Application of Remote Sensing and GIS in Land Resource Management

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ABSTRACT

Land use Land cover (LU/LC) mapping serve as a basic information for land resource study. Detecting and analysing the quantitative changes along the earth’s surface has become necessary and advantageous because it can result in proper planning which would ultimately result in improvement in infrastructure development, economic and industrial growth. The LU/LC pattern of Madurai city, Tamil Nadu, has undergone a significant change over past two decades due to accelerated urbanization. In this study, LU/LC change dynamics were investigated by the combined use of satellite remote sensing and geographical information system. To understand the LU/LC change in Madurai city, the different land use categories and their spatial as well as temporal variability has been studied over a period of seven years (1999-2006), from the analysis of LANDSAT images for the years 1999 and 2006 respectively, using ArcGIS 9.3 and ERDAS Imagine 9.1 software. This result shows that Geospatial technology is able to effectively capture the spatio-temporal trend in the landscape pattern associated with urbanization for this region.

Keywords: GIS; LANDSAT; Land Use; Land Cover; Remote Sensing

1. Introduction

Planning and development of urban areas with infrastructure, utilities, and services has its legitimate importance and requires extensive and accurate LU/LC classification. Information on changes in land resource classes, direction, area and pattern of LU/LC classes form a basis for future planning. It is also essential that this information on LU/LC be available in the form of maps and statistical data as they are very vital for spatial planning, management and utilization of land. However, LU/LC classification is a time consuming and expensive processes. In recent years, the significance of spatial data technologies, especially the application of remotely sensed data and geographic information systems (GIS) has greatly increased. Now-a-days, remote sensing technology is offering one of the quick and effective approaches to the classification and mapping of LU/LC changes over space and time. The satellite remote sensing data with their repetitive nature have proved to be quite useful in mapping LU/LC patterns and changes with time[^6^,^7^,^9^,^10^].

Quantifying the anthropogenic or human activity that governs the LU/LC changes has become a key concept in the town planning profession. A major objective of planning analysis is to determine how much space and what kind of facilities a community will need for activities, in order to perform its functions. An inventory of land uses will show the kind and amount of space used by the urban system.

LU/LC study with the use of remote sensing technology is emerging as a new concept and has become a crucial item of basic tasks in order to carry through a series of important works, processes such as the prediction of land-use change, prevention and management of natural disaster, and protection of environment, etc and most importantly analysing the present development and future scope of development of the nation. In the recent years, with the enhancement of more advanced Remote Sensing technology and Geo-Analysis models, monitoring the status and dynamical change of LU/LC thoroughly using remotely sensed digital data has become one of the most rapid, credible and effectual methods.

The main aim of this paper is to assess the LU/LC changes, and to observe the growth of various urban classes...
over a period of seven years along Madurai City, by using remote sensing and GIS technology. For this purpose, multi-spectral, multi-temporal LANDSAT images were downloaded from USGS Earth Resources Observation Systems data centre. The classification, identification and graphical representation of the changes detected in the classes defined for the study area were done using ERDAS Imagine 9.1 software and ArcGIS 9.2 software. The paper focuses on the analyses and discussions of the results including the pattern of changes in LU/LC studied from year 1999 to 2006.

2. Study area

The study area is Madurai city, Tamil Nadu (Figure 1), one of the famous historical and cultural cities in India. It is 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.Km, dividing into four regions Zone I, II, III, IV. There has been rapid growth in Madurai from 1967 and it has gradually increased over the years in Madurai and its surrounding areas. Most of the areas around Madurai are least developed and are in the transformation stage. It extended geographically from 9°50’ North latitude to 10° North latitude and 78°02’ East longitude to 78°12’ East longitude, and approximately 100 m above MSL. The terrain of the city is gradually sloped from the north to south and west to east.

The River Vaigai is the prominent physical feature which bisects the city into North and South zones with the north sloped towards Vaigai River and the south zone sloped away from the river. The city became municipality in 1867 and was upgraded as a corporation in 1971 after 104 years. The corporation limit was extended from 52.18 km² to 151 km² in 2011. As per 2011 census the population of the city is 15.35 lakhs[4]. The area has been experiencing remarkable land cover changes due to urban expansion, population pressure and various economic activities in the recent years.

![Figure 1: Study Area Location](image)

3. Methodology

3.1 Data

For this study, Landsat ETM+ (path 143, row 53) images were used (Table 1). Landsat images were downloaded from USGS Earth Resources Observation Systems data centre[2]. A base map of Madurai city was provided by Local Planning Authority of Madurai. The The Landsat ETM+ image data consists of eight spectral bands, with the same spatial resolution as the first five bands of the Landsat TM image. Its 6th and 8th (panchromatic) bands have resolutions of 60 m and 15 m, respectively. All visible and infrared bands (except the thermal infrared) were included in the analysis. Remote sensing image processing was performed using ERDAS Imagine 9.1 software. Landsat data of 1999, 2006, and SOI Toposheet were selected and used to find the spatial and temporal changes in the study area, during the period of study.
3.2 Image classification

In this study, totally, four LU/LC classes were considered as vegetation, Built-up land, waste land, and water area. The classes in the images were decided based on the LU/LC classification system devised by National Remote Sensing Agency (NRSA) for Indian conditions[8]. The LU/LC classes are presented in Table 2. In the study area, a supervised classification of the image was performed using the signature files from the unsupervised classification. For the supervised classification a maximum likelihood rule was used for a parametric rule[1,3]. The LU/LC classified maps for 1999 and 2006 were produced from Landsat images and are given in Figure 2.

3.3 Result and discussion

4.1 LULC change analysis

The LU/LC classification results are summarized from the year 1999 to 2006 in Table 3. From 1999 to 2006, built-up area increased by 17.09. On the other hand open land decreased by 11.82 % respectively. The fluctuations were observed in vegetation and water area due to seasonal variation found in the study area. All these land use change are closely related with the development of regional economy and the population growth in the city. The trend of LU/LC and urban change in the city is shown in the Figure 3.
5. Conclusion

This paper aims investigating LU/LC changes occurred in Madurai city between 1999 and 2006 using remote sensing and GIS. The areas of urban settlements and construction land in Madurai city increased by 17.09% from 1999 to 2006. The results of the study suggest that the analysis of sequential satellite data offers means of extraction of information on LU/LC. In fact, for shorter intervals satellite data are very helpful for the detection of LU/LC changes, due to repetitive coverage at very short intervals. In this study analysis has been done for period of seven years. This work shows that it is feasible to analyse and monitor LU/LC change based on remote sensing images and GIS applications. The results would be of great help to the land management department in quick decision making.

References