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Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 05

Res. Jr. of Agril. Sci. (2022) 13: 1605–1609

CARAS

Res. Jr. of Agril. Sci. (Sep-Oct 2022)
13(5): 1605–1609

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

www.rjas.org

Full Length Research Article

Change Detection Analysis of Land Use and Land Cover Changes in Vinukonda, Guntur District, Andhra Pradesh, India Using Geospatial Techniques

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Received: 04 Aug 2022 | Revised accepted: 26 Sep 2022 | Published online: 20 Oct 2022

A B S T R A C T

In order to map the landcover / land use changes in the Vinukonda region of the Guntur district, Andhra Pradesh, India, maximum likelihood supervised classification and post-classification change detection techniques were applied to Landsat 8 OLI/TIRS images taken in 2015 and 2021, respectively. supervised classification was carried out on the six reflective bands for the two images individually with the aid of ground truth data. The LULC maps are classified in to seven different categories, i.e., agriculture crop land, agriculture fallow land, barren/waste lands, built-up Land, dense vegetation, shrubs/sparce vegetation, and waterbodies. Using ancillary data, visual interpretation, and expert knowledge of the area through GIS further refined the classification results. Changes among different land cover classes were assessed. Agricultural crop land and built land have caused a very significant shift in the land cover over the study period. In a part of the study region, these changes in land cover caused vegetation to degrade and water logging.

***Key words*:** Remote sensing, GIS, LULC, Landsat, ERDAS imagine, Waterbodies

Land is utilized for a variety of reasons, including agriculture, industry, recreation, and housing. A region's land use/land cover pattern results from how humans have used social and economic elements through time and space. Due to intense agricultural activity and population pressure, land is becoming increasingly scarce. The natural vegetative cover types that distinguish a certain location are referred to as land cover. Although they frequently reflect the local climate and landforms, they can also be changed by human activity. In developing countries like India, the livelihood of the people mainly depends on the availability of natural resources [1-5]. The land use/land cover pattern related to the distribution of resources spatially available on the Earth's surface. The information of LULC is significant for spatial planning and management activities as it involves in modelling and understanding the Earth's features [6-8].

The word "land use" refers to the human activity or economic purpose connected to a particular parcel. Land use is the management and transformation of the wilderness or natural environment into the developed environment [9-13]. The phrase "built environment" refers to the artificial surroundings created by humans that serve as the backdrops for human activities. Fields, pastures, and villages are all part of the built environment. The term "land use" refers to how humans use the land. Natural resources such as water, soil, nutrients, animals, and plants all suffer significant effects from land use and land management approaches [14-16].

The earth's surface's physical substance is known as the land cover. Grass, trees, barren ground, water, etc. are examples of land cover. The bio-physical characteristics of the earth's surface are reflected in the land cover, which includes populated regions, grassland, woods, rivers, and lakes [17-21]. Due to its nature on the surface of the planet, the land cover changes from place to place and throughout time [22]. There have been many natural changes from the ancient times to the present. During the last few decades, the focus of land-use/land cover change has moved from simple models to realistic models thereby to complex model studies [23-24]. Earlier studies on land use/land cover were mostly concentrated with the physical aspect of the LULC change. Later, it moved towards the global environmental change and thereafter focused on LULC influence on climate change.

A general definition for human modification of the earth's surface is "LULC change." For the sake of collecting food and other supplies of life, humans have been altering the land, and as a result, ecosystems and the environment have changed locally, regionally, and globally. Environmental issues brought on by these changes include climate change, deforestation, biodiversity loss, pollution of land, water, and air. With these viewpoints in mind, an effort has been made to

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analyze the changes in land use that have occurred between 2015 and 2021.

MATERIALS AND METHODS

The study area is located in Guntur District in Andhra Pradesh of India, which lies between 79°34′ 30″ E to 79°52′ 30″ E longitude and 15°54′ 00″ N to 16°07′ 30″ latitude. The climate of the watershed is humid in the semi-arid region. However, winter months are October to January of the study area; the winter seasons of minimum and maximum temperatures were found between 20 to 25 °C, respectively. The watershed area is under the dry land agriculture zone, so the total agriculture land depends on the rainwater and groundwater. So, agriculture crops are affected and decrease the crop yield production. Hence, land-use change is a very important to the development of hydrological process system and agriculture perspective (Fig 1). Total annual rainfall is 850 to 900 mm. The area is situated barren land regions have more compare with other mandals in Guntur. It is a very critical issues that have been facing LULC in the semiarid region. The clay, gravelly, and sandy soils were observed in the area. The chillies, cotton, tobacco, and paddy crops are found in the study area. The study area farmers are much more familiar with rainfed crops. The waterbody, agriculture, and other vegetation, built-up land, and wasteland area are most important to sustainable development and conserve the natural resources.

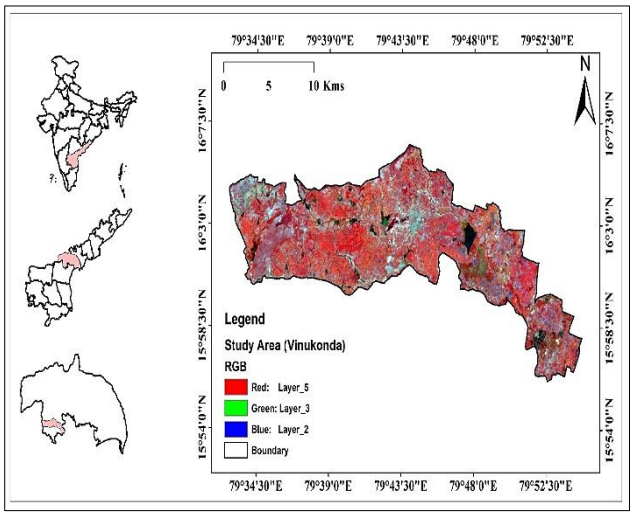

Fig 1 Location map

Data acquired

1. SOI (Survey of India) topo sheet no. 57 J/02
2. Landsat imageries of two dissimilar periods i.e., 2015 and 2021 have been collected freely from USGS earth explorer site (http://earthexplorer.usgs.gov/) and from NRSC site (http://bhuvan.nrsc.gov.in). with the resolution of 30m, datum WGS 1984 and UTM zone 44N.

Software used

1. ERDAS Imagine 2014.
2. ArcGIS 10.8.

The following flowchart demonstrate the adopted methodology for the LULC map preparation (Fig 2).

Processing of data & preparation of LULC map

Data correction have to made for image pre-processing they are likely atmospheric, image matching and mosaic and geometric, etc. with the help of ArcGIS software and toposheet are georeferenced, consuming datum WGS 1984 and UTM zone 44N. After that for the generation of LULC map, Supervised classification was conceded out in ERDAS imagine software. Visual interpretation like tone, texture is crosschecked with the assistance of Google Earth engine in this software with carrying out signature editor option is selected in raster tool [25-29]. Before going to the signature editing, satellite imageries of the study area of the two different years were taken i.e., 2015 and 2021 and layer stacking is done and then proceed to subset option for selecting the study area boundary and these imageries were selected and done as new signature files [30]. For every feature or class has been divided and done by visual observation of the satellite imageries. In this supervised classification a specific signature file has to be prepared for each class. According to signature classification, seen categories (seven features) have identified in the study area, namely (i) Agriculture Crop Land (ii) Agriculture Fallow land (iii) Barren/Waste Lands (iv) Built-up Land (v) Dense Vegetation (vi) Shrubs/Sparce Vegetation (vii) Waterbodies (which is not shown in the LULC maps because in supervised classification it should be considered as zero).

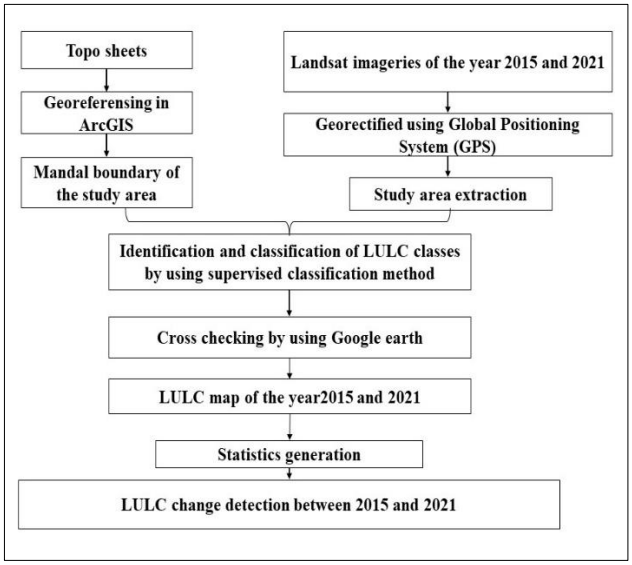

Fig 2 Methodology

RESULTS AND DISCUSSION

The LULC of the study region was assessed by adopting supervised classification techniques, and maximum likelihood classification in the ERDAS Imagine software. During the period 2015 to 2021 the LULC changes are assessed. Fig.3 depicts the LULC of the study area for the year 2015. (Fig 4) depicts the LULC of the study area for the year 2021. (Fig 5) depicts the graphical representation of resultant LULC changes. (Table 1-2) showing the resultant LULC changes during the study period.

Table 1 LULC changes during 2015 to 2021

LULC types	Area Km^2	
	2015	2021
Agriculture crop land	78.11	63.51
Agriculture fallow land	98.48	83.88
Barren / waste land	42.26	30.94
Built-up land	18.30	36.18
Dense vegetation	20.17	26.68
Shrubs / sparse vegetation	15.36	29.10
Waterbodies	7.51	9.91

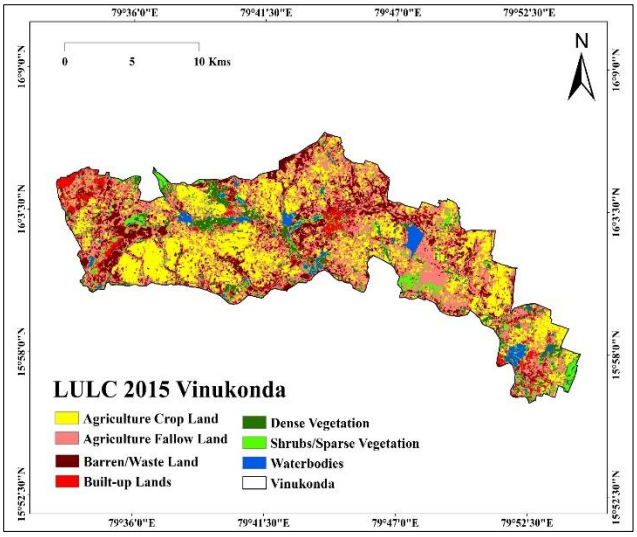

Fig 3 LULC changes in the year 2015

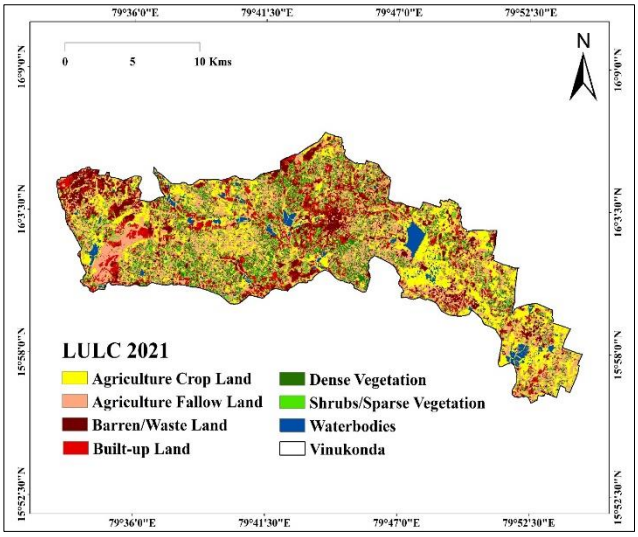

Fig 4 LULC changes in the year 2021

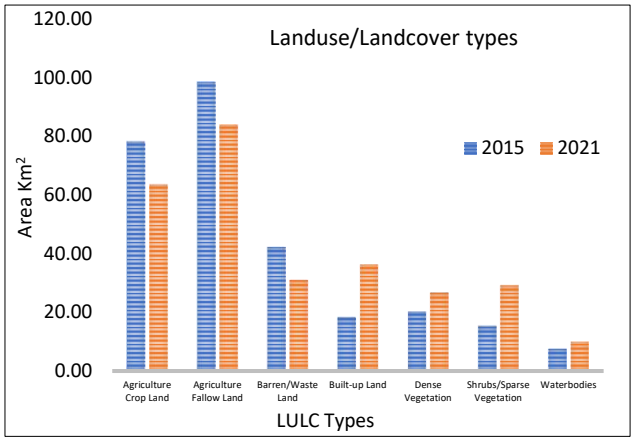

Fig 5 Graphical representation of LULC changes from 2015-2021

Table 2 The resultant LULC changes from 2015 to 2021 in the study part

LULC categories	Changes from 2010-2020	
	Km^2	Percentage
Agriculture crop land	-14.6	5.21
Agriculture fallow land	-14.6	5.21
Barren / waste land	-11.32	4.04
Built-up land	17.88	6.38
Dense vegetation	6.51	2.32
Shrubs / sparse vegetation	13.74	4.90
Waterbodies	2.4	0.85

Changes into agriculture crop land

From the year 2015 to 2021 the agricultural land showing decreasing trend. In the year 2015 the agricultural lands are estimated to be 78.11 km^2, and after six years, i.e., 2021, these agricultural lands decreased and estimated to 63.51 km^2. The results reveal that 14.6 km^2 of agricultural land has loosed and this may lead to degrade the land and reflects to increase in fallow land, barren land, and built-up lands in the study area.

Changes into agriculture fallow land

Basically, the term agricultural fallow land refers to land that is ploughed and tilled but left unseeded during a growing season. During the year 2015 to 2021 the agricultural fallow land showing decreasing trend. In the year 2015 the agricultural lands are estimated to be 98.48 km^2, and after six years, i.e., 2021, these agricultural lands decreased and estimated to 83.88 km^2. The results reveal that 14.6 km^2 of agricultural fallow land has not cultivated. The long-term uncultivated lands lead for agricultural degradation and causes for increase in barren, and built-up lands in the study area.

Changes into barren/waste land

This is a piece of land that is not developed due to lack of water. It changes into crop cover when the water is available to this land; and if it is not available, it goes into bare land. During the study period from 2015 to 2021, the barren lands also showing the decreasing trend, it is because of the increase of settlement in the study area. In the year 2015, the barren lands are estimated to be 42.26 km^2, and in the year 2021, these lands are decreases to 30.94 km^2 the resultant changes are estimated to 11.32 km^2.

Changes into built-up land

Decreasing trend in agricultural lands, agricultural fallow lands, and barren lands leads to increase in the built-up lands. Including all residential, commercial, industrial, and transportation. Now a day's increasing the built-up land / urbanization is very common, because of the increasing of the population. In the year 2015 it is noticed as 18.30 km^2 and it is increased in the year 2021 as 36.18 km^2. Results reveals that built-up-land is increased during the study period and estimated to 17.88 km^2.

Changes into dense vegetation

A dense vegetation cover protects the soil and helps regulate waters movement and surface erosion. In the year 2015 the dense vegetation land cover is estimated to 20.17 km^2, and in the year 2021 it is increased and estimated to 26.68 km^2. Increasing trend has been noticed during the study period from 2015 to 2021. The resultant changes are estimated to 6.51 km^2 of dense vegetation land is increased during the study period in the study area.

Changes into shrubs/sparse vegetation

Land with woody vegetation less than two meters in height is considered to be shrubs or sparse vegetation. In the year 2015, the shrubs vegetation is estimated to 15.36 km^2, and in the year 2021 the shrubs vegetation is increase to 29.10 km^2 during the study period from 2015 to 2021 the shrubs vegetation is increased and estimated to 13.71 km^2.

Changes into waterbodies

A body of water or waterbody is any significant accumulation of water, generally on a planet's surface. Some bodies of water collect and move water, such as rivers and streams, and others primarily hold water, such as lakes and oceans. In the year 2015 water bodies are estimated to 7.51 km^2 and in the year 2021 these are showing increasing trend and estimated to 9.91 km^2. Results reveal that the waterbodies are slightly increased from 2015 to 2021, is 2.4 km^2.

CONCLUSION

This study's objectives were to provide a perspective on the types of land use land cover changes that have occurred over the past six years, to integrate visual interpretation with supervised classification using GIS, and to investigate the potential for combining remote sensing and GIS to study the spatial distribution of various land cover changes. A considerable increase in waterbodies has taken place as well as huge increase in built-up land. The area of natural vegetation has decreased considerably. The agricultural crop lands, agricultural fallow lands are decreases to 5.21 and 5.21% respectively. The waste lands are decreased to 4.04%, the built-up lands are increased to 6.38%, the dense vegetation and, shrubs are increased to 2.32%, and 4.90% respectively. A little increase in waterbodies is noticed and estimated to 0.85%. Integrating GIS and remote sensing provided valuable information on the nature of land cover changes especially the area and spatial distribution of different land cover changes.

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