



MONITORING OF LAND USE/LAND COVER CHANGE AND URBAN SPRAWL OF TIRUPATI: A FAMOUS PILGRIM CENTRE IN INDIA

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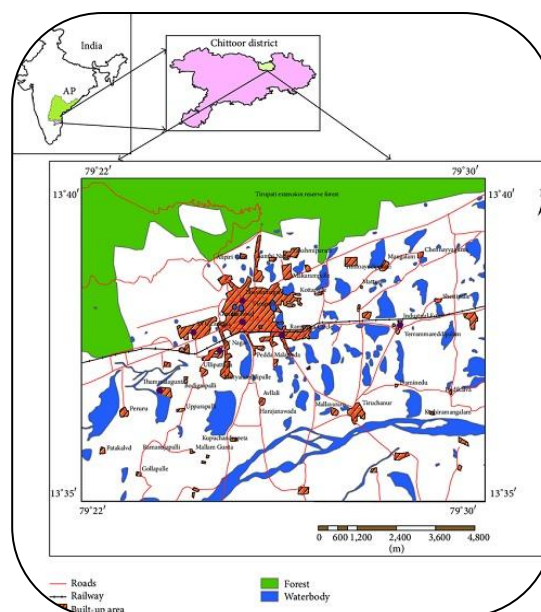
ABSTRACT:

Monitoring of land use/land cover change overtime has been widely used in recent years. Generally, land use category is complicated that needs land use/land cover classification. This study explores the spatial and temporal characteristics of urban sprawl and land use/land cover changes of Tirupati, a world famous temple city in South India. In this paper subset of Landsat TM and ETM images acquired in 1991 April and 2001 February respectively and also ortho rectified IRS(Resource Sat-2) LISS-III acquired on 28th January 2016, were used for land use/land cover classification. A supervised classification with maximum likelihood classifier has been applied. Based on this classification the land use was categorized into 6classes: Urban, Forest, Water, hill rock, agriculture land and vacant land. The remotely detected land use changes from 1991-2001 shows a drastic change and increase in urban area of Tirupati. The trends of land use/cover change indicate significant changes in urban, agriculture and vacant land.

KEYWORDS: Monitoring, land use, land cover, supervised classification.

INTRODUCTION :

Monitoring of land use/land cover change overtime has been widely used in recent years. During the last Ten Years, much more attention has paid to urban land use/land cover change because ecosystems in urban areas are strongly affected by human activities and have close relationship with the life of almost half of the World's population (Stow and Chen,2001).Growth of Urban population and Urban Centres is becoming a major issue in the World since 20th century. Urban population is growing 3 times faster than rural population. By 2030 more than 60% of World's Population



and 50% of India's population will be urban. India has experienced unprecedented growth of population over the past three decades. At present India's population is 1.3 billion, 29%of whom live in urban areas, projected to increase nearly 50% by 2030. More than half of the urban population of India are living in small and medium Towns. With this rapid urbanization we are facing so many problems like urban expansion, loss of natural resources, environmental pollution and degradation etc. Hence it is need to shift the focus on such urban areas and its sprawl for balanced urban growth.

URBAN SPAWRL

The boundary of the city or an area expands as its population increases. This expansion is nothing but urban sprawl. Urban sprawl is not easy to define. It is a phenomena that occurs around / outside of the urban area. It refers to the extent of urbanisation, mainly

driven by population growth and migration. One of the prerequisite for understanding urban sprawl is successful land use change detection. This is made possible by accurate registration of the satellite imageries. The urban sprawl was studied by many researchers in developed countries (Batty et al.,1999;Torrens and Alberti,2000; Hurd et al.,2001; Epstein et al.,2002) and in developing countries such as China (Yeh and Li,2001;Cheng and Masser,2003) and India (Jothimani,1997;Lata et al.,2001 and Sudhira et al 2003).

Some of the common causes for the urban sprawl are population growth, Economy,Job opportunities, Infrastructure development etc. Generally sprawl leads to Increase of urban area and decrease of agricultural land, forest, open space and water bodies. The direct implication of urban sprawl is the change in land use and land cover of a country/region.

LAND USE (LU) / LAND COVER

Land use is defined as series of operations on land taken by human to obtain products/ benefits using land resources. Land use is defined as “the type of human activity taking place at or near the surface” (Cihlar and Jansen,2001).Land cover is defined as observed bio- physical cover on the Earth's surface (FAO,2000).Land cover refers to the Physical description of land where as land use refers to the purpose of the land.A change in LU leads to change in land cover, but LC may change even without LU change. Both terms are improperly used in practice, but their meanings are quite different. The rapid land cover changes are characterised by urban sprawl(Dewan et al.,2012,Liu et al.,2014) and form land displacement(Du et al.,2013). The study of land use /land cover change is very important for planning and utilization of resources and their management.

Generally, land use category is complicated and it needs land use/land cover classification. This study explores the spatial and temporal characteristics of urban sprawl and land use/ land cover changes of Tirupati, a world famous temple city in south India.

WHY SELECTION OF TIRUPATI AS STUDY AREA?

Tirupati is medium in size but a very fast growing city in India. Its population growth rate is higher than that of State (A.P) and Country during the past four decades. Being a pilgrim and education center it attracts many people and face lot of environmental problems with inadequate basic amenities. The town is not equipped to meet the needs and demands of the present population and floating population. Hence it is need to focus on Tirupati as study area for urban sprawl.

Aim and Objectives

The broad aim of the present study is to make an application of remote sensing for generation of spatial data.

Objectives

1. To identify various land uses and the patterns of urban sprawl by using Remote sensing data.
2. To reveal the main causes responsible for urban sprawl and land use/ land cover change.

Study area

Tirupati is a famous temple city located at the foot of Seshachalam hill ranges(Eastern ghats) in chittoor district of Andhra Pradesh, India. Geographically Tirupati is situated between 13°34' to 13°45' North latitude and 79°15' to 79°35'E longitude and an altitude of 500ft above Sea level. It is the gate way of Tirumala and daily more than one lakh pilgrims are coming to this place. It has a semi-arid climate. The summer temperature varies from 25° to 40° and winter temperature ranging from 14°-30° Celsius. Tirupati is well connected with other parts of the country by Road, Rail and Air. It is getting an average rain fall of 400mm /year. The populations of this city go on increasing starting from the first census taken in 1871.

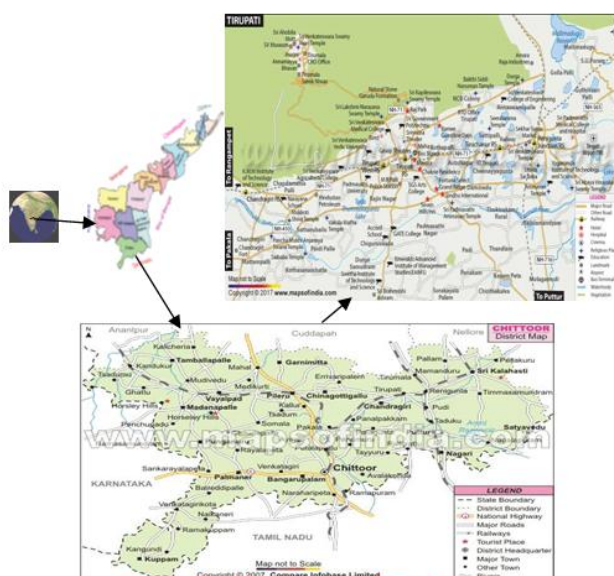


Figure1: 1.Location of Study Area

MATERIALS AND METHODS

1)Analog data:

Survey of India Topographic map56 O/6 of 1:50,000 scale

2)Statistical data:

Population data from chittoor district Census Hand book and Town Directory.

3)Digital data:

Land Sat TM and ETM images (path143/row050) acquired on10.4.1991and 24.2. 2001 were used to generate digital data and maximum likelihood unsupervised and supervised classification were done with ENVI software. Orthorectified IRS(Resource Sat-2) LISS-III image acquired on 28th January 2016(path 101 row064) with 23.5Metre resolution and a swath of 141Kms was also used in this study and on -screen digitization with visual interpretation was done using this IRS LISS-III image to monitor the land use/ land cover change of Urban sprawl of Tirupati. A schematic methodology has been depicted in Flow chart- Figure2..



Figure2: Flow chart showing the Methodology

In this study the Land sat images were rectified and geometrically corrected using 16 ground control points (GCPs). All the GCPs were verified in the Operational Navigation Chart (ONC) of scale 1:1000, 000 and toposheet No.56 O/6 of 1:500000 scale. Overall root mean square error (RMS) was less than 0.5. Then it was

resampled to pixel size 28.5mts. Resampling was done using nearest neighborhood method. After geo-referencing images were displayed in false color composite (FCC) (7, 4, 2) for better visualization and identification of land cover. The training area was generated. A six class classification system was designed and supervised classification with maximum likely hood classifier was used to detect the land cover.

Data analysis

Urban sprawl dynamics has been analysed considering some of the factors such as Population, Geographical area population density etc. Population growth of Tirupati has been analysed using Census of India data for Ten decades. A unique feature of Tirupati is that the population of Tirupati is continuously increasing from 1911-2011. The Table below reveals that starting With a population of 16701 in 1911 to 459985 in 2011 a twenty five year fold in ten decades.

Table1: Growth Trends of Population in Tirupati

Name of the town	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	2011		
Persons	16701	17434	19138	20143	25207	36845	71984	123847	210705	303521	459985		
Devition		733	1704	1005	5064	0638	29998	49449	86858	92816	156464	303521	459985
%Deviation		4.39	9.77	5.25	25.14	42.20	99.69	72.10	52.57	44.05	51.55	44.05	51.55

Source: Census of India



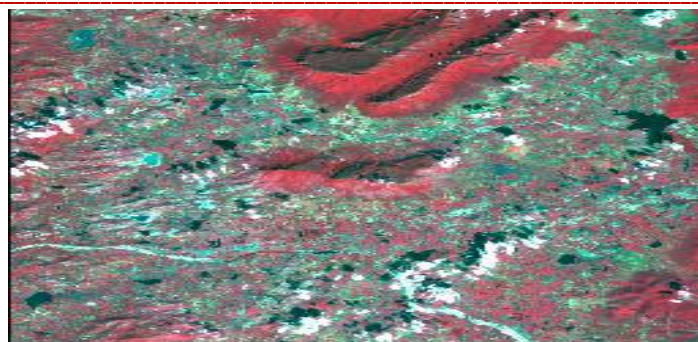
Figure3: Selection of GCP points



(a) TM image1991

(b) ETM image 2001

RGB(Red :Band 7 , Green: Band 4 , Blue: Band 2)



c) IRS LISS-III Image 2016

Figure 4 : Satellite Images(a,b,c) before classification

RESULTS AND DISCUSSION

Land use of Tirupati

The comparison of two classification maps showed that urban area has increased in contrast to agricultural land; vacant land & forest are decreased. Rapid urban sprawl observed around Tirupati in star shaped pattern along transportation lines. But towards East it appears in linear or ribbon pattern along the roads and railway line. The growth is more towards South and North East but limited towards West and North West.

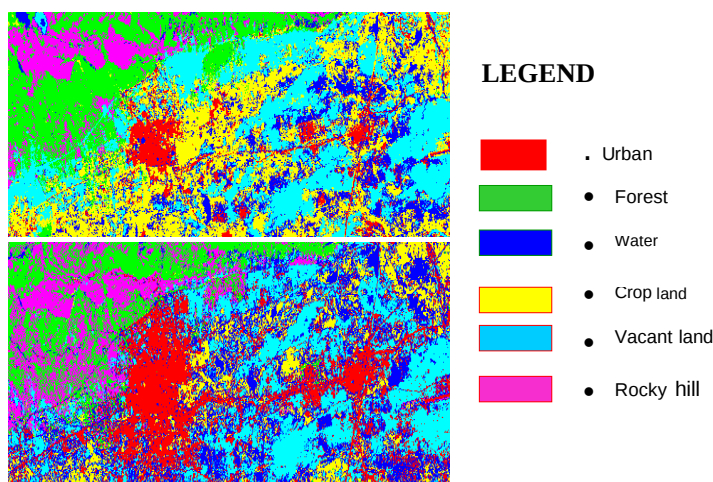


Figure5: Classified maps of land use/cover of Tirupati in 1991 and 2001

Table1: Land use of the Tirupati in different classes

Class name	1991		2001	
	hectares	%	hectares	%
Urban	619	5	1446.5	14
Forest	1278	12	1136.5	11
Water	164	2	310.0	3
Agriculture	2902	30	2066.4	20
Vacant	4350	42	3926.1	38
Rocky hill	1019	9	1446.5	14

The loss of agricultural land and vacant land is more apparent towards the East and South of Tirupati town where the town growth is more. There is limited growth towards Northern side because of the existence of reserved forest and also there is an ordinance not to develop any constructions beyond the radiance of about 20 K.M to the holy temple. However, the bottom of the hills was occupied by built-up areas. With human interference and ravaging fires the green part decreased from 1991 to 2001 as observed from maps. The trends of land use/cover change revealed that urban expansion has been associated with loss of agricultural, forest and vacant land.

Table2: Accuracy assessment

Year	Over all Accuracy %	Over all Kappa Statistics %
1991	84.5	0.85
2001	86	0.87

The trends of land use/cover change revealed that urban expansion has been associated with loss of agricultural, forest and vacant land.

Causes responsible for urban sprawl

Tirupati is not an industrial town but has been attracting large number of people because of its religious & educational importance. The factors responsible to grow Tirupati are:

- Establishment of educational institutions
- Job opportunities, religious activities and
- Increase of transportation facilities especially after the formation of Andhra Pradesh state and construction of second Ghat Road to Tirumala.

Only with these aspects, the town developed into a religio- academic center in a short period. In addition to this, natural increase of population and improvement of other amenities after the establishment of Tirupati Urban Development Authority (TUDA) in 1981 are the other factors that influenced Tirupati urban expansion.

CONCLUSIONS

Urban Population in Tirupati experienced 25 fold increase in 10 Decades. Both statistical and remotely sensed data showed a drastic change and increase in urban area of Tirupati during 1991-2001. According to the study it is concluded that considerable land use /cover change revealed urban built up area that has been increased, while agricultural and vacant land decreased. It also became evident for the first time that the town of Tirupati had doubled in size and that most of the development was happening outside the municipal limits. This has tremendous pressure on basic civic amenities. The town is not equipped to meet the needs and demands of the present population and thousands of floating population for pilgrimage. The results of this study based on Landsat data suggested that visual interpretation of imagery is reliable and effective technique for detection of urban change with the help of town maps and local knowledge. It is essential to identify an urbanizable zone and plan for infrastructure in this area in the near future to avoid problems of unplanned growth.

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