DYNAMICS OF URBAN SPRAWL DIRECTION OF MADURAI CITY, TAMIL NADU USING DIGITAL IMAGE PROCESSING OF UNSUPERVISED CLASSIFICATION TECHNIQUE

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Abstract: The continuous changes are in the land use and land-cover types in Madurai city, Tamil Nadu in the past 30 years. The major change is the conversion of agriculture and forest lands into urban areas mostly in an unplanned manner making urban sprawl characterizing the urban change dynamics. The principal aim of this research was to apply remotely sensed data, geospatial tools to detect, quantify, analyze, and detect the urban land use changes of Madurai city using Remote Sensing (RS) and Geographical Information System. Madurai City, located in South Central Tamil Nadu, is the second largest city after Chennai and is the headquarters of Madurai District. In 2011, the jurisdiction of the Madurai Corporation was expanded from 72 wards to 100 wards covering area 151 Sq.Kms. It is extended geographically from 9^0 50‟ North latitude to 10^o North latitude and 78^0 02‟ East longitude to 78^o12‟ East longitude, and approximately 100 m above MSL. The corporation limit was extended from 52.18 km^2 to 147.9 km^2 in 2011. As per 2011 census, the population of the city is 15.35 lakhs. The city spreads over 147.9 km^2 which divided into 100 wards for administrative purpose. The ultimate objective of the research is to detect the land use/land-cover change of Madurai city from 1996 to 2006. Satellite images of Madurai city at different periods, 1996, 2006, and 2016 were analyzed. The software programs that have been used in this study to process, quantify, analyze and change detection are ArcMap 9.3.1 and ERADAS 9.1. Change detection techniques namely post-classification comparison (indirect method) and image-to-image comparison change detection (direct method) were employed. Post-classification comparison change detection was conducted to reveal the direction of the areas that have changed over the period of 30 years.

Keywords- Urban Change, Urban Sprawl, RS, GIS, Madurai Corporation

I. INTRODUCTION

The modern technology of remote sensing which includes both aerial as well as satellite based systems, allow us to collect lot of physical data rather easily, with speed and on repetitive basis, and together with GIS helps us to analyze the data spatially, offering possibilities of generating various options (modeling), thereby optimizing the whole planning process. These information systems also offer interpretation of physical (spatial) data with other socio-economic data, and thereby providing an important linkage in the total planning process and making it more effective and meaningful. State of history of urban growth indicates that urban areas are the most dynamic places on the Earth's surface. Even though their regional economic importance, urban growth has a considerable impact on the surrounding ecosystem (Yuan et al., 2005). Digital image processing provides an opportunity to use the same data at different scale as per the requirements. Satellite data with 1 m spatial resolution or higher can be used to prepare cadastral level map as well as to extract land use/ land cover information at city level. Satellite data with 30 m spatial resolution from Landsat has been successfully used to monitor the urban growth. Most often the trend of urban growth is towards the urban-rural-fringe where there are less built-up areas, irrigation and other water management systems. In the last few decades, a remarkable urban growth has occurred in the world, and demographic growth is one of the major factors responsible for the changes. Urban growth is happening in common almost all countries over the world though the rate of growth varies. Currently, these are the major environmental concerns that have to be analyzed and monitored carefully for effective land use management. The rapid urban growth and the associated urban land cover. Land degradation results mainly due to population pressure which leads to intense land use without proper management practices (Prakassam, 2010)

II. STUDY AREA

The study area consists of plain section with a few rock outcrops. The geology of the study area comprises the archaen rocks with quartizites, complex gneiss and charnokites. A small section of the Vaigai river flows in the northern part of this panchayat union. The study area has only one canal namely Nilaiyur Channel a branch Canal of the Periyar canal which takes off from river

Vaigai. The study area experiences semi arid tropical monsoon type of climate with an average temperature of 28.1oC. Analyzing the season wise distribution pattern of rainfall a significant amount of rainfall was received during the North East monsoon accounting for about 44.2 percent of the total rainfall. This is followed by the Southwest monsoon (38.10 %) and summer (15.7%). Winter months have received a low amount rainfall. Thus the monsoon seasons have received about 82.3 percent of the total rainfall. The annual rainfall amount fluctuates from year to year. The rainfall variability is about 25 percent and as such rainfall is less reliable. Hence the need arises to substantiate the water requirements for crops through irrigation. Well and tank irrigation plays a significant role in the agriculture of the study area. The total population about 59.6 percent lives in rural settlements and 40.4 percent, in urban settlements. The literacy level (51%) recorded in Thirupparankundram Panchayat Union for the 1981 census is higher than that of Madurai district (46.6%) and Tamil Nadu State (45.8%). Regarding occupational structure about 38.3 percent are classed as workers. About 46.6 percent of the workers are engaged in agricultural activities. About 22 percent of the workers are classed as cultivators and about 24.6 percent of workers are classed as agricultural labourers. About 45.6 percent of the workers are engaged in other than agricultural activities. (Chandramohan et al).

III. AIMS AND OBJECTIVES OF THE PRESENT STUDY

The main aim of this research is to apply Remotely Sensed data, GIS technique to detect, quantify, analyze, and urban land use changes.

The following were the specific objectives of the research:

1. Extracting the satellite Imagery by Digital Image Processing techniques of unsupervised classification method
2. To Identify urban movement direction.

IV. METHODOLOGY

Image classification and analysis operations are used to digitally identify and classify pixels in the data. Classification is usually performed with multi-band data sets and this process assigns each pixel in an image to a particular class of theme based on statistical characteristics of the pixel brightness values. For the study, Landsat satellite images of Madurai city were acquired for 3 decades; Landsat LISS-III 1996, 2006, and 2016. The Epochs were obtained from Global Land Cover Facility (GLCF) an Earth Science Data Interface.

4.1 Unsupervised Classification

The goal of unsupervised classification is to automatically segregate pixels of a satellite image into groups of similar spectral character. Classification is done using one of several statistical routines generally called "clustering" where classes of pixels are created based on their shared spectral signatures. Clusters are split and /or merged until further clustering doesn't improve the explanation of the variation in the scene. No extensive prior knowledge of the region that is required. The opportunity for human error is minimized because the operator may specify only the number of categories desired and sometimes constraints governing the distinctness and uniformity of groups. Many of the detailed decisions required for supervised classification are not required for unsupervised classification creating less opportunity for the operator to make errors. Unsupervised classification allows unique classes to be recognized as distinct units. The selected method should fit the research questions, available data and resources (Modara et al, 2013).

4.2 Land use and Land Cover

The remote sensing (data products) technology to provide them information on existing land use and their periodic updating and monitoring. In addition, with appropriate technique and methodology the same data products can be used to Study urban growth/sprawl and trend of growth. To achieve this study the two different land-covers and land use classes were analysed. These values quantify the percentage change in each land cover category. Remote Sensing and GIS technique has the capability of monitoring such changes, extracting the change information from satellite data relies on effective and accurate change detection technique (Dhanasekarapandian et al, 2015). The change 'from to' makes post classification change detection so unique. The other task is the detection of the urban expansion as described in the post classification change detection processes. Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures (Erle Ellis, 2016). In order to determine the "urban sprawl" the images for 1996, 2006 and 2016 were classified as shown in figures 1, 2 and 3. The results indicate a moderate growth of towns in the study area. The town is recorded with moderate to fast urban growth. Distribution of landuse-preference weights differs as a function of scale (Tom P.Evans and HughKelley, 20047). Town expansion is attributed to the commercial and industrial activities. The increasing conservation effort should be made to protect the Mediterranean-type forests and scrublands, as well as traditional agricultural practices (Luigi Maiorano and Luigi Boitani, 2007). The intra-regional variations in growth are mainly associated with acceleration of economic activity, transportation network, administrative and government interventions. The smaller area coverage compared to other LULC classes, except for grass land (Eshetu Yirsaw et al, 2017). LULC change associated with deforestation and agricultural extensification and intensification (Stephen J Walsh et al, 2001).

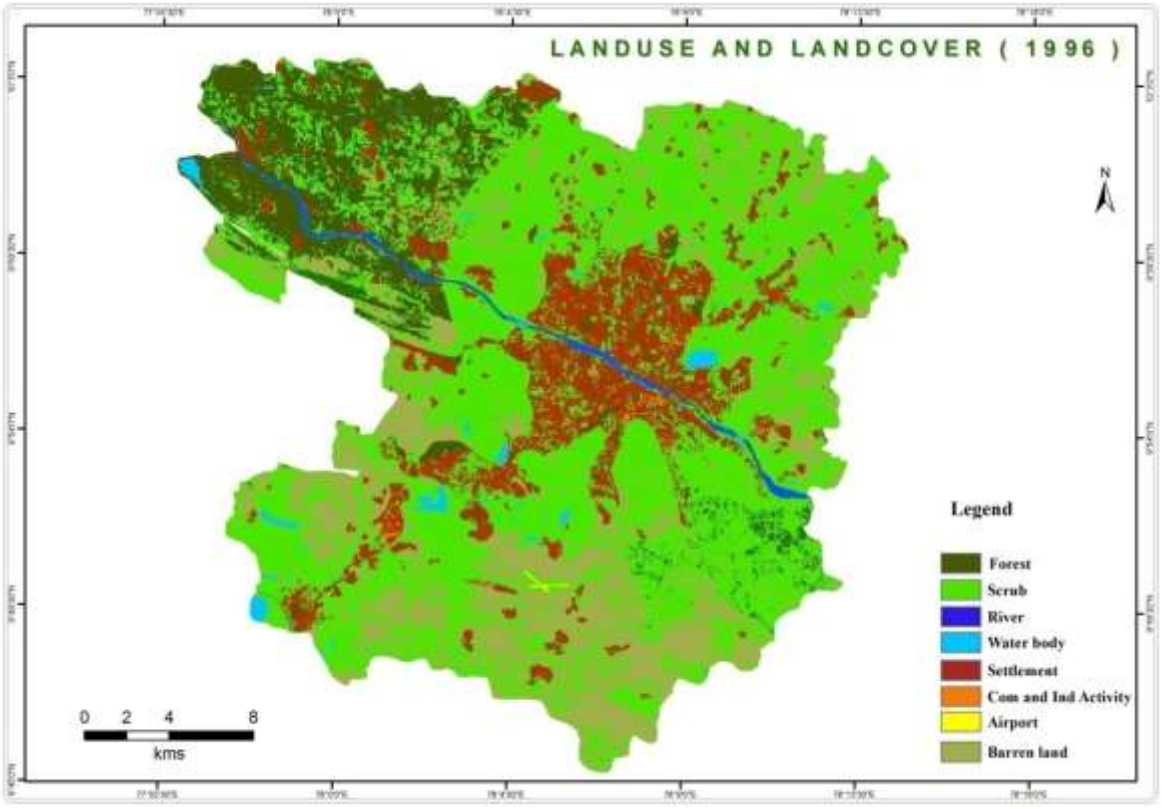

Figure.1 Land use and Land cover in Madurai LPA (Local Planning Area) year 1996

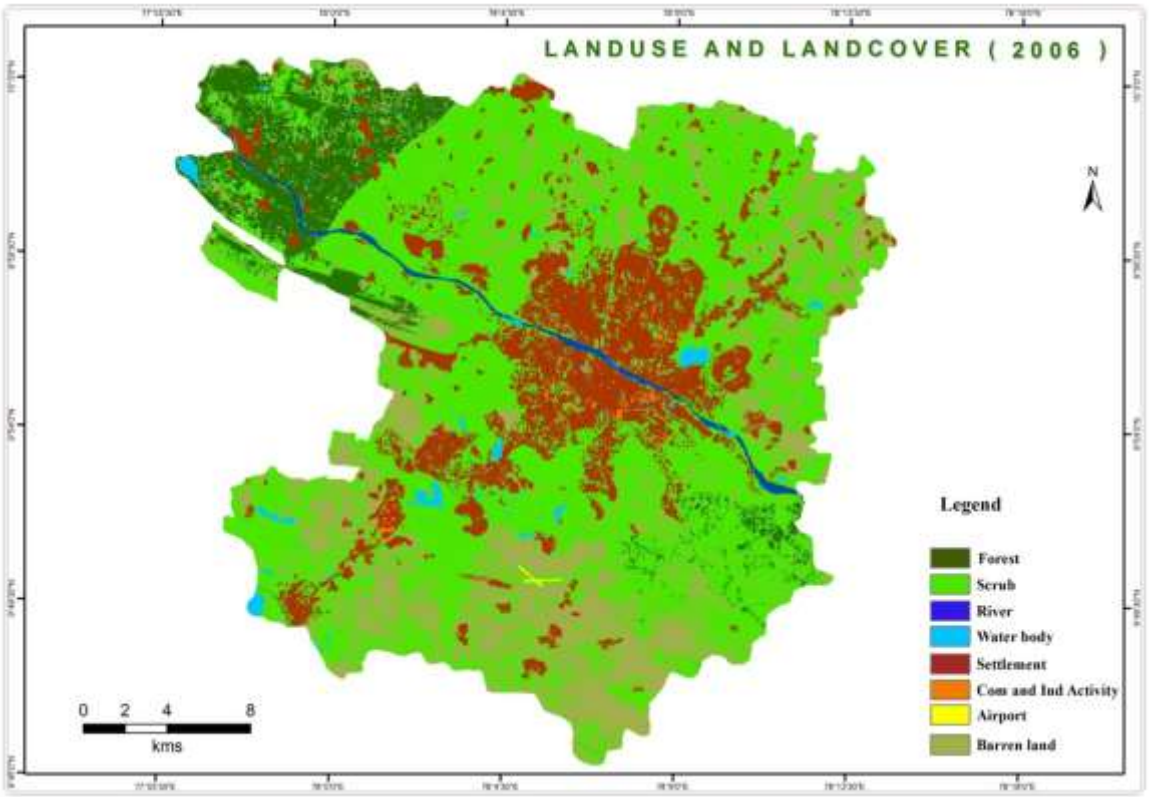

Figure.2 Land use and Land cover in Madurai LPA (Local Planning Area) year 2006

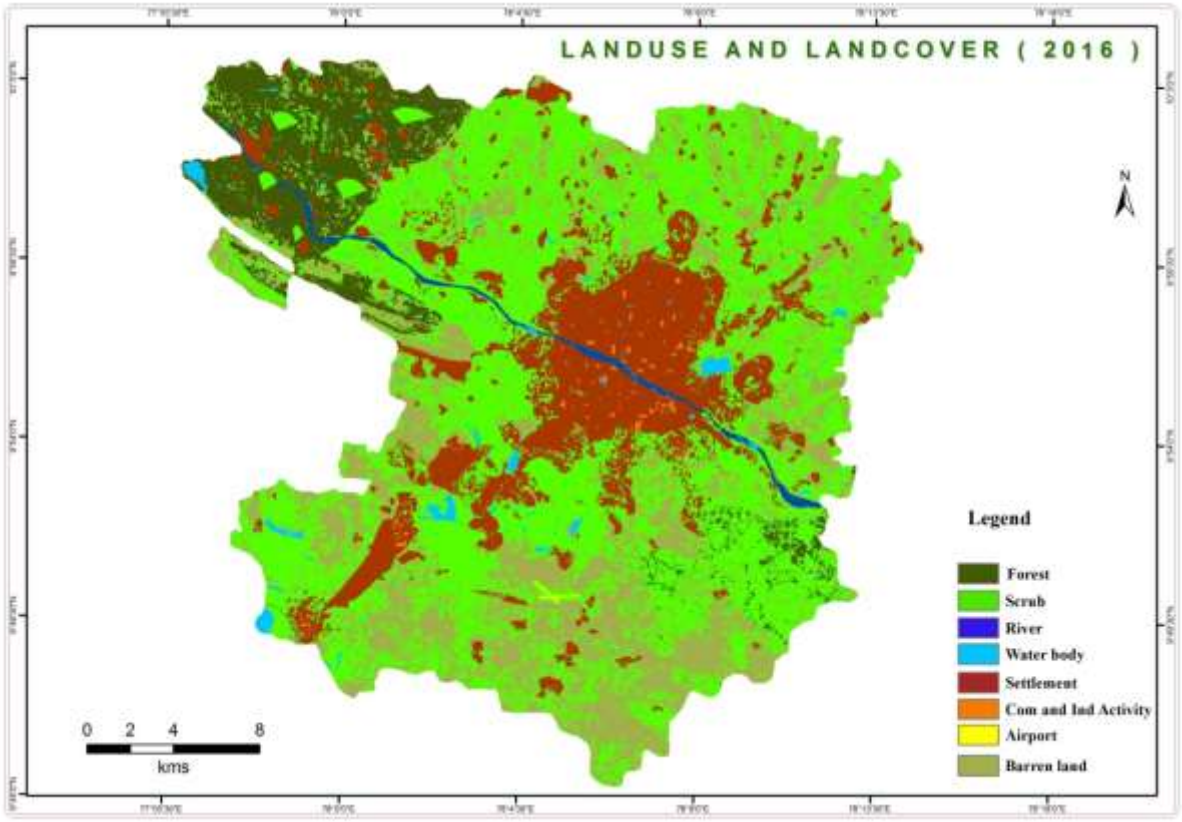

Figure.3 Land use and Land cover in Madurai LPA (Local Planning Area) year 2016.

Table.1 Area of Land use and Land Cover Classification Based on Unsupervised Classification Techniques. Area calculation present in Hectares

CLASSIFICATION	**1996**	**2006**	**2016**
Forest	9841	5866	3874
Scrub	53028	39407	30931
Barren land	5289	14189	20313
Settlement	3186	12076	16293
Commercial activity	77	174	571
Water body	1050	804	653
River	700	643	531
Airport	21	33	24
	73191	**73191**	**73191**

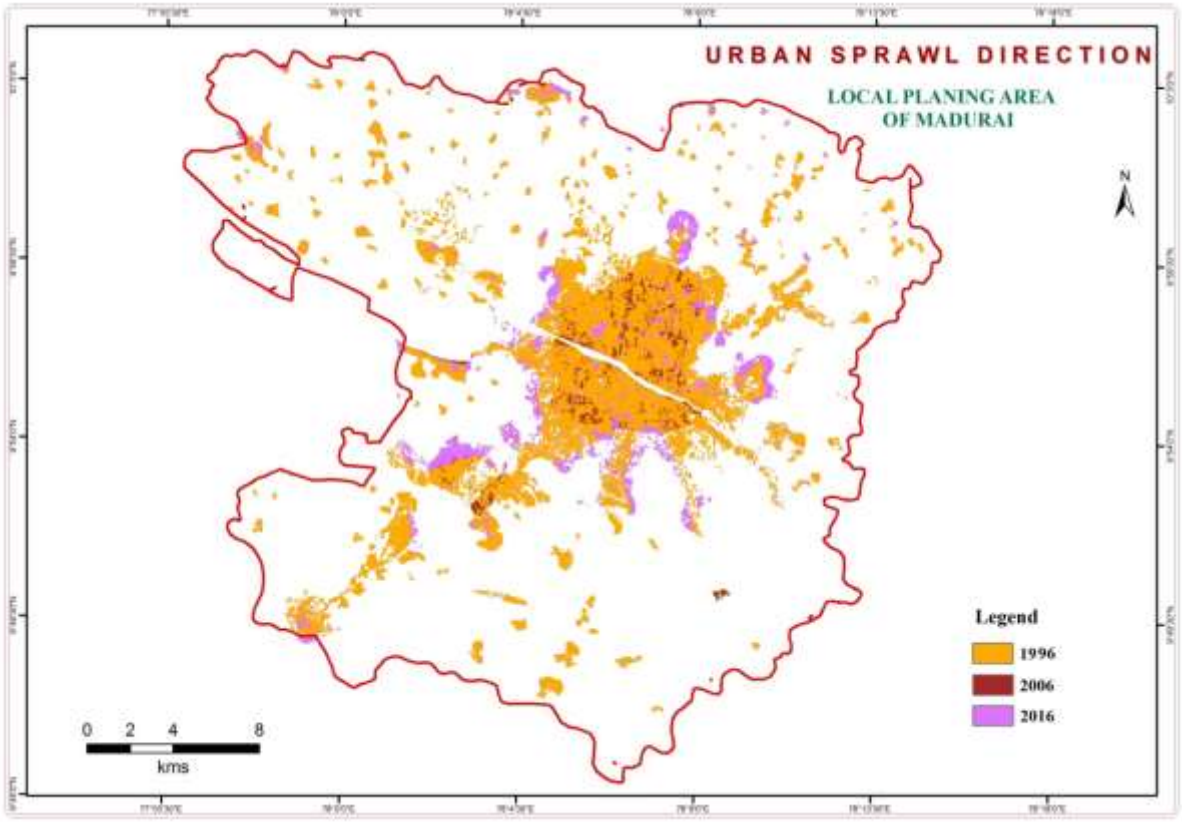

Figure.4 Urban Sprawl Direction Map

Table.2 Percentage and Variations land classification within 1996 to 2016

CLASSIFICATION	1996	2016	VARIATIONS OF 1996 TO 2016
Forest	13.45	5.29	-8.1515
Scrub	72.45	42.26	-30.1908
Barren land	7.23	27.75	20.5276
Settlement	4.35	22.26	17.9080
Commercial	0.10	0.78	0.6755
Water body	1.43	0.89	-0.5424
River	0.96	0.73	-0.2307
Airport	0.03	0.03	0.0042

V. URBAN SPRAWL DIRECTION

Based on the table .1 area calculations, the classifications of forest given by 9841 hectare in 1996 and it was tremendously reduced by 3874 hectare in 2016. It is nearly 8.15 % area of forest land degreased. As well as the settlement gradually increased from 3186 to 16293 hectare of 1996 to 2016 respectively. It is nearly 17.9 % land increased by the settlement engaged. The settlement area increment occupied by the forest land, agriculture land and also covered with barren land due to the increasing of urban population. Due to the urban expansion 30.2 %, 0.54 % and 0.23 % scrub land, water body and river area reduced respectively. But 20.52 % of barren lands, 0.68 % of commercial activities are increased. Mostly the urban sprawl moves in the directions of North east and South – west direction.

VI. CONCLUSION

The urban area of Madurai city has increased extremely within the 30 years. As a result, rural-urban migration has been characterizing in Madurai city. The overall percentage increased during the period of 26 years about -8.1515, -30.1908, +20.5276, +17.9080, +0.6755, -0.5424, -0.2307, and +0.0042 Forest, Scrub, Barren land, Settlement, Commercial, Water body, River and Airport respectively. There has been decrease in the Forest, Scrub, Water body and River and increasing of settlement, commercial and airport. The results of this study were based on Digital Image Processing of Unsupervised classification technique and its interpretation. The mapping of the urban sprawl direction movement of Madurai town shows the development of North-east and South-west direction. Because of the education institutions, industries, and factories mainly newly established as well as express road way connect the Chennai, Bangalore like metropolitan city in North-east direction of Madurai city. The Madurai Airport present in South-west direction of Madurai city as well as the express road ways connects the historical place of Thiruchenture, big port of Tuticorin, etc are located and upcoming here. The interpretation of multi-date satellite helped in the preparation of urban sprawl map of the study area. The decrease in agricultural/Scrub area is due to conversion of urban land use or discontinuation of agricultural lands. The Barren land has been increase as cultivable land is gone with low of cultivation due to lack of ground water table reduction and seasonal variations are made them to be available as such. Similar studies can be under taken for other major cities also to estimate to make necessary arrangement to plan accordingly to preserve the natural environment.

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