Land Use Land Cover Changes using Geospatial Technologies and their Influence on the Ecosystem in West Zone of Hyderabad

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Abstract*— Land is regarded as substantial natural resources currently available. Transformations in the Land systems are the result of human interactions with the natural environment. Land Use-Land Cover changes is the central to debate of sustainable development because it has been considering one of driving force of global change that directly affect the status and integrity of ecosystems The urban intensification that has been occurring from the past few decades accompanied in large consumption of resources, habitat fragmentation, loss of green cover and encroachment of water bodies, open land etc. The present study mainly focuses on identifying LULC changes occurring at west zone of Hyderabad in the span of 1991 to 2018 using remote sensing and GIS technology. Maps were developed using Landsat images from USGS Earth Explorer. Image pre- processing and classification technologies were employed and accuracy assessment has performed to validate the output. The obtained accuracy is between 85 to 100 percent for the all classes. Transformation studies show that the open land has been reduced by 36.07% and urban land has increased by 120.85%, vegetation has decreased by 22.55% and water bodies diminished by 20.82 %. These information is useful to the urban planners and local authorities for the sustainable development of urban intensifying cities.

Index Terms—Land Use Land Cover, Landsat, Accuracy assessment, GIS, USGS Earth Explorer

I. INTRODUCTION

Land has proven to be a key component in the development of the human population and is viewed as one of the most significant natural resources currently available. This observation brings into question the recent debates surrounding the pressures people tend to impose on the land, which have resulted in transformations in its physical landscape and usage. Anthropogenic impacts on the earth in terms of the transformations in land cover and land use have rapidly increased over the years. However, as a result of these continuous land transformations, planning and designing sustainable urban development has become challenging due to the additional fact that the available mapped resources of the land can be outdated or of very poor quality. One of the main methods of depicting the significant changes in land cover or land usage is through the utilization of remote sensing and its key application of change detection. Change detection enables the user to analyze the transformations of land use and land cover as it is able to provide consistent coverage at short intervals.

Land use and land cover change (LULC) has been suggested to be the most important anthropogenic disturbance to the environment at a local level, causing various microclimatic changes. Anthropogenic influences on the landscape such as alteration in land use through agriculture, forestry, urbanization have a profound effect on the functioning of the landscape and ecosystems. Change detection is the process of identifying differences in the state of an object or phenomenon by remotely observing it at different times. Remote sensing data is very useful because of its synoptic view, repetitive coverage and real time data acquisition. The digital data in the form of satellite imageries, therefore, enable to accurately compute various land cover/land use categories and helps in maintaining the spatial data infrastructure which is very essential for monitoring change detections studies. One of the main methods of depicting the significant changes in land cover or land uses is through the utilization of remote sensing. Remote sensing is considered to be, "the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation. With the increasing ability to quantify and monitor the expansion of urban environments, remote sensing offers users a set of spatially consistent data, greater spatial precision and an overall higher resolution when compared to that of existing aerial imagery. Combined with the use of Geographical Information Systems (GIS) and Global Positioning System (GPS) tools, remote sensing is able to generate better results for detecting LULC changes.

Water, air and land are considered to be essential components to support any life on the earth. Due to increase in population on the earth there is an increase in the needs of the people. The basic needs of a life include food, water and shelter. To develop the standard of life of human being, many industries and IT sectors are coming up. In order to create shelters different residential buildings and houses are developed. As India is one of the developing countries it has been encouraging various

startups. Due to this accelerating expansion of urban land many of landscape features of different cities has been encroaching and vanishing. In Hyderabad due to development of the city some physical features like vegetation land, water bodies and open land became extinct. In the five zones categorized by GHMC of Hyderabad, West Zone is the area which has been affected greatly due to above fact. So change detection studies will be helpful to urban planners in sustainable development of the city and to regulate the urban expansion.

The aim of this study is to assess and analyse the land use and land cover changes that have occurred in Hyderabad using remotely sensed data and to further understand the socio – economic implications and green cover loss of these changes and to suggest the safety measures to prevent green cover loss from being degraded due to urbanization . Utilising the change detection method of maximum likelihood classifier, the remotely sensed data provided by the United States Geological Survey was analysed to identify the changes that have occurred from 1991 to 2018.

II. STUDY AREA

Hyderabad, the capital of Indian state of Telangana, is located in the central part of the Telangana. Geographically the city is located in the northern part of Deccan plateau, in Southern India on the banks of Musi River. The west zone of GHMC i.e study area is spread over 174 square km with a population 1 million (as per 2011 census) and projected as 17° 32' 18.28" N and 78° 14'20.70"E. It is considered to be an important part of GHMC zones. West zone is blessed with a unique landscape – spectacular rock formations which are about 2,500 million years old; amongst the oldest and hardest rocks in the world. Rocky and hilly regions around the city are under obliteration for urbanization. Granite ridges and hillocks weathered into picturesque balancing forms are a part of the Deccan Shield area. Grey and Pink Granites are among the world's oldest. Crops are commonly grown in the surrounding paddy fields. The city's soil type is mainly red sandy with areas of black cotton soil. West zone falls in the seismic zone-II and is seismically least exposed to earthquakes. According to India Meteorological Department, the summer months of April & May 2009 recorded the warmest temperatures since 1901, with mean maximum temperatures hovering frequently at around 42 °C with maximum temperature touching 45 °C.

The west zone area consist of 4 circles that are 11, 12, 13, 14. GHMC has categorized hyderabad into five zones: East zone (L.B nagar), west zone (serilingampally), north zone (Kukatpally), central zone (khairathabad), south zone (charminar). The areas included in this west zone are serilingampally (circle11), chandanagar (circle 12), patancheru and Ramachandrapuram (circle 13), moosapet (circle 14A), Kukatpally (circle 14B).

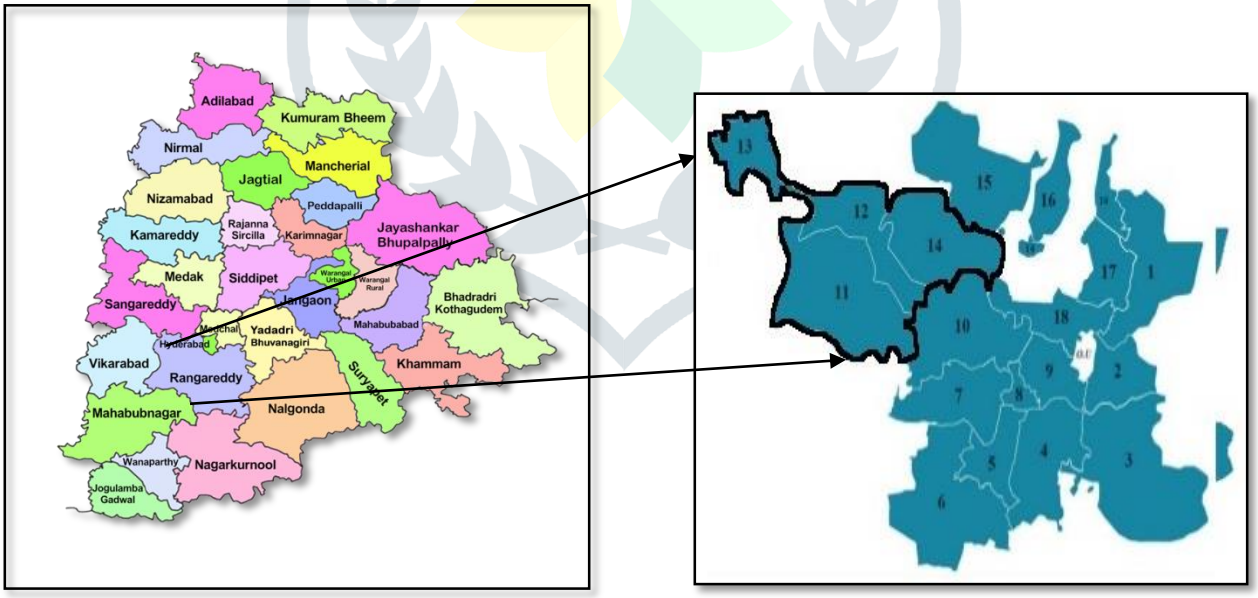


Fig 1 Location of study area

III. METHODOLOGY

- **Data Collection**

While carrying out research, there are many factors which need to be consider especially with respect to the manner and adopted approach to the process of collecting the data. The present study involves collecting the Toposheets from the Survey Of India and the city map from the Greater Hyderabad municipal corporation and relevant authorities. For the present purpose E44M6& E44M7 Toposheets are requires as the west zone of Hyderabad comes under above maps.

Details of Toposheet

Scale: 1:50,000
Projection: UTM
Datum: WGS 84

The data products are collected from USGS Earth Explorer contains spatial resolution of 30m, which are used for the LULC Change Detection Analysis.

Table-1 Details Of Landsat Data Collected

S.NO	DATE OF IMAGE	SATELLITE/SENSOR	REFERENCE SYTEM/PAH/ROW
1	27-01-1991	Landsat5/TM	WRS-2/144/48
2	12-01-2001	Landsat7/ETM+	WRS-2/144/48
3	18-01-2011	Landsat7/ETM+	WRS-2/144/48
4	29-01-2018	Landsat7/ETM+	WRS-2/144/48

With the wide scope of data and information provided by the remote sensing process, determining changes or transformations in LULC has become increasingly easy, cost efficient and more importantly, a source of reliable information.

- **PRE-PROCESSING OF COLLECTED DATA**

All the downloaded images from USGS earth explorer contains multiple bands which are to be stacked to get a composite image. All the stacked images are initially processed and projected to Universal Transverse Mercator system. Other techniques like periodic noise removal , Histogram equalization etc are performed to enhance the quality of the images. Toposheets were collected from Survey of India and city maps collected from Greater Hyderabad Muncipal Corporation which are used as a base map. These base layers used to subset the area of interest which is considered as a study area.

The extracted images from Landsat imagery are shown in the Figure below

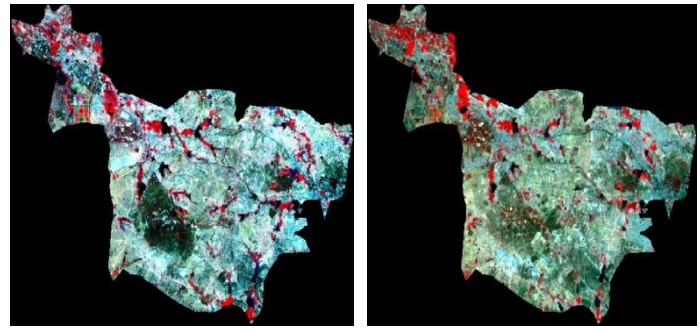
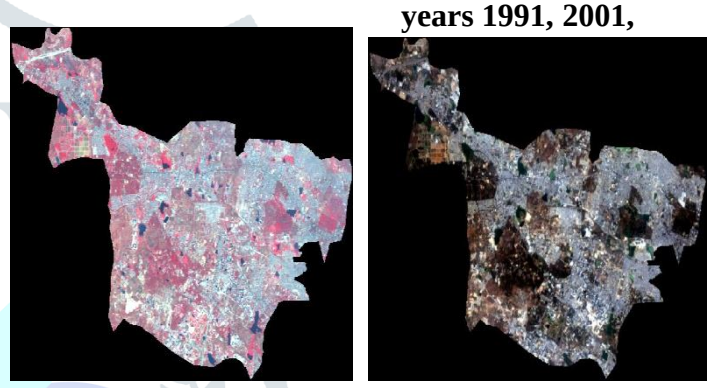


Fig 2 Images of Extracted study area for the years 1991, 2001,



2011 and 2018

IV. IMAGE CLASSIFICATION

Image classification is regrouping all image pixels into a number of classes which are defined by the user.

Supervised classification uses maximum likelihood classifier algorithm. This algorithm is directed by calculating the likelihood that specified pixel belongs to a set of classes which are predefined, subsequently the algorithm continues by allocating every pixel to the specific class to which the probability is highest. Four classes were identified in this classification which is water bodies, vegetation, urban land, open land.

- **Identification of LULC Classes**

In order to ensure that the correct land cover classes were used for this research study, data such as Google Earth imagery and online aerial photographs were utilised to outline potential land cover classes prior to conducting the required field work. Although this process may seem tedious, it allowed for an overall visual assessment of the study site and permitted a shortlist of land cover classes to be identified with the area in question. As a result, the following land cover classes were identified for this specific study: Water body, Vegetation, Urban land, Open land.

Table -2 Types of classes used for Classification

S.NO	Class Name	Description of the Land cover type
1	Water body	Land covered with water
2	Vegetation	Land consist of dense and low vegetation, plants, Grass
3	Urban land	Built up land like roads, buildings, other structures
4	Open land	Barren land, Rocky knob

V. ACCURACY ASSESSMENT

It comes under post classification procedure after performing the essential digital classification process, conducting accuracy assessment is the next important step in LULC change study.

It is used particularly to express the degree to which a classification is considered as correct. Assessment of remotely sensed data is of ultimate important. There are numerous causes behind undertaking an accuracy assessment, as, "to arrange an overall measure of the map quality and an attempt to understanding of errors".

It relates the classified image to another source data that is considered to be accurate. Besides, accuracy assessments have been considered to be both a qualitative and quantitative in nature. Accuracy assessments with quantitative in nature are based on the quantified parameters which are comparable, while assessment of qualitative features are based on visually comparing results found to that are seen on the surface of the ground.

VI. RESULTS & DISCUSSIONS

The classified images produced after preprocessing and supervised classification showing the Hyderabad city west zone region land use land cover are specified in the following figures. These classified images showing the information about geomorphology i.e physical features of the earth of study area. The blue colour indicates the waterbodies, green colour represents the vegetation land, red colour urban land and cream colour shows the open land.

- **LAND USE LAND COVER IMAGES AFTER CLASSIFICATION**

Given below are the images obtained after classification for different years as shown in figures 3 to 6.

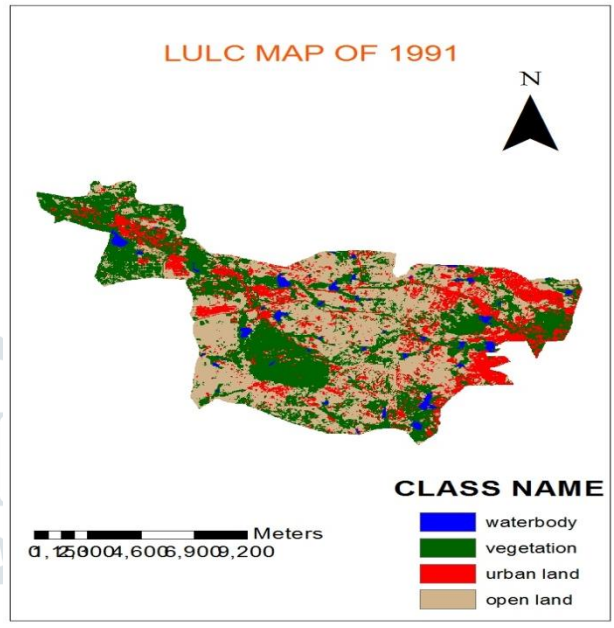


Fig 3 After Classification LULC Map of the study area in 1991

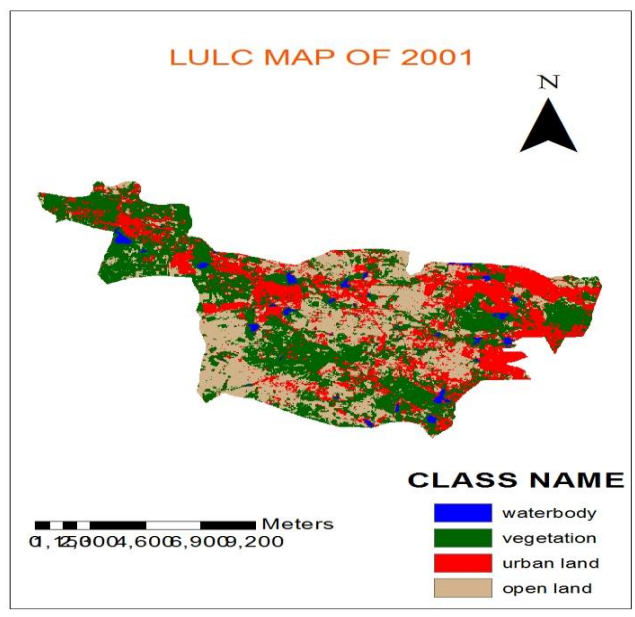


Fig 4 After Classification LULC Map of Study Area in 2001

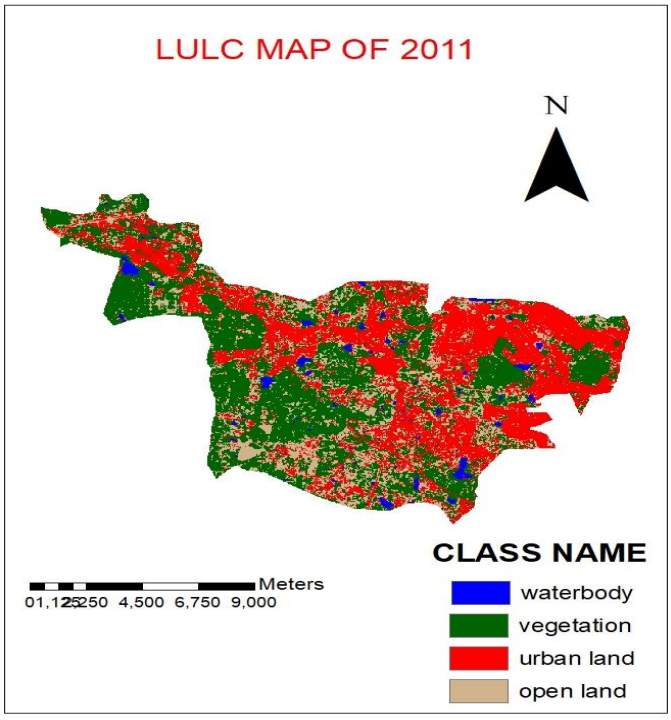


Fig 5 After Classification LULC Map of Study Area in 2011

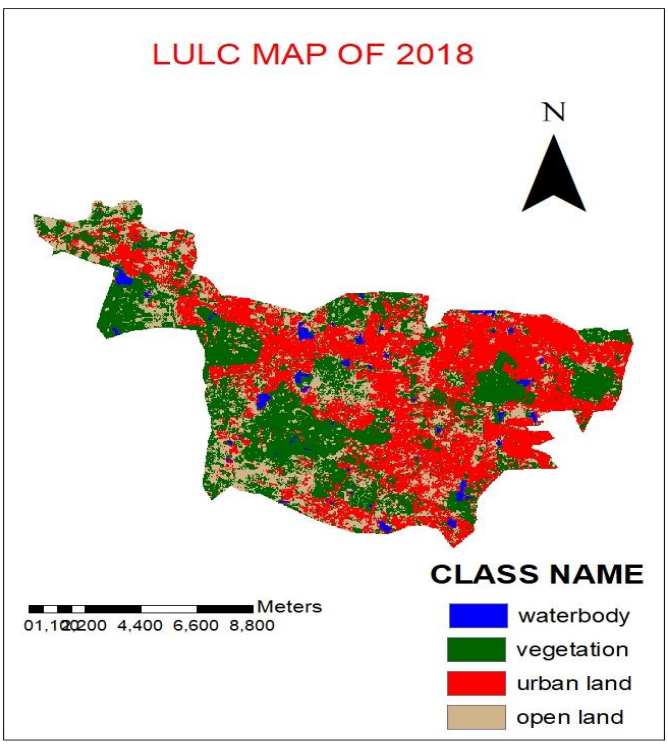


Fig 6 After Classification LULC Map of Study Area in 2018

- **Accuracy Assessment Report**

Given below are the accuracy report obtained after classification for different years shown in table 3 to 6.

Table-3 Accuracy Assessment Report For the Year of 1991

1991		
CLASS	**PRODUCER'S ACCURACY**	**USER'S ACCURACY**
Water bodies	100.00%	100.00%
Vegetation	87.50%	100.00%
Urban land	100.00%	93.33%
Open land	100.00%	91.67%
Overall classification Accuracy	95.16%	
Overall kappa statistics	0.928	

Table-4 Accuracy Assessment Report For the Year of 2001

2001		
CLASS	**PRODUCER'S ACCURACY**	**USER'S ACCUACY**
Water bodies	100.00%	100.00%
Vegetation	86.84%	100.00%
Urban land	93.75%	88.24%
Open land	100.00%	81.82%
Overall classification Accuracy	91.78%	
Overall kappa statistics	0.871	

Table-5 Accuracy Assessment Report For the Year of 2011

2011		
CLASS	**PRODUCER'S ACCURACY**	**USER'S ACCURACY**
Water bodies	100%	100%
Vegetation	100%	98.33%
Urban land	97.87%	100%
Open land	95.45%	95.45%
Overall classification Accuracy	98.45	
Overall kappa statistics	0.975	

Table-6 Accuracy Assessment Report For the Year of 2018

2018		
CLASS	**PRODUCER'S ACCURACY**	**USER'S ACCURACY**
Water bodies	100.00%	100.00%
Vegetation	86.67%	100.00%
Urban land	100.00%	96.67%
Open land	91.67%	84.62%
Overall classification Accuracy	94.83	
Overall kappa statistics	0.918	

- **LAND USE LAND COVER CHANGE DETECTION ANALYSIS RESULTS**

Land use land cover change detection analysis has been conducted and shown in table 7.

Table -7 Land use land cover change detection for the years 1991, 2001, 2011 and 2018

		1991	2001	2011	2018
S. No.	**Name of the class**	**Area in ha**	**Area in ha**	**Area in ha**	**Area in ha**
1	Water body	379.17	281.88	335.97	300.91
2	Vegetation	7727.32	7143.48	7170.57	5984.71
3	Urban land	3289.59	4821.66	6432.84	7265.28
4	Open land	5973.74	5122.8	3430.44	3818.92

VII. CONCLUSIONS

In order to examine the change in LULC which has taken place in the west zone area of Hyderabad, Landsat images were acquired, classified and finally analyzed. Attention towards monitoring and observing patterns, trends of different types of features, land cover in specific area becoming necessary so LULC transformation study became important parameter and Particularly with changes in LULC occuring at such unprecedented and rapid rate, remote sensing can provide details and overall alteration of one land cover type to other.

The water body class between1991-2001 has experienced decrease of 25.65% and the transformation between 2001-2011 was 281.88 ha to 335.57ha and from 2011-2018 was minor i.e from 335.57 ha to 300.19 (-10.63%). It is because of programs conducted by the lake protection committee which is initiated by HMDA identified some new kuntas in GHMC west zone region. The overall decrease in water bodies from 1991 to 2018 identified as (379.17 ha to 300.19 ha) 20.82%.

The output generated from this study within the time period from 1991 to 2018, indicates that vegetation land between 1991-2001 decreased by 7.55% and between 2001-2011 change in area obtained as 0.37%.It is due to the several factors like high rainfall average and programs which were initiated by HMDA in association with Royal Netherlands department under the GHEP. Overall change in vegetation land from 1991 to 2018 obtained as -22.55%.

The other important class built-up land was experienced major transformation between 1991 -2001 as in the same decade open land has decreased by 14.24%. From these analysis it is clear that most of the land transformation was at the cost of conversion of open and vegetation land to the built-up area.

Continuous long term land use land cover change detection is necessary as it helps in the process of land management and decision making in account of ecosystem's organisms and natural process. The impact of land use land cover changes will have an effect on species present in the ecosystem. Disturbances in the ecosystem like urbanization, pollutants discharge into the water body may lead to spread of non invasive species like water hyacinth which in turn effects the lake ecosystem. In order to plan and implement meaningful policies and effective schemes to sustain regional development, there is a crucial need to know the land use/land cover patterns in a particular region

- **SAFETY MEASURES**

Urban containment policies considered to be basic tools for management of urban growth which are widely used to regulate urban sprawl, to shape growth of urban spaces, to conserve open spaces.

There are three important parameters of urban containment policy, they are

1. Urban Service Boundary

2. Urban Growth Boundary

3. Green belt

USB: It is delimited area beyond which urban services such as water, sewer are not provided.

UGB: It is not a physical area , but a separating line drawn around an urban place to divide it from surrounding rural areas.

Green belt: It is a physical area eg: forest, farmland or other green place, which surrounds the metropolitan area or a city and it is considered to be a barrier to control urban growth permanently.

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