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Urban SPRAWL Modelling for then using RS and GIS

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ABSTRACT

Theni is the one of the Agricultural based city in Tamil Nadu due to the population increase its more urbanized. The urban Sprawl modelling for the Theni town was made and the comparative built up area was calculated. A comparative study of land use land cover of the Andipatty taluk under Theni district of Tamil Nadu was done using remote sensing and GIS techniques. The period under study was 2004-2017. Since in this 13 years there has been massive growth all over India the rate of growth was massive. Multi-temporal Landsat Imageries (LANDSAT 5 and LANDSAT 7) were obtained in this study. Arc GIS 10.4 had been used. Erdas Imagine 14 was used for land cover classification. It was classified into three categories: Built-up area, Vegetation and Water bodies. Land cover maps were generated and change detection analysis was performed. There was a steep rise in the built-up area and it continues to encroach on the forest and vegetation. There was also a second method where the area was digitized and land use was classified in ArcMap for two different years.

Keywords: *Remote Sensing, GIS, Urban SPRAWL, Modelling, Land Use, Land Cover, etc.*

1. INTRODUCTION

Unplanned rapid urbanization is one of most important factors of loss of biodiversity and has been identified as the driver of deforestation in India post 1990 .The process of preparing visionary documents such as developmental plans are ineffective considering the fact that spatial patterns and dynamic behavior of growth is not considered and lack of skills and tools to help in informed decision making The dynamically increasing urban growth is driven by the fact of availability of land resources and ageing pattern .Urban growth model should be flexible to identify the specific pockets of development to aid in making absolute and informed decisions .Many studies suggested that traditional large-scale urban simulation approaches existing in early 90's were based on theories, and suffered from significant weaknesses such as poor handling of space-time dynamics and too much generalization of data. The demographic transformation of human societies into the urban era has pushed the monitoring of urban areas to the forefron0t of environmental and developmental agendas. Due to this transformation, a higher percentage of the world's population currently resides in urban areas than ever before, and growth in urban areas is occurring at an unprecedented rate. Accordingly, many South Asian metropolitan areas have experienced dramatic urban growth, dominated by the continuous shrinking of rural areas into urban areas. This trend has been characterized by massive congestion, poor public transportation, and a noticeable lack of proper sanitation in South Asian metropolitan areas. It has also increased socioeconomic disparities, crime, and vulnerability to natural and man-made risks. In this context, an assessment of spatiotemporal patterns of land-use/cover changes and the factors affecting these transformations is vital to developing rational, economic, social, and environment policies.

2. STUDY AREA

Theni is bounded by Dindigul District to the north, Madurai District to the east, Virudhunagar District to the southwest, and Idukki district of the Kerala State to the west. A range of hills which runs parallel to Western Ghats from north to south separate it from the Kerala. Theni District is divided into two natural divisions: The hilly areas constituted by parts of the three taluks Periyakulam, Uthamapalayam and Andipatti with thick vegetation and perennial streams from the hills on the western side and Cumbum valley which lies in Uthamapalayam taluk. This district is surrounded by the Western Ghats, with it ubiquitous green stretches of cultivated lands and tea gardens. Silk cotton, soft towels, coffee seeds, cardamom, mango, are the main produce of the district. Theni district is the main route for the tourist bound from Madurai to Kochi via Bodinayakanur and Munnar and Madurai to Thekkadi wildfife sanctuary. Theni is the district headquarters. It is a business center for cotton, chili, textiles, etc. It is connected by Rail and Road to Madurai. The nearest Airport is Madurai. Good network of Road links all destinations within the District, State and Country.

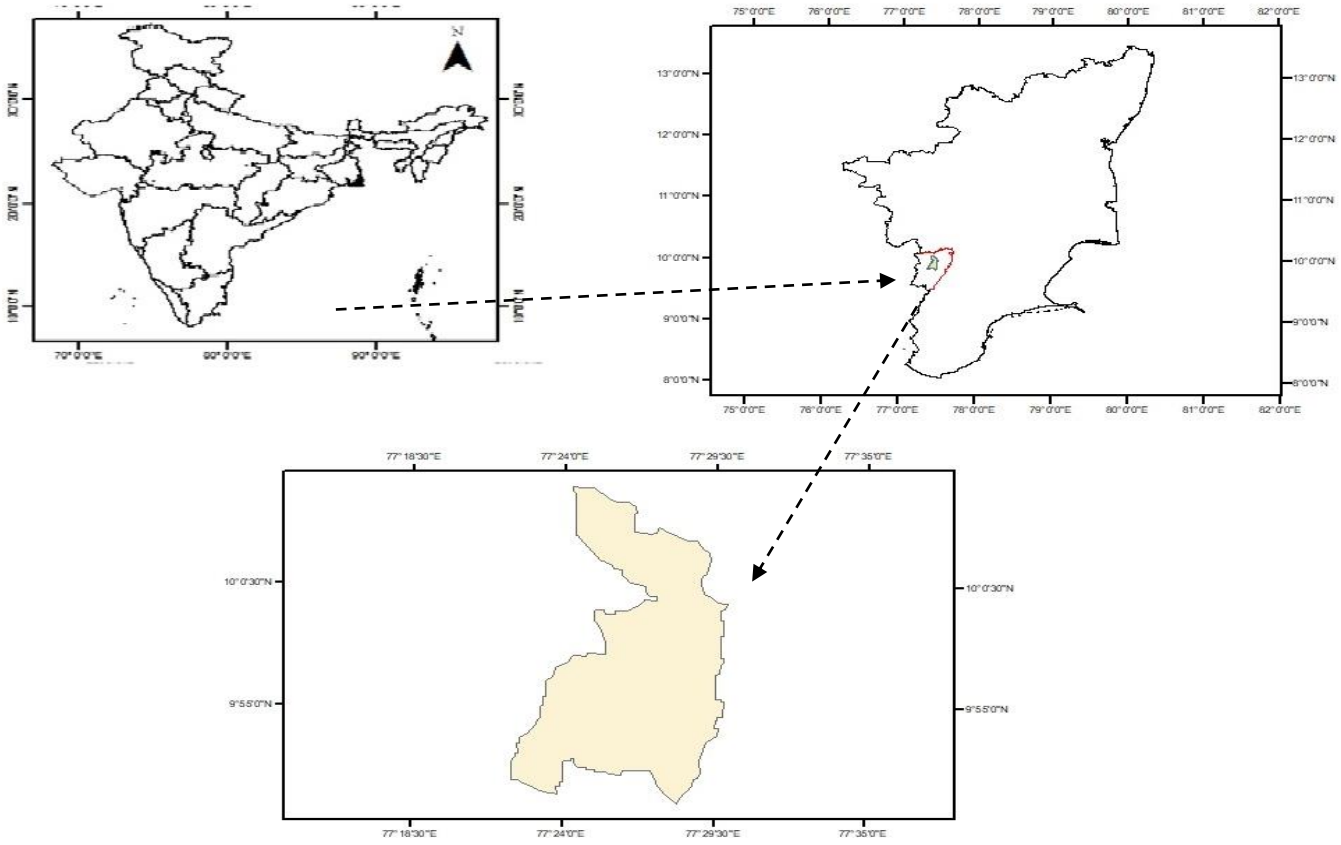


Fig-1: Location Map

3. OBJECTIVES

The aim of this study is to estimate land surface temperature by the following objectives in order to persuade the aim are,

- Identify the patterns of urban sprawl;
- Analyse the urban sprawl pattern through remote sensing and geographic information systems techniques
- Analyses of causal factors of urban sprawl and
- Modelling of sprawl in urban environment.
- Identify the pattern of urban Sprawl.

4. MATERIALS AND METHODS

4.1 Data Used

Landsat 8 is one of the Landsat series of NASA (National Aeronautics and Space Administration). The data of Landsat 8 is available in USGS (United States Geological Survey) Earth Explorer website at free of cost. Landsat 5 &7 satellite images the entire earth once in 16 days. In the present study, the bands Short infra-red 1, near infra-red and red are used to identify and classify the built up area in the study area. Bands, Wavelength and Resolution of Landsat 5 and 7are as given in Table – 1.

Table–1: LANDSAT 5&7

BANDS	WAVELENGTH (Micrometers)	RESOLUTION (Meters)
Band 1 – BLUE	0.45 - 0.52	30
Band 2 –GREEN	0.52 - 0.60	30
Band 3 –RED	0.63 - 0.69	30
Band 4 –NEAR INFRA RED(NIR)	0.76-0.90	30
Band 5 – SHORT WAVE INFRA RED(SWIR)1	1.55-1.75	30

Band 6 – THERMAL	10.40-12.50	120*(30)
Band 7 – SHORT WAVE INFRARED (SWIR)2	2.08-2.35	30
Band 8 – PANCHROMATIC (Landsat 7)	0.52-0.9	15

4.2 Software's Used

- Arc GIS Pro 2.0
- ERDAS IMAGINE 2015
- Iridis

4.3 Methodology

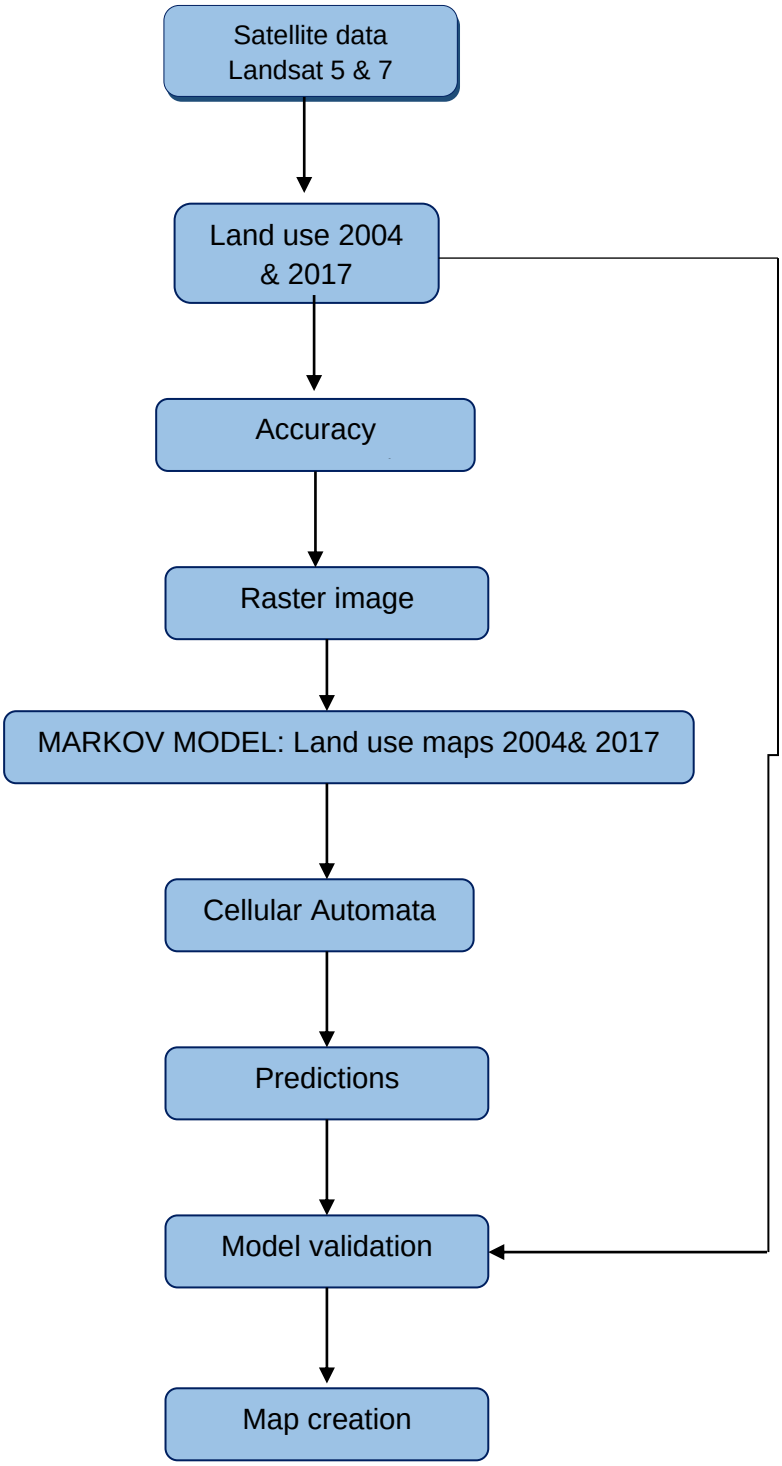


Fig – 2: Flowchart

4.3.1 Process

Markov Chain

A markov chain is a stochastic process (based on probabilities instead of certainties) with discrete or continuous parameter space with markov property. In this random process the current state of variable or system is independent of all past states, except current/present state. In simple, the state of a system at time (t+1) depends only on the state of system at time t, not on the previous states. Some examples of Markov processes are flow of traffic, Behavior of business or economy (stock /share price), Progress of an epidemic etc.

In a markov chain the probability of the next state is only dependent upon the current state. this is called markov property and stated as:

$$P(\xi_{t+1} = X_{it+1} | \xi + X_{i1} \ldots\ldots\ldots \xi t = Xit) = P(\xi_{t+1} = X_{it+1} | \xi = X_{it})$$

The probability of Markov chain can be ξ1, ξ2 …… can be calculated as:

$P(\xi_1 = X_i \ldots. \xi_t = X_{it}) = P(\xi_1 = X_{i1}).\ P(\xi_2 = X_{i2} | \xi 1 = Xi_t).$

$\ldots\ldots P(\xi_t = X_{it} | \xi_{t-1} = X_{it-1})$

The conditional probabilities:

$$P(\xi_{t-1} = X_{it-1} | \xi_t = X_{it})$$

These are called the 'Transition probabilities' of the Markov chain

Transition matrix for Markov Chain

Let's consider a Markov chain with n states $s_1, s_2 \ldots s_n$.

Let pij denote the Transition probability from State sj, i.e

$P(\xi_{t-1} = S_j | \xi_t = S_i)$

The transition Matrix of this Markov Process is Defined as:

$P = .p_{ij \geq 0.}$

$$\begin{pmatrix} p11 & \ldots & p1n \\ \ldots & \ldots & \ldots \\ pn1 & \ldots & pnn \end{pmatrix}$$

5. RESULTS AND DISCUSSION

The urban modelling for the Theni town for the 2004 is shown in the fig. 2.

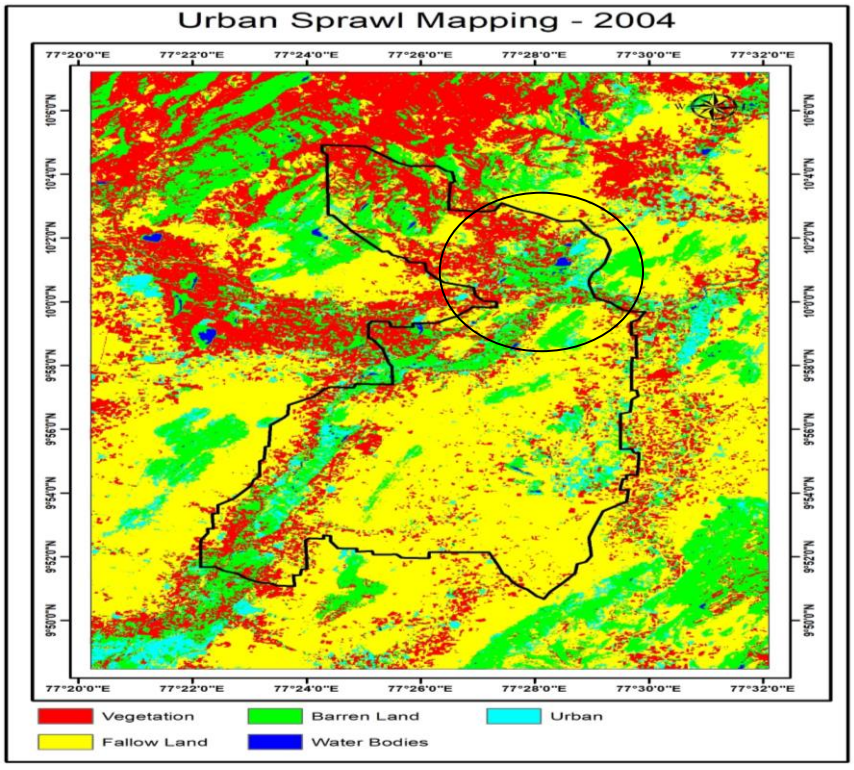


Fig – 2: Urban Sprawl Mapping - 2004

The highlighted area shows the urban patches in the main city.

Table – 2: Percentage of area occupied by the different categories

Category	No. of Pixels Taken in ROI	Total No. of Pixels after Classification	Percentage
Vegetation	2042	363421	27.14
Barren Land	7751	614497	18.72

Water Bodies	1039	676463	4.65
Urban	1770	1339039	4.22
Fallow Land	1107	1282456	45.25

The urban modelling for the year 2017 is shown fig.3. The urban sprawl in 13 years is wide and highly accumulated in the main town area.

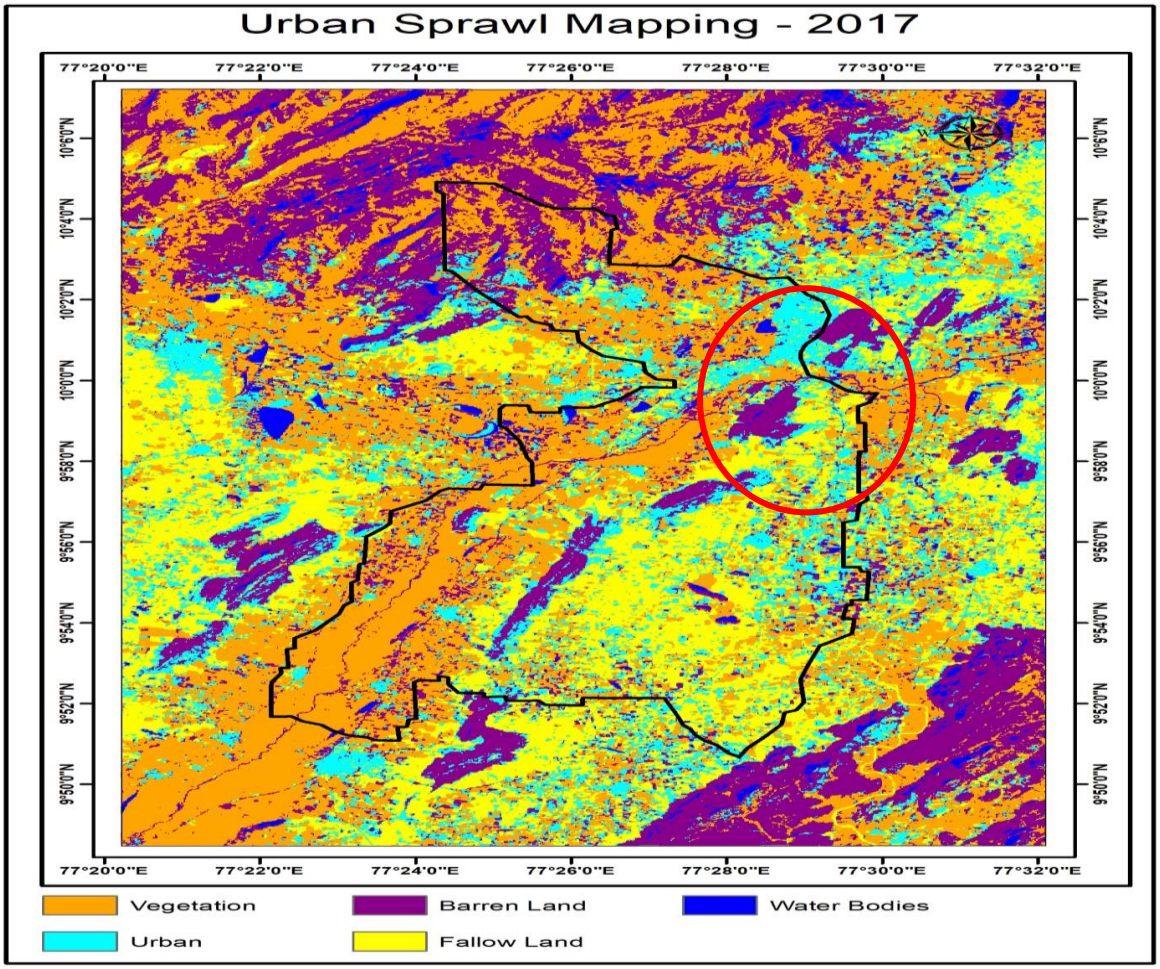


Fig-3: Urban Sprawl Mapping - 2017

Table – 3: Percentage of urban and agricultural land have been increased on the other hand the water bodies and fallow land have been decreased

Category	No. of Pixels Taken in ROI	Total No. of Pixels after Classification	Percentage
Vegetation	2042	433924	37.22
Barren Land	7751	727014	25.14
Water Bodies	1039	751325	2.08
Urban	1770	913378	19.90
Fallow Land	1107	1165554	21.63

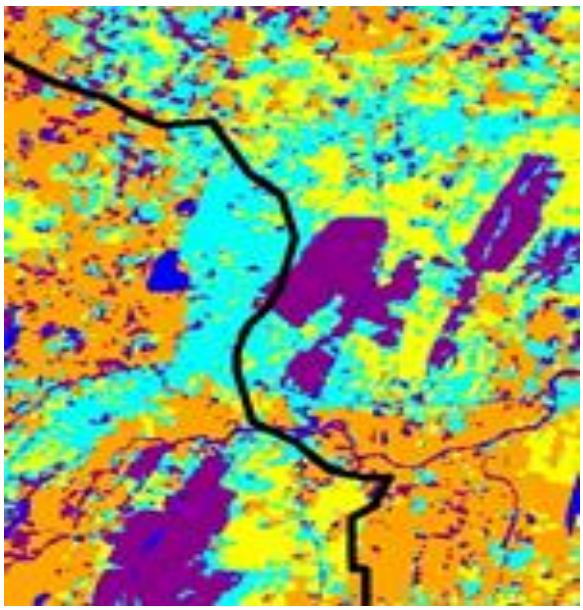


Fig – 4: Year 2017

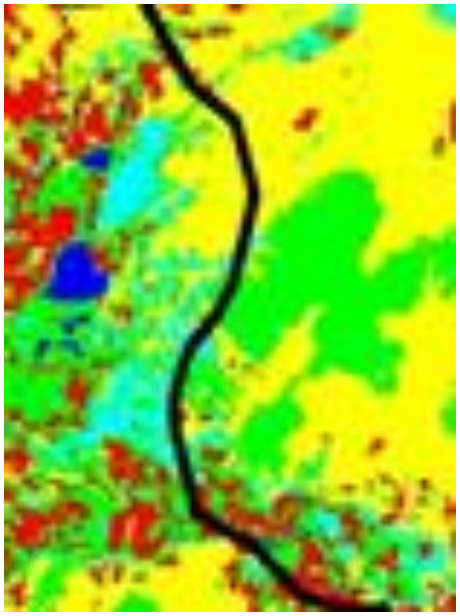
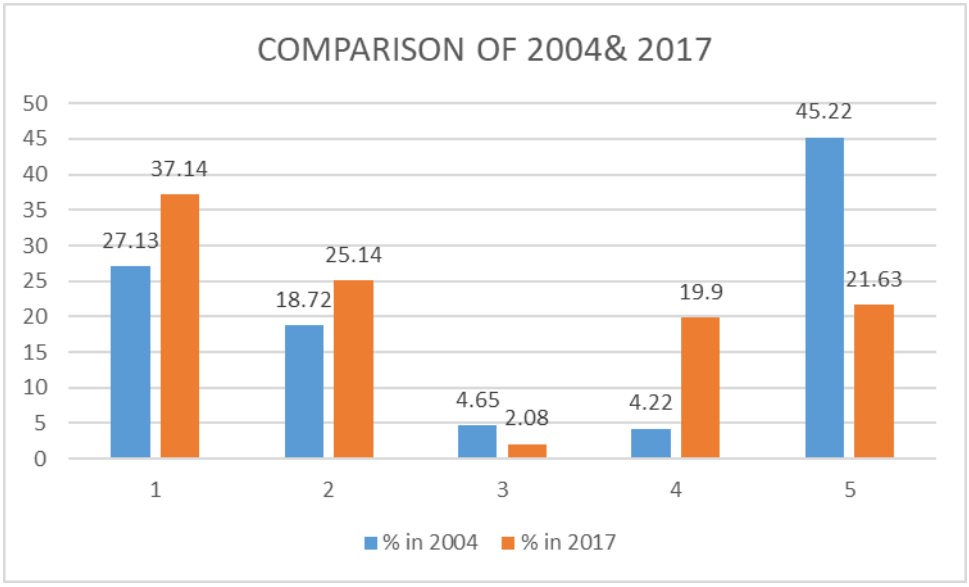


Fig – 5: Year 2004

The above figure 4 and 4 shows the same main town of Theni in the years 2017 and 2004 respectively



6. CONCLUSION

The geo spatial study of Urban Sprawl of Theni, Tamil Nadu has brought out interesting aspects and current facts in respect to land use. The results of this study were based on image classification and interpretation. The maps for two periods were prepared which brought out the situation where Theni has urbanized to an extent where more waterbodies are turned into Built up within the city. GIS and RS tools is found as very useful for analysis the urbanization. The government and other local bodies shall make use various map prepared in this study for planning and monitoring the changes. The percentage of water bodies and fallow land in 2004 was 4.65 and 45.25 respectively where this is reduced to the percent of 2.08 and 21.63 respectively in 2017. on otherhand the builtup was increased from4.22 to 19.9 in 2017.thus urban sprawl modelling was obtained.

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