CHANGE DETECTION IN LAND USE LAND COVER USING GEOSPATIAL TECHNOLOGY AND OPENSOURCE DATA IN LANKAMALLA FOREST AND THE NEIGHBOURHOOD – A CASE STUDY IN ANDHRA PRADESH, INDIA

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ABSTRACT

Land use and land cover is an important component in understanding the interaction of the human activities with the environment. Mapping land use/land cover (LULC) changes at regional scales is essential for a wide range of applications, including landslides, erosion, land planning, global warming etc. LULC alteration (based specially on human activities), negatively affect the patterns of climate, the patterns of natural hazards and socio-economic dynamics in global and local scale. The Lankamalla reserved forest is dense forest in the surroundings of kadapa and its geographical extent is 498.67km^2. In recent times, remote sensing and geographical information system (GIS) is extremely beneficial in assessing the land use land cover data analysis. Remote sensing is considered as a significant data source for forest monitoring purposes, and has been widely used for monitoring deforestation. LANDSAT 8(OLI) of 2014 and 2018 were downloaded from USGS Earth Explorer, for analyzing the trends in deforestation and land use land cover changes in Lankamalla forest and its neighbourhood. In image preprocessing, supervised classification has performed to classify the images into various land use classes using Digital Image Processing tools.

The study area is classified in to 1. Dense forest, 2. Deciduous forest, 3. Agriculture land, 4. Water bodies and 5. Waste land. The Agriculture land is again sub dived into three classes a. Crop land, b. Fallow land and c. Plantation. The results indicates that during the last decade dense forest of the Lankamalla reserved forest area have been decreased about 46.55% (i.e, 223.86 km^2) and 27.21% (i.e, 130.86km^2) while Water bodies, Crop land decreased by 0.008%, 0.034% respectively. The study area consists of ten mandals, such as Atlur, Badvel, Bhramamgarimattam, Chennur, Kadapa, Khajipet, Sidhout, Mydukur, Vallur and Vontimitta. In the Sidhout area dense forest, Fallow land, Crop land, Plantation, Waste land have increased. The crop land increased from1.2% to 5.95%, fallow land increases from 10.93 to 23.01%, plantation increases from 2.8 to 20.04%, and waste land occupancy increases from 7.85 to 20.85 %.

Key words: Deforestation, LandUseLandCover Changes, Conservation planning. Remote Sensing and Geographical Information System (GIS), Opensource.

INTRODUCTION

Land use/land cover (LULC) changes play a major role in the study of global change. Land use/land cover and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster-flooding. These environmental problems are often related to LULC changes. Therefore, available data on LULC changes can provide critical input to decision-making of environmental management and planning the future. Land resources are being exploited faster than they are renewed, as a result ecosystems are degraded, life support processes are threatened and biodiversity, being the key factor in maintaining biospheric resilience is decreasing at an alarming rate. Land use Land cover is an important component in understanding the interaction of the human activities with the environment. Soil, water, flora and fauna are the important land resources, which together influence in the survival of human beings by supporting food production and providing a congenial living environment. The huge amount of plant life growing naturally in an area is called forest. Forests play a crucial role in global carbon cycle. These are the renewable resources and natural complex ecosystems. Many animals need forests to live and survive. Forests occupy one third of the Earth's land area. India's forest covers about 23% of total geographical area of the country. Temperature and rain fall are the two most important things for it. Forests are present through the world in different climatic conditions. The forest floor is comprised of soil, dead plants and small plants such as grasses and wild flowers. Trees help to create special environment. Forests clean the air and they cool air during hot days, conserve heat at night & act as excellent sound absorbers. They control the soil erosion by forming layer of leaves that fall around the tree. Also prevents runoff and allows the water to percolate in to soil. Roots help to hold the soil and prevent soil erosion. They produce large quantities of oxygen and take carbon dioxide. Forests provide several ecological, economical and social perspective functions viz. to life.

Some of the benefits of the forests are given below:

- Water supplies,
- Soil conservation,
- Nutrient cycling
- Genetic diversity species and
- Green house gases regulation.

Hence forests are also useful for human life. Now a days, the forests are decreasing due to anthropogenic activities. One of the main reasons for decreasing of the forests is deforestation. Deforestation is defined as clearing of virgin forests, or intentional destruction or removal of trees and other vegetation for agricultural, commercial, housing, or fire wood use without replanting (reforesting) and without allowing time for the

forest to regenerate itself. Deforestation can have negative impact on the environment. Deforestation is the direct (or) indirect human activity. It converts forest land to non forest land. Eighty percent of Earth's plants and animals live in forests. Due to this act that destroys their homes. The ever-growing human population is considered as a major threat to forests. Reasons for causing the deforestation are Agricultural expansion, Mining, Industry, Climate change and Urbanization

These are primary responsible causes for deforestation. Much of the agriculture land has been created at the expense of natural forests, grassland & wet lands that provide valuable habitats for species and services for humans (MEA, 2003).The effects of deforestation are Global warming, Loss of species diversity, Floods and soil erosion, Air and water pollution and Depletion in water resources

Remote sensing plays very important role in the identification of deforestation and land use land cover changes. Remote sensing means acquiring information about a phenomenon object or surface while at a distance from it. In these remote sensing Satellites, aircrafts and other ground borne platforms are used. This name is attributed to technology in which satellites and spacecraft are used for collecting information about the earth's surface. The collected information is present in the form of images and photographs. Remote sensing is a very powerful tool in the provision of such information. This is an outcome of developments in various technological fields since 1960 onwards. The use of remotely sensed data is to map land use land cover changes started as early as the landsat imagery was made available in the 1970's. The use of remote sensing in monitoring deforestation processes is performed both visual and digital analysis (Kilic, S., F. Evrendilck, S. Berberoglu).

GIS is a system designed to create, capture, store, manipulate, analyze, manage, and produce information related to the surface of the earth. Remote sensing and GIS support advanced ecosystem management. Remote sensing and geographical information system (GIS) approach could form part of a conservation and decision support management system that informs management actions on the ground for prioritizing efforts and then quantifies whether these interventions have reduced deforestation. The present study aimed to map forest deforestation in Lankamalla reserved forest using multi temporal remote sensing data (2014 & 2018) and topographical maps and to analyze forest cover changes using GIS techniques.

OBJECTIVES

1. To access the increase and decrease of canopy of lankamalla forest.
2. Detecting land use land cover change in Lankamalla reserved forest neighbourhood.
3. The studies on forest cover change can reveal the status of forest & facilitate for its conservation.

STUDY AREA

Kadapa has a tropical wet and dry climate characterised by year around high temperatures. It has a record of reaching 48^0 Celsius temperatures in the recent times. Early summers are especially uncomfortable

with hot & dry climate. During this time temperatures range from a minimum of 34^0 Celsius and can rise up to a maximum of 48^0 Celsius. The forest area in YSR Kadapa district is 5,050km^2; it is 32.87% of the district area. The overall condition of the forest is not very good. In Kadapa district forests Red sandalwood is available in plenty. Kadapa is home for two major reserve forest areas in south India - the Sri Lanka Malleswara wildlife sanctuary & Sri Venkateshwara national park. 5km buffer is created along the Lankamalla forest boundary. Ten mandals come under this buffer zone. They are Atlur, Badvel, Chennur, Kadapa, Khajipet, Sidhout, Vontimitta, Vallur, Mydukur and Bhramamgarimattam.

The wild life sanctuary provides a home to nearly 1400 species and nearly 176 families of vegetation and living organisms. The sanctuary has hilly terrain having thick cover of shade trees, gorges and steep slopes. Sri Lanka Malleswara wild life Sanctuary is rich in dry evergreen shrubs and dry and deciduous mixed forests. The sanctuary is a treasure house of exotic varieties of flora and fauna. Other species of plants found here include Anogeissus, Hardwickia and cassia among the non thorny species while Carissa, Zizyphus and Acacia among the thorny ones. Some of the main species of animals and birds spotted in forest cheetahs, tigers, Chinkaras, sambars, Nilgais & Sloth bears and others. Recently Honey Borjar (mammal) animal is appears in lankamalla forest .It is one of the rare animal. So these reasons conservation of forests are very important.

Lankamalla reserved forest is a forest reserve with in Andhra Pradesh and lies in southeast of Talapuri bodu & north of Lankamalla hills, Votiimadugu & Bokkarati bodu, east of Konduru, south of Sidhout, west of Chennur are present. Lankamalla reserved forest has an elevation of 880 meters. The Lankamalla reserved forest is present in a semi arid zone and it is consist of good tree cover. Waterfalls are present with in forest area. The Lankamalla forest is present in the toposheet numbers 57J14, 57J15, 57N2 and 57N3 on 1.50,000 scale. The lankamalla reserved forest in YSR kadapa district extends over 498.67 km^2, of the total geographical area. It is the home of red sanders, an endemic species of the area. Study area contains of Bairenkonda Quartzite's, shale's and phyllites, Nandhyala shale's and koilakuntla limestone. In this area there are also two anticlinaldomes. The lankamalla forest is located between the latitude of 14^0 28' N &14^0 43' N and longitudes of 78^0 48'E & 79^0 4' E. It is an inlier where older Bairenkonda rock formation is surrounded by younger cumbum formation. It is a structural dome. It is trending in NE-SW direction. It is a very large dome. It shows that it is a combination of two intersecting anticlines perpendicular to each other. Hence the domal structure is formed and is composed of resistant Quartzites. Glassy Quartz crystals are available in near to Khajipet mandal & Anticline and Syncline folding nature is present. Penna River is flow near to Lankamalla forest.

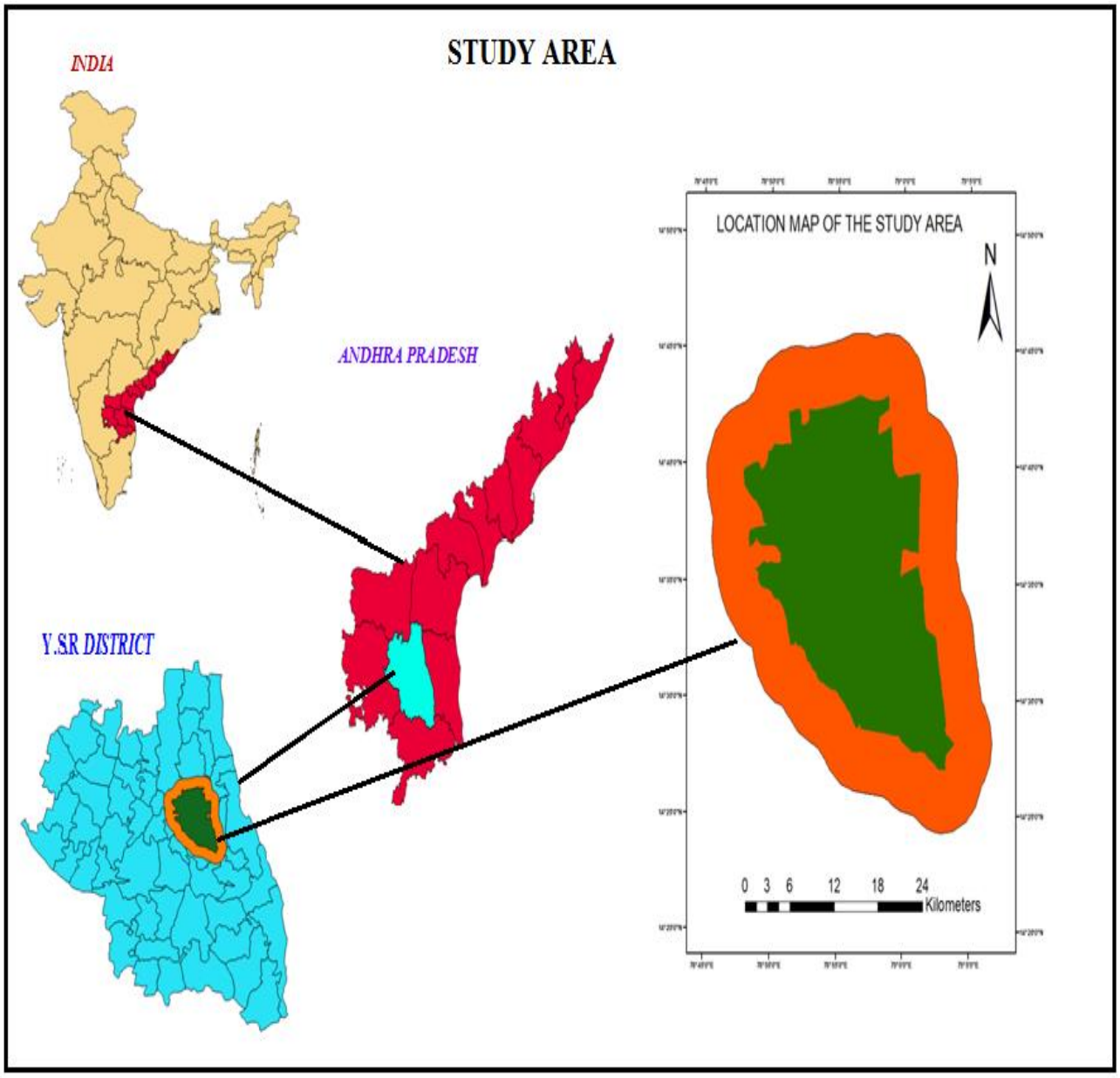


Fig. 1

LOCATION MAP

METHODOLOGY

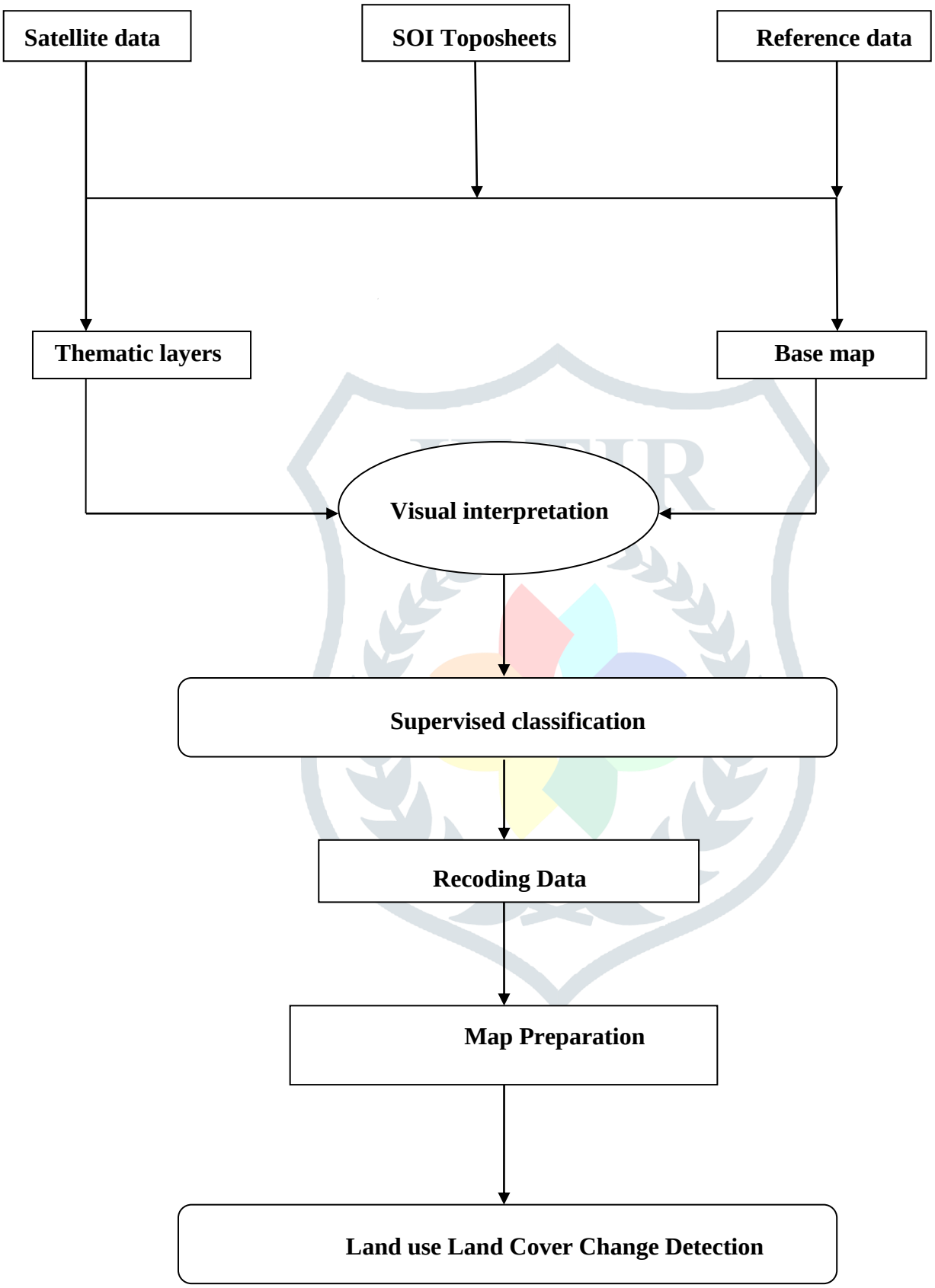


Fig. 2 FLOWCHART

DESCRIPTION

Land Use Land Cover change detection is a laborious process in which the base map is prepared using geospatial technology. The series of geospatial processing as mentioned in the methodology are illustrated using opensource softwares step wise as in the following paragraphs.

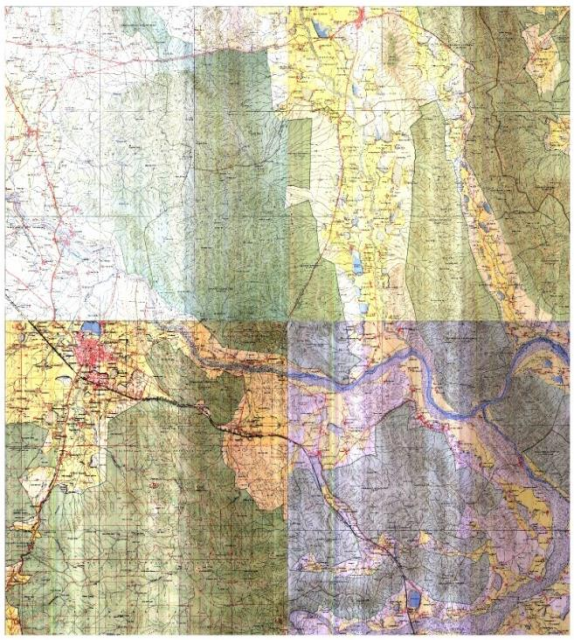
Georeferencing

The study area is identified in 57J14, 57J15, 57N2, 57N3 of SOI toposheets. For georeferencing opensource QGIS is used with the plugins and tools of Georeferencer.By opening the JPG Toposheet and providing X and Y map coordinates, a minimum of three but four. In transformation the target SRS is chosen as WGS84-4326.

Mosaicing

The four toposheets are made to Mosaic using the options in raster-miscellaneous-merge. Select the input raster images and give the output file name, select no data value, click ok. Two or more images combined set as single image.

Fig 3 Georeferenced map



Delineation of the Lankamalla Forest boundary

SOI Toposheets are used as reference map for the delineation of the study area that is Lankamalla forest Boundary. This process is completed using the option layer-create layer-new shape file layer.

Fig 4 Lankamalla Forest Boundary

Creating buffer

The buffer is created to the forest boundary with 5 km distance, again using the tools vector-Geoprocessing tools-Fixed distance buffer.

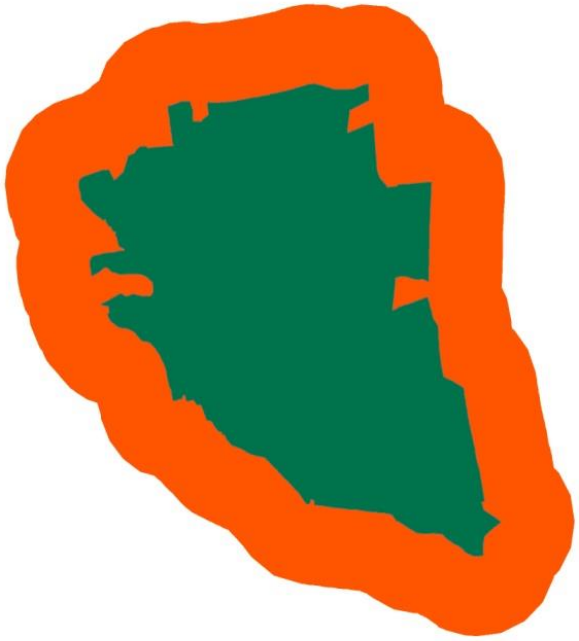


Fig. 5 Lankamalla Forest Boundary with Buffer

Subsetting

Toposheets are supposed to subset to the area of interest or study area for which the options raster-extraction and the extent as the shape file is chosen and clip the process.

Data collection

The open source LANDSAT imageries are downloaded from USGS Earth Explorer in comparison to Survey of India toposheets is used for temporal analysis. The LANDSAT -8 (OLI) contains 11 bands data. These sensors provide seasonal coverage of the global landmass at a spatial resolution of 30 meters. Area is calculated using QGIS 2.14.20 software and compared changes for both images. The images, archived in the United States and at LANDSAT receiving stations around the world, are a unique source for global change research and application agriculture, cartography, geology, forestry, regional planning, surveillance and education, and can be viewed through the U.S. Geological Survey (USGS) 'Earth Explorer' website (Trigg, S.N., L.M. Curran).

The important steps like Layer stack, Resolution Merge, Subsetting, Supervised classification and Recoding are essential for the statistics of the data.

Layer stack

Layer stack is a procedure for combining the individual layers here LANDSAT data 2, 3, 4 & 6 bands are used for vegetative analysis.

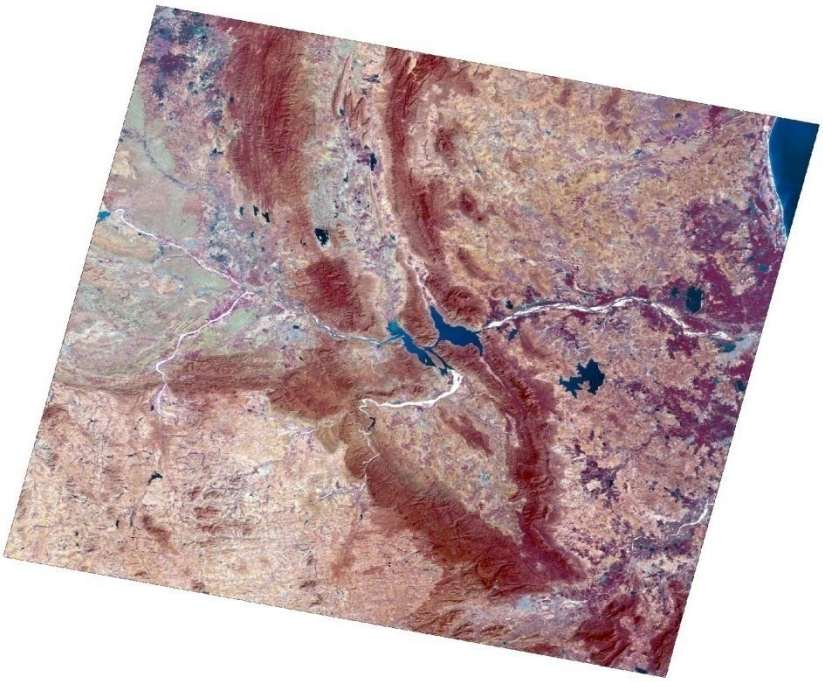


Fig. 6 Layer stack tile

Resolution merge and subsetting the study area

The Resolution merge is for integrating the differential resolution bands of the LANDSAT imageries pertaining to the same study area. Subsetting raster image with the area of interest to the study area i.e., Lankamalla Forest area and its neighbourhood similar to the process earlier mentioned in for the preparation of the basemap and is as shown below.

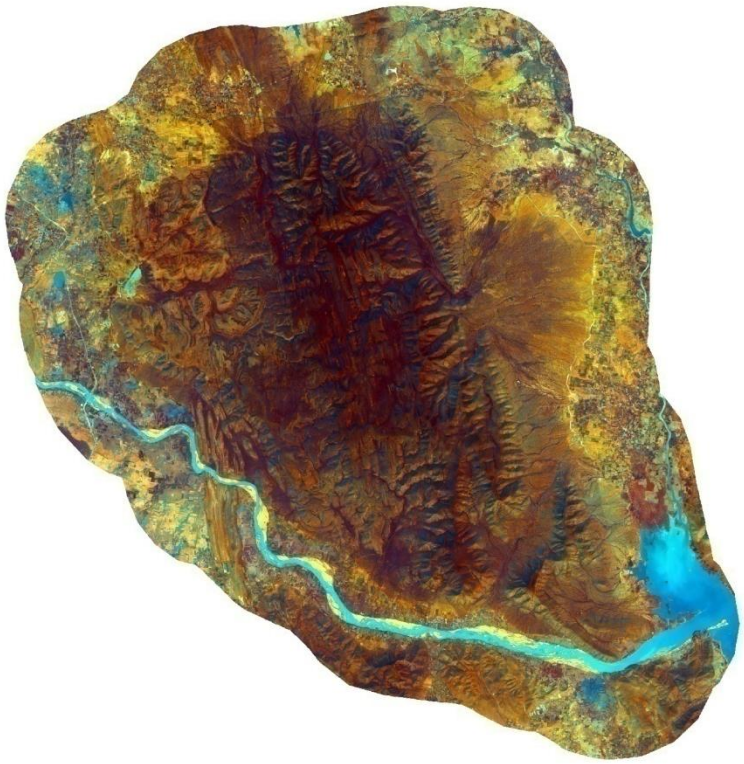


Fig. 7 Subset of LANDSAT imagery

Supervised classification

The primary LULC classification scheme used for this project was derived from the Soil survey of India classification 2015 system for a level one classification. Multispectral classification is an information extraction process analyses the spectral and then assign pixels to categories based on similar signatures. In supervised classification the analyst user prior knowledge derived from field surveys, photo image, interpretation, topographic map information about different features to be classified by the computer using the feature signature defined by the analyst. The training area should be homogenous i.e., they should contain pure pixels. The training sets should contain a sufficient large number of pixels. The training data set of each class should exhibit a normal distribution. Training area should be a minimum five number of training sets. They are Dense forest, Deciduous forest, Agriculture land, water bodies, Waste land. The agriculture land again divided in to crop land, fallow land and plantation. The images are then recoded using the attribute table and viewers windows. The image pixels change from one class to the other for the sake of generalization within the detailed classification.

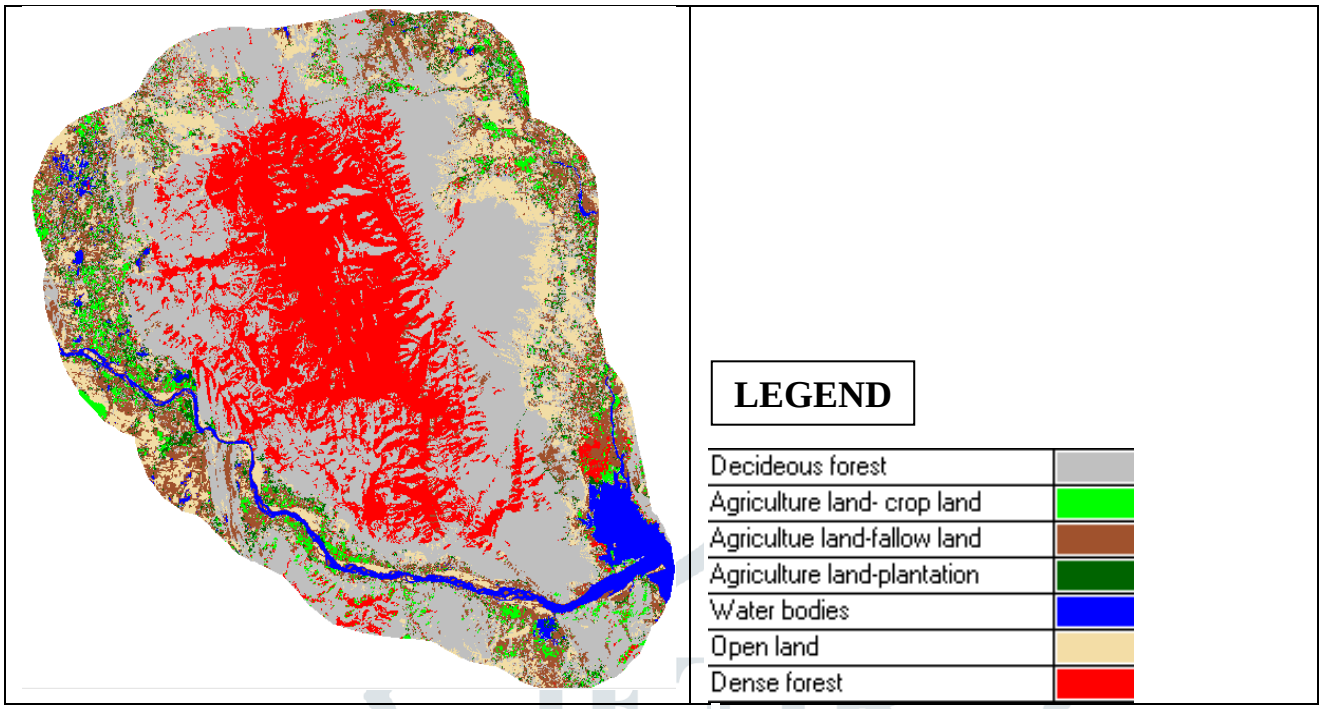


Fig. 8 Classified and Recoded Image

Land use land cover map

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi natural habitats. Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture etc. Land use cannot be determined from satellite imagery. Land use/Land cover play major role in the study of global change. Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water. Land use shows how people use the landscape – whether for development, conservation, or mixed uses. The different types of land cover can be managed or used quite differently.

Land cover can be determined by analyzing and classifying satellite imagery. Land cover maps provide information to help managers best understand the current landscape. To see change over time, land cover maps for several different years are needed. With this information, managers can evaluate past management decisions as well as gain insight into the possible effects of their current decisions before they are implemented.

The study area land use land cover data is created by Bhuvan thematic data, using the WMS option in the QGIS. The land use land cover is quite essential for deforestation and degradation identification, It is mainly used for change detection studies. Land use land cover and human natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increasing natural disaster flooding.(maset.,2004;Zhao et al.,2004).

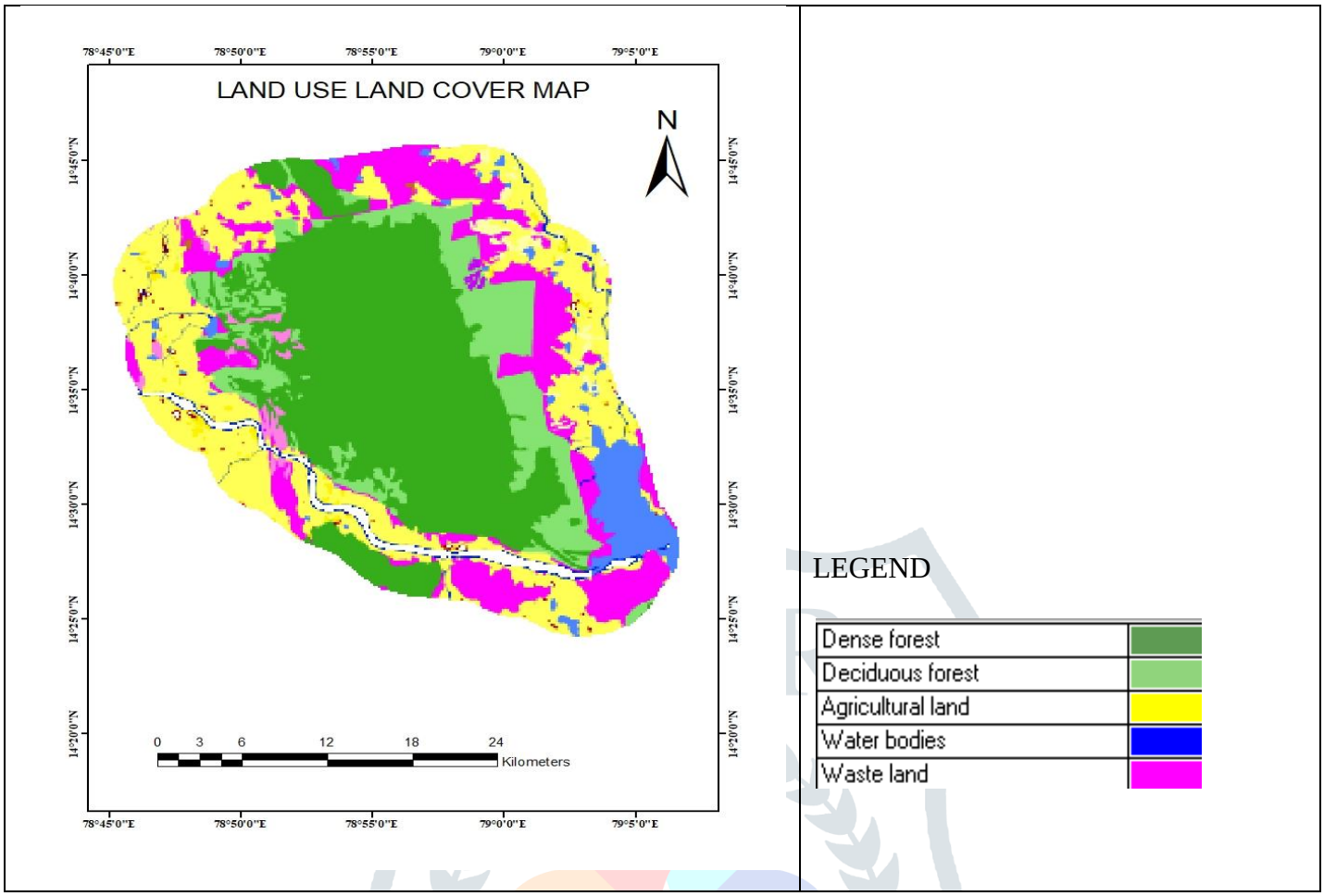


Fig.9 Land Use Land Cover Map

Results and Discussion

The comparative analysis of the classified images of the two years 2014 and 2018 reveals the following facts with the statistical interpretations is as follows.

Dense forest

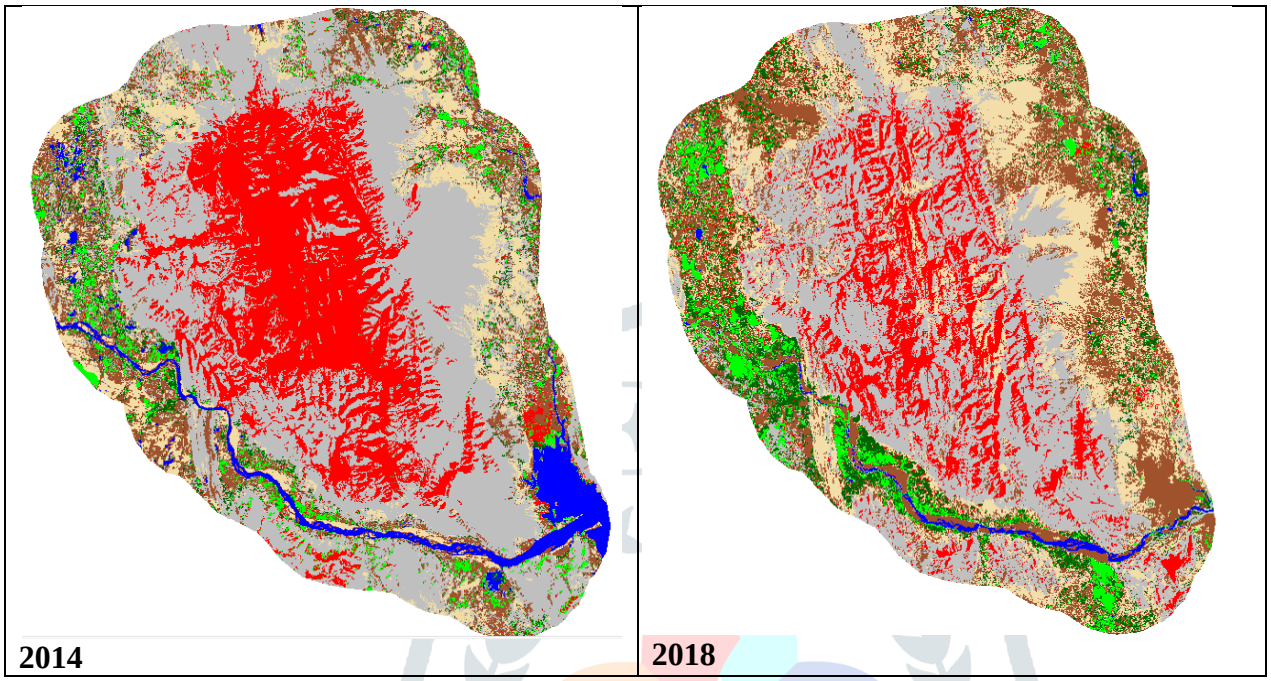
These are the areas that comprise of thick and dense canopy of all trees, which predominantly remain green throughout the year. It includes tropical broad leaved species. In the satellite image the dense forest is in red in color. The dense forest reduced significantly during 19.34% from 2014 to 2018. An area of 223.86 km^2 (46.55%) of the forest in 2014 is decreased to 130.86 km^2 (27.21%) in 2018. In surrounding mandals the dense forest increased almost all the mandals except Atlur. The Atlur mandal area decreased from 4.26% in 2014 to 2.65 % in 2018.

Deciduous forest

These are the forest types that are predominantly composed of species, which shed their leaves once a year, especially during summer. The deciduous forest occupies an area of 239.42 km^2 during 2014 and 260.89 km^2 during 2018. In the satellite images the deciduous forest is present in grey in color. The deciduous forest is changed in all the mandals but in kadapa, it slightly increased from17.89 % to 18.7 %.

Agriculture land

This encompasses both cultivated and irrigated lands. These are the lands mainly used for farming and production of food and other commercial and horticultural crops with the help of satellite data it is possible to identify various agricultural land uses. Crop lands are found in and around the water bodies. The different types of agricultural lands are identified in the study area. It includes crop land, follow land and Plantation. A synoptic view of the data is a follows



Crop land

It includes those lands with bearing crop as on the date of the satellite imagery. The crops may be of either Kharif or Rabi or both seasons. Its spatial extent varies in size and shape, with smooth texture (when the crop is in full matured stage) to coarse or mottled (at the early stages of planning and growth). In the present study area the crop lands changed in both the directions in almost all the mandals.

Fallow land

These are the lands, which are taken up for cultivation but temporarily allowed to rest, un-cropped for one or more seasons, but not less than one year. In satellite image the fallow land is consists brown in color. The fallow land varied most in Atlur, Bhramhumgrai mattum, Sidhout and kadapa. As a whole the fallow land increased from 10.33% to 22.32% during the brief period.

Plantation

These are the areas under tree crops (agricultural) planted adopting certain management techniques. It is rough in texture. The trees are mango, lemon, banana, etc. The plantation is improved in all mandals viz., Sidhout, Mydukur, Khajipet and Vontimitta to mention a few with more percentage.

Waste land

Waste land is described as degraded land which can be brought under vegetative cover with reasonable effort and which is currently underutilized land. This is deteriorating for lack of appropriate water and soil management or on account of natural causes. Waste land is not used for any purpose. The waste land is presented in light yellow in color, rough texture of satellite data. The waste land increased in all mandals of study area.

Water bodies

This category comprises areas with surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as steams, river, canals etc. The water body is present in blue in color, smooth texture. The water bodies are mainly decreased in Sidhout mandal. In river area the water body is change in to fallow land, crop land and waste land. In that area water bodies decrease from 51.07 % to 5.69 %.

The statistical data is represented in the following tables as a nut shell for ready reference.

Table 1 Classification of the Study Area

LULC	2014 area in (sq.km)	2018 area in(sq.km)	% area(2014)	% area(2018)	Increase and decreases of area in %
Dense forest	223.86	130.86	46.55	27.21	-19.34
Deciduous forest	239.42	260.89	49.78	54.25	4.47
Crop land	0.23	0.032	0.04	0.006	-0.034
Fallow land	10.33	22.32	2.14	4.64	2.5
Plantation	0.72	1.22	0.14	0.25	0.11
Water bodies	0.05	0.01	0.01	0.002	-0.008
Waste land	6.26	65.54	1.30	13.63	12.33

Table 2. Mandal wise classification (2014)

Mandal	Dense forest	Deciduous forest	Crop land	Fallow land	Plantation	Water body	Waste land
Atlur	4.39	31.92	3.45	17.55	4.57	18.77	22.43
Badvel	1.11	20.07	4.41	14.67	3.38	0.71	19.24
B. Mattam	0.72	19.12	2.52	13.37	4.33	0.50	12.24
Chennur	0.72	6.92	4.46	11.11	4.25	2.91	8.31
Kadapa	0.03	6.72	0.24	8.33	0.94	0.56	4.72

Khajipet	6.33	18.12	6.23	18.16	6.44	2.72	10.65
Sidhout	1.44	26.58	4.86	13.16	3.40	61.46	9.45
Mydukur	2.21	17.00	1.88	4.73	1.18	0.1	9.59
Vallur	0.002	1.49	0.01	0.91	0.06	0	0.25
Vontimitta	0.27	12.83	2.32	10.05	1.52	6.89	4.34

Table 3. Mandal wise classification (2018)

Mandal	Dense forest	Deciduous forest	Crop land	Fallow land	Plantation	Water body	Waste land
Atlur	2.73	7.94	1.80	40.85	8.57	1.16	39.76
Badvel	1.4	2.18	2.98	25.67	8.17	0.54	22.66
B. Mattum	2.51	4.79	2.37	14.83	6.49	0.12	21.71
Chennur	2.02	5.26	7.58	8.81	10.86	0.46	3.7
Kadapa	1.00	4.05	1.66	5.04	3.37	0.09	6.34
Khajipet	7.85	7.21	9.25	1.84	12.72	0.55	11.46
Sidhout	3.87	7.70	8.20	14.96	13.03	3.70	13.56
Mydukur	2.38	4.49	0.86	11.43	5.15	0.07	12.33
Vallur	0.02	1.02	0.02	0.24	0.15	0	1.27
Vontimitta	1.72	5.44	5.42	9.33	6.44	1.38	8.48

In the present study, the area of dense forest is gradually decreasing, because of lack of rain fall and climatic changes. The actual rate of deforestation is difficult to determine. Scientists study the deforestation of forests by analyzing satellite imagery of forested areas that have been cleared. According to the results, the conservation practices may minimize the forest loss. In this work, it was proved that the supervised classification of multi-temporal satellite images is an effective tool to quantify current land use as well as to detect changes in a changing environment. The information on spatial distribution of natural forests is critical to stop the progress of deforestation and degradation. Based on empirical studies, the present study has provided geospatial data base on spatial patterns of forest cover and land Use changes which is useful for conservation prioritization and strategic planning in the present study site. The results indicate that during the last decade dense forest of the Lankamalla reserved forest area have been decreased from 46.55% (i.e, 223.86 km^2) to 27.21% (i.e, 130.86km^2) while Water bodies, Crop land decreased by 0.008%, 0.034% respectively. In the Sidhout area dense forest, Fallow land, Crop land, Plantation, Waste land is increased. The crop land increases from1.2% to 5.95%, fallow land increased from 10.93 to 23.01%, plantation increases from 2.8 to 20.04%, and waste land occupancy increases from 7.85 to 20.85 %.The Plantation is highly present in Chennur 28.07% and Khajipet 25%.the Vallur is consists water bodies zero in status. The crop land is decreases in Atlur and Badvel mandals, in the Khajipet mandal 25% and Chennur consists of plantation higher with 28.07% when compared to other mandals.

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