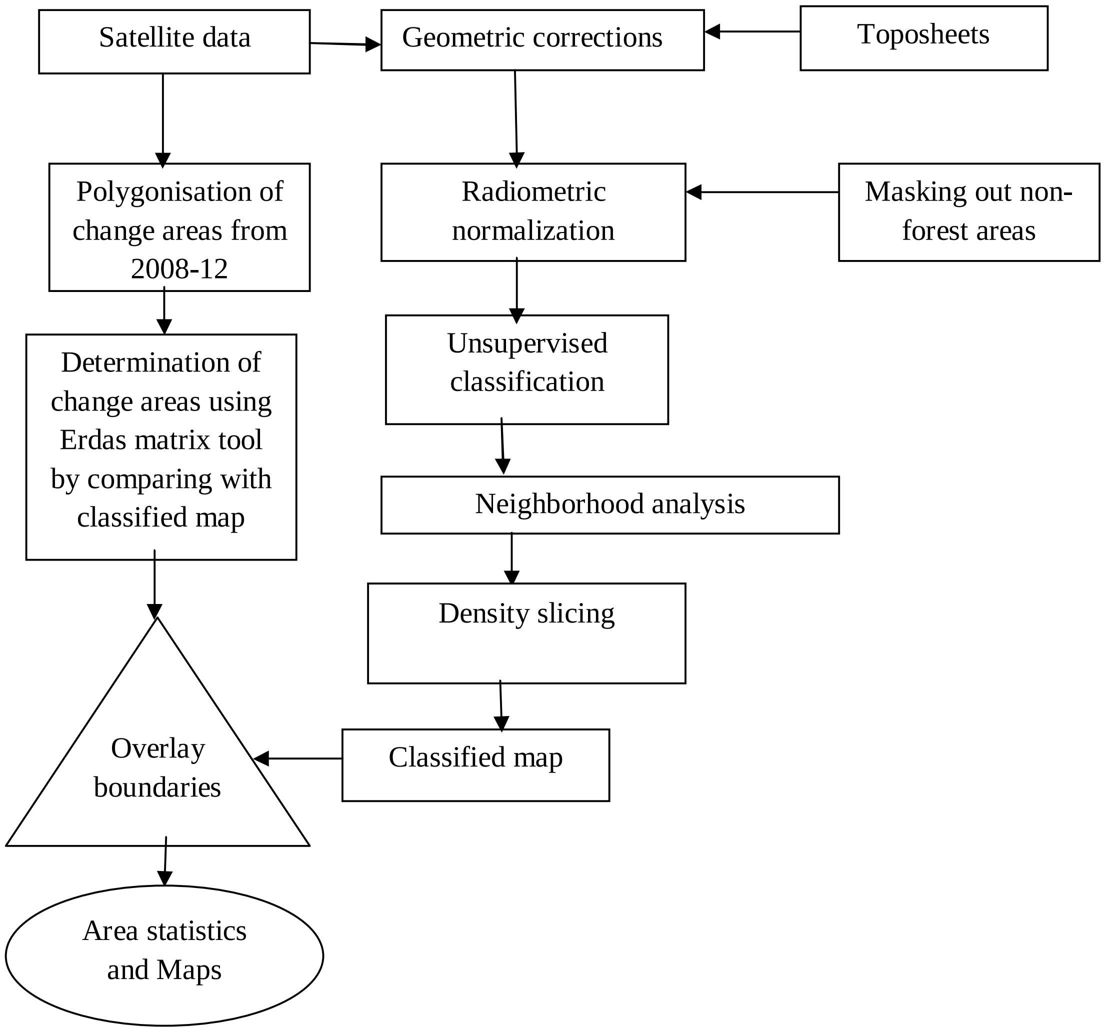

Figure2. Flowchart of methodology

A. *Image Processing*

Following the flow chart, Erdas Auto sync module is used to register the images. It takes only minutes to geo-reference one scene. After this, the image is roughly classified into various classes and the Erdas matrix tool is used to determine the various changes from each class of 2008-2012. The 2008 polygons were overlaid on the 2012False Color Composite (FCC) and changes between 2008 and 2012were determined by manual Polygonisation. The latitude and longitude of the changed polygons as well as changed classes (from class to class) and areas in Hectare are represented in Arc GIS Server Advanced Enterprise version 10. The authors have visited some areas of Chittoor study area changes to determine an accuracy of their works. Finally, the results of the changes are tabulated.

B. *Unsupervised Classification*

Classification is the process of assigning individual pixels of a multi-spectral image to discrete categories. By assembling groups of similar pixels into classes, one can form uniform regions or parcels to be displayed as a specific color or symbol. Remember that although these classes appear homogenous they can be made up of heterogeneous pixel values and therefore, each class will exhibit some degree of variability. In unsupervised classification, clusters of pixels were separated based on statistically similar spectral response patterns rather than user-defined criteria. Each pixel in an image is compared to a discrete cluster to determine which group it is close to colors and is then assigned to each cluster and the analyst interprets the clusters after classification based on knowledge of the scene or by visiting the location on the ground (ground truthing). The supervised classification method requires the analyst to specify the desired classes upfront, and these are determined by creating spectral signatures for each class. For the

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unsupervised classification, *k-means* clustering was used, which defines image classes by determining the optimal partitioning of the data distribution into a specified number of subdivisions. While doing unsupervised classification the window (Fig.3) will appear, we have to give input and output and color scheme options of 4, 3,and 2. The authors have given 150 in number of classes' options and 10 iterations given; if we give more number of classes we can achieve high accuracy. After running unsupervised classification we get output with 150 classes, after getting output we have cluster pixels and customize to 6 classes (Fig. 4)after clustering the pixels we have to do Neighborhood analysis. Finally, this raster data was converted to vector data for further analysis.

IV. RESULTS AND DISCUSSIONS

A. Land Use Land Classification

This section deals with the changes in forest canopy cover for Chittoor district during 2008-2012based on the interpretation of IRS P6 LISS-III data (Fig. 3). It is observed(Table 2) that the forest cover in 2008 is very dense with an area of3.21 km^2, moderate dense forest with an area of 399.07km^2, open forest with an area of about 2698.05 km^2, scrub forest with an area of about 1205.8 km^2 and non-forest occupied area about 493.21 km^2. The occupied areas in 2012(Table3) for very dense forest, moderate dense forest, open forest, scrub forest and non-forest is 94.42 km^2, 2050.69 km^2, 1805.62 km^2, 686.71 km^2 and 166.63 km^2 respectively. It is observed form Fig. 3(a) that there is huge decrease in forest cover and the total degraded forest cover is 2711.76 km^2 during 2008-09. It is observed that there is huge decrease is forest degradation from 2009 to 2012. Further, it is observed from Fig. 3(c) that there is no change in forest cover in 2010-11. Furthermore, it is found that the degraded forest cover is about 5.37 km^2 during 2008-12(Table3). Therefore, the decrease in degradation forest cover after 2009 concluded that there might be huge measures took place.

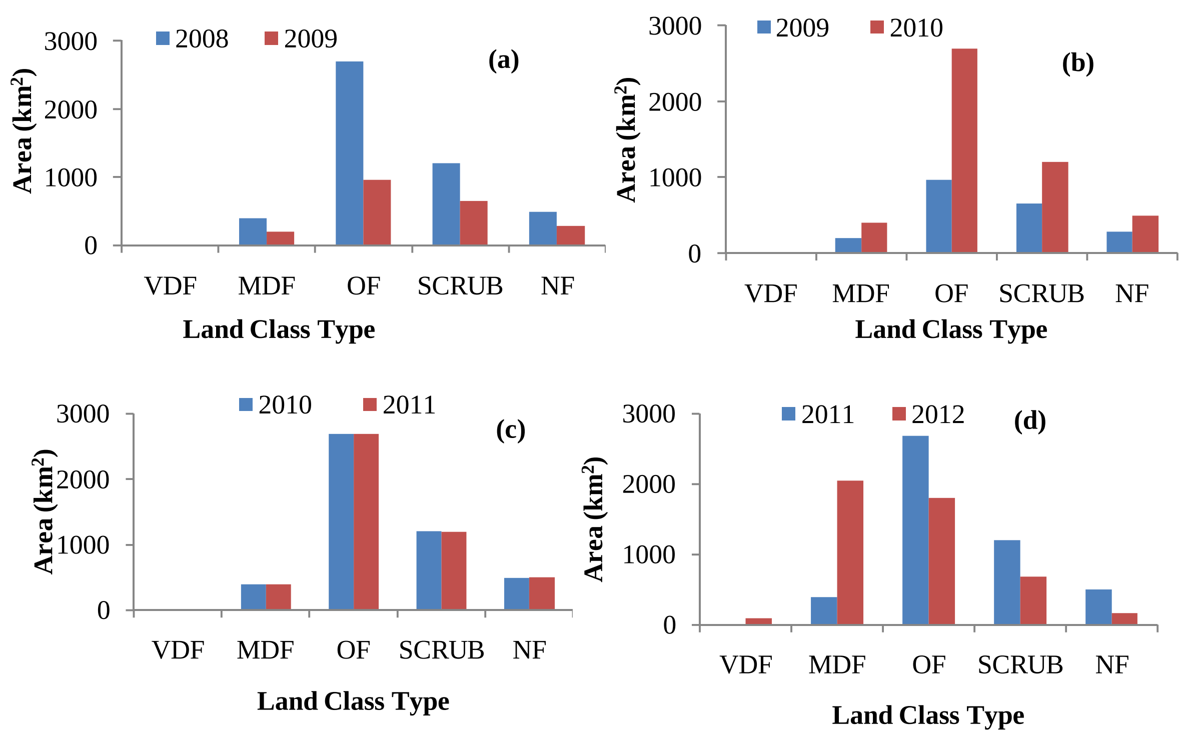

Figure3.Forest covers change from 2008 to 2012

There are so many causes for degradation such as harvesting of plantations in forest land, attempt for encroachment of forest land, diversion of forest land for non-forestry purposes, diversion of forest for cultivation and degradation of land due to fire occurrence in forest land. By constructing a change detection map (Fig. 4), the advantages of satellite remote sensing in spatially disaggregating the change statistics can be more fully appreciated. It shows a map of the major land cover types and the conversion from forest to another uses. Fig. 4 reveals that area occupied by forest in the district and it reveals that location of dense forest, open forest, scrub forest and non forest areas. The present study helps in detailed analysis such as micro level/watershed wise vegetation analysis and forest cover changes assessment. The main causes of deforestation are expansion of rangeland, agriculture and settlement, excessive commercial use of timber, and fuel wood and cattle grazing. The conversion of forest to rangeland, agriculture and settlement is due to cutting of the trees up to steep slopes and river valleys by the local people and they use to graze their livestock, farm and settle in

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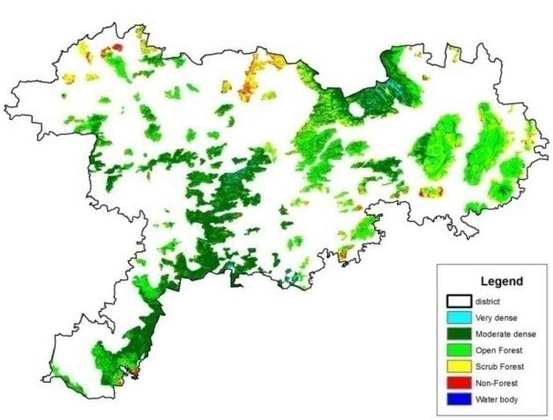
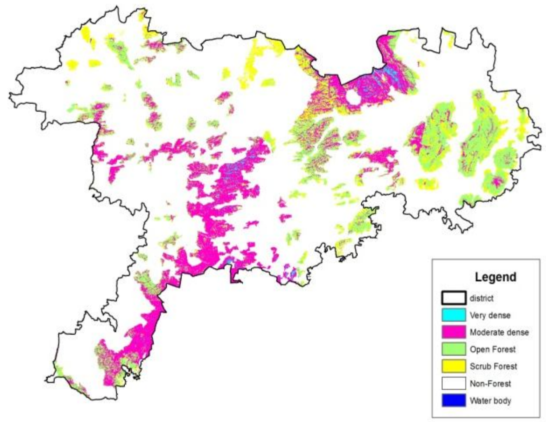
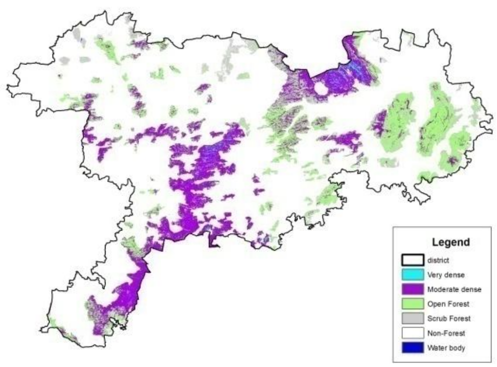
those areas, especially nearby the villages. Nomadic herding is a common practice in this area. Usually many herds of sheep and goats used to keep at the high altitude during the summer and bring down in the winter. This migration comes to be important problem in the region due to increasing the demolition of the forest. Firewood is the common and mostly used source of household energy. The demand for firewood is increasing with the rapid inflow of tourists in the region. In summary, information from satellite remote sensing can play a significant role in quantifying and understanding the nature of changes in land cover and where they are occurring. Such information is essential for natural resources managers to managing the area and policy makers in the formulation of forest resources management strategies.

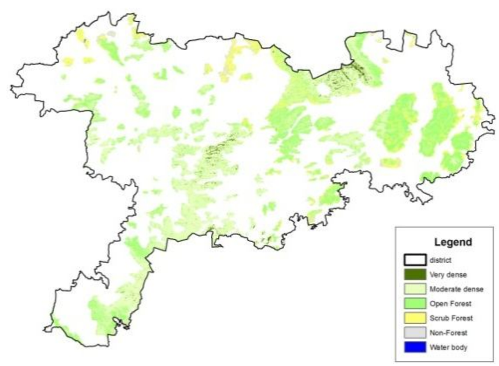




2008-09

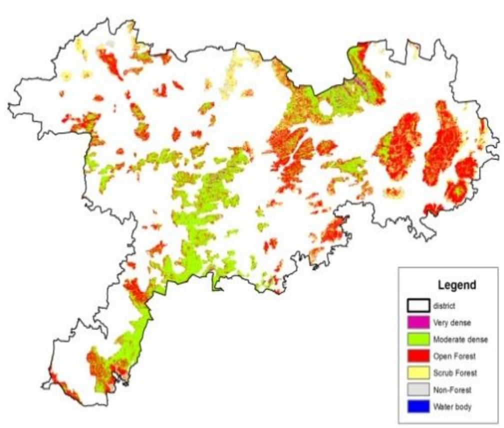
2009-10





2010-11

2011-12



2012-13

Figure4. Land covers classification of Chittoor district during 2008-13

Table2. Forest cover change matrix from 2008-11

2008	VDF	MDF	OF	SF	NF	WB	Total of 2008
Very Dense Forest	3.21	0	0	0	0	0	3.21
Moderately Dense	0	399.07	0	0	0	0	399.07
Open Forest	0	0	2698.05	0	0	0	2698.05
Scrub	0	0	0	1205.8	0	0	1205.8
Non-Forest	0	0	0	0	493.21	0	493.21
Water	0	0	0	0	0	5.23	5.23
Total of 2009	3.21	399.07	2698.05	1205.8	493.21	5.23	4805.32
Net change	0	0	0	0	0	0	
2009	VDF	MDF	OF	SF	NF	WB	Total of 2009
Very Dense Forest	3.21	0	0	0	0	0	3.21
Moderately Dense	0	399.07	0	0	0	0	399.07
Open Forest	0	0	2695.81	0.03	0	0	2695.84
Scrub	0	0	0	1205.47	0.2	0	1205.67
Non-Forest	0	0	0	0	496.55	0	496.55
Water	0	0	0	0	0	5.23	5.23
Total of 2010	3.21	399.07	2695.81	1205.5	496.75	5.23	4805.32
Net change	0	0	-0.03	-0.17	0.2	0	0
2010	VDF	MDF	OF	SF	NF	WB	Total of 2010
Very Dense Forest	3.21	0	0	0	0	0	3.21
Moderately Dense	0	399.07	0	0	0	0	399.07
Open Forest	0	0	2693.62	0	2.19	0	2695.81
Scrub	0	0	0	1201.82	3.68	0	1205.5
Non-Forest	0	0	0	0.16	496.41	0	496.57
Water	0	0	0	0	0	5.23	5.23
Total of 2009	3.21	399.07	2693.62	1201.98	502.28	5.23	4805.32
Net change	0	0	-2.19	-3.52	5.71	0	
2011	VDF	MDF	OF	SF	NF	WB	Total of 2011
Very Dense Forest	94.42	0	0	0	0	0	94.42
Moderately Dense	0	2050.69	0	0	0	0	2050.69
Open Forest	0	0	1800.5	0.49	0	0	1800.99
Scrub	0	0	5.12	684.61	2.35	0	692.08
Non-Forest	0	0	0	1.61	164.28	0	165.89
Water	0	0	0	0	0	1.25	1.25
Total of 2012	94.42	2050.69	1805.62	686.71	166.63	1.25	4805.32
Net change	0	0	4.63	-5.37	0.74	0	

Table3. Summary of forest classification area statistics for 2008-12

Forest class	2008	2009	2010	2011	2012
Very dense	3.21	0.03	3.21	3.21	94.42
Moderate dense	399.07	197.72	399.07	399.07	2050.69
Open forest	2698.11	962.68	2695.81	2693.62	1805.62
Scrub	1205.8	646.95	1205.5	1201.98	686.71
Non-forest	493.97	280.2	496.75	502.28	166.63

V. CONCLUSION

The experiment shows that IRS-P6 LISSIII classifications can be used to produce accurate landscape change maps and statistics. General patterns and trends of land cover change in the Chittoor were evaluated by: (1) classifying the amount of land that was converted from Different types of forest land during period from 2008 to 2012. Reasons for negative change maybe harvesting of plantations, land preparation for rising of plantation, diversion of forest land for non- forestry purpose and for positive change maybe because rising of plantation and evacuation of encroachers from encroachment land. This study can be useful to do carbon sequestration in forest.

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