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A Comparative Change Detection Analysis Using Remote Sensing and Geographical Information System for Coimbatore City, Tamilnadu

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ABSTRACT

The Change detection Map for Geographical Information System (GIS) is a process that measures how the attributes of a particular area has been changed from past to present. It involves comparing the aerial photographs or satellite imagery of a particular area taken at different times. It is widely used to assess cultivation, forest area, urban growth, impact of natural as well as man-made disasters etc. It is possible to make a map using the data obtained by manual surveyfor a constrained area whereas, for a large area, it is quite impossible. This could be overcome possibly with the help of Remote Sensing and Geographic Information System. The attributes of the city like agricultural, Forest, Waterspread and Build up areas could be taken into account to prepare a Land Use Land Cover (LULC) Map using GIS techniques. The periodic open-source data obtained from government authorized websites for the following year 1985, 1995, 2005 and 2015. The LULC dataset are analyzed and prepared the change detection map for the Coimbatore city. The series of LULC maps so obtained are overlapped to arrive at the overall change detection analysis map for the Coimbatore city. On account of the obtained change detection analysis map, itis much easy to study about the infrastructure development, road patterns (planned/unplanned), urban growth and its directions, extent of agricultural lands and encroachment details of water bodies of the city. Using this analysis, it is possible to analyze the land deformations which the city has undergone for the pastdecades. Besides, it will be socially effective to predict the upcoming land changesin a city. Thus, it will be economic for the government to precast an area keeping in view with land deformation.

Key words : *Remote Sensing, GIS, LULC, Change Detection, Effective, Economic.*

Introduction

Change detection is the measure of the distinct data framework and thematic change information that can guide to more tangible insights into underlying process involving land cover and land use changes information obtained from continuous change. Digital change detection is the process that helps in determining the changes associated with land use and land cover properties with reference to geo-registered multi-temporal remote sensing data. It helps in identifying change between two or more data's that is uncharacterized of normal variation. Change detection is useful in many applications such as land use changes, habitat fragmentation, rate of deforestation, coastal change, urban sprawl, and other cumulative changes through spatial and temporal analysis techniques such as GIS (Geographic Infor-

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mation System) and remote sensing along with digital image processing techniques. Change detection in watersheds helped in enhancing the capacity of local governments to implement sound environmental management. This involved development of spatial and temporal database and analysis techniques. Efficiency of the techniques depends on several factors such as classification schemes, spatial and spectral resolution of remote sensing data, ground reference data and also an effective implementation of the result. The basic principle of all change detection techniques was that the digital number of one date is different from the digital number of another date. Land-cover refers to the physical characteristics of earth's surface, captured in the distribution of vegetation, water, soil and other physical features of the land, including those created solely by human activities e.g., settlements. Land-use refers to the way in which land has been used by humans and their habitat, usually with accent on the functional role of land for economic activities. It is the intended employment of management strategy placed on the land-cover type by human agents and managers. Land use/Land-cover change information has an important role to play at local and regional as well as at macro level planning. Remote sensing data of better resolution at different time interval help in analyzing the rate of changes as well as the causal factors or drivers of changes. Hence it has a significant role in regional planning at different spatial and temporal scales. This along with the spatial and temporal analysis technologies namely Geographic Information System (GIS) and Global Positioning System (GPS) help in maintaining up-to date land-use dynamics information for a sound planning and a cost-effective decision.

Materials and Methods

Study Area

Coimbatore is the third largest city of the Tamilnadu state, one of the most industrialized cities in Tamil Nadu, known as the textile capital of South India or the Manchester of the South India, the city is situated on the banks of the river Noyyal, Coimbatore and located geographically 10.9675° N, 76.9182° E. The study area about 4723 Sq. Km and population is 34,58,045 (www.tn.gov.in). Coimbatore is divided into four broad regions: North, Central, South and East. Coimbatore East and its surrounding region is primarily a textile and industrial hub. Central Coimbatore is the commercial heart of the city.

Data Used

The remote sensing data were used to prepare the land use cover map. The date was collected from daac.ornl.gov website. The remote sensing data were derived from Landsat, India Remote Sensing satellites (IRS) Resourcesat data, ground truth surveys and visual interpretation.Land cover maps were produced using a process that began with the classification, visual interpretation, and data verification of the 2005 imagery (using ground truth data) to produce a 2005 national LULC map. The 1995 Landsat images were overlaid onto the 2005 map and polygons were traced where LULC change had occurred. The process was applied to the 1985 imagery using the 1995 map as the starting reference. On-screen image interpretation was used to assess the maps (Meiyappan *et al.,* 2016 in review). This study utilized Landsat satellite imagery, data that were projected to World Geodetic System 1984 (WGS84) datum (Universal Transverse Mercator (UTM) 44N projection) at sub-pixel level.

Methods

The overall methodology adopted for the assessment of change detection map in Coimbatore district using Remote sensing and GIS is illustrated in the flow chart below (Fig. 1).

The collected Land Use Land Cover data set for different periodic years were processed using Quantum GIS(QGIS) software. To process the data, it should be in vector/shapefile format, but the collected data in raster file format. Hence the processes are included in the data conversion and it contains the data for India. In the preparation of the Land Use Land Cover Thematic map, the collected data should be extracted by using Coimbatore district boundary data. Once the extraction by mask operation is over, using processed data of different periodic year and Coimbatore district boundary data, correspondingly different periodic year LULC maps are generated. The recent Land Use Land Cover Data for the periodic 2015-2016 is obtained from the Bhuvan ISRO website. Finally, overlay analysis was done for the LULC map of 1985,1995,2005 and 2015. In this analysis, change detection analysis map and statistics data are obtained.

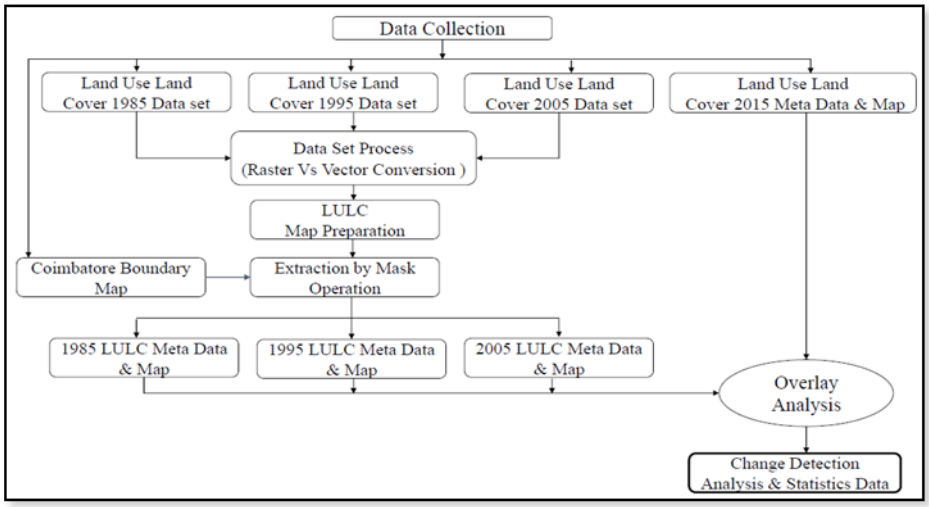

Fig. 1. Methodology Flow Chart

Results and Discussion

In this work, the maps of Coimbatore region have been taken out for particular periods of 1985, 1995, 2005, 2015 each of ten years difference. The data about the place have been gathered and verified theoretically. The comparison has been made among the data on the basis of Barren lands, built up areas, Deciduous broadleaf forests, Croplands, Water bodies, Wastelands, Mixed forests, Grassland, etc., and

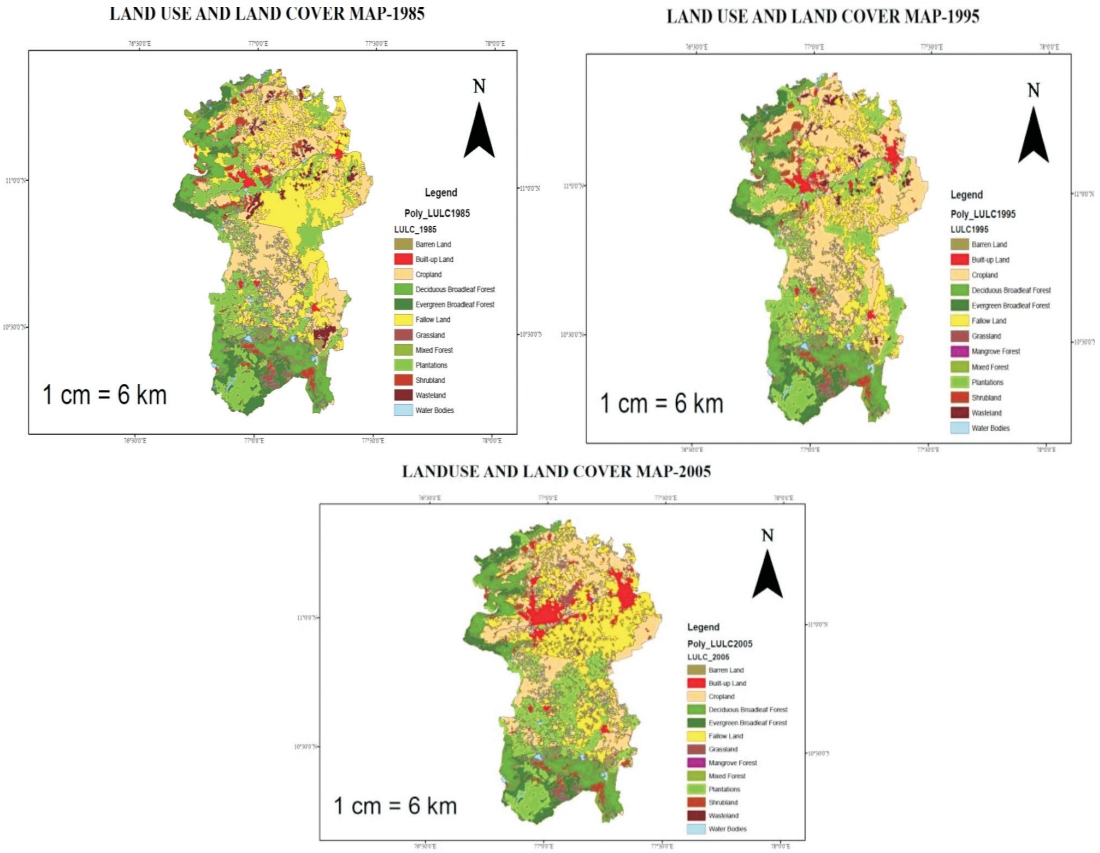

Fig. 1. Land Use Land Cover Map of Coimbatore City

the variations are denoted in various colours. In an instance, during the year 1985 the total built up area of Coimbatore was 164789600. 71sq.m, whereas during the year 1995, the area of built-up land was 277399459. 90sq.m and during the year 2005, the value has been changed to 480488165. 78sq.m. (Table 2).

From the three years observations, the area of built-up land has been increased drastically. Initially, the water bodies in the year 1985 was 106015549.05 (sq.m) while in the year 1995, water bodies have been extended upto 114426325.598 (sq.m), and in 2005 waterbodies was about 1224073226.38 (sq.m). (Table 2).

From these observations, it can be concluded that

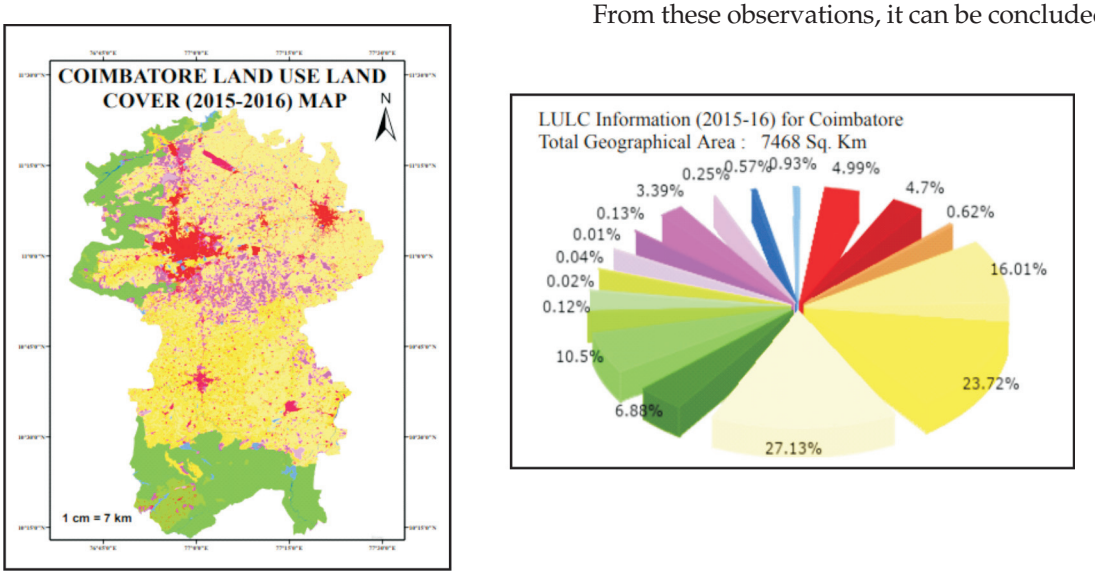

Fig. 2. 2015 -LULC Map of Coimbatore City

Table 1. Comparison of Primary Land Use Land Cover Areas

S. No.	Land Use Land Cover Classes	Assessment Period Year		
		1985 (Sq.M)	1995 (Sq.M)	2005 (Sq.M)
1	Built-Up Area	164789600.71	277399459.90	480488165.78
2	Plantation	1316101950.15	1469246899.22	1224073226.38
3	Water bodies	1060155409.05	114426325.59	160017121.15
4	Deciduous Broadleaf Forest	749841307.45	675050548.13	730458949.17
5	Barren Land	93916364.64	92746393.57	94420870.11

Table 2. Change Detection Statistical Data

LULC	1985 Area (Sq.M)	1995 Area (Sq.M)	2005 Area (Sq.M)	Change Detection Result Area (Sq.M)
Deciduous Broadleaf Forest	343754544	286163799.7	302166317	-41588227.2
Cropland	1028600847	1608209621	990620927	-37979920
Built-up land	141775025.2	240020082.1	430336528.4	288561503.3
Mixed Forests	62605552.24	90390359.35	41549105.99	-21056446.3
Shrub land	149224704.2	8883020329	96527761.79	-52696942.4
Barren Land	10420637.85	10346080.	11685456.26	1264818.409
Fallow Land	835805391.9	891368543.2	549498093.5	-286307298
Waste Land	139957022.1	116945473.4	6619785.406	-133337236
Water bodies	48412911.45	52585373.73	31323439.21	-17089472.2
Plantation	698230050.7	746282336.4	13001981	-56821023
Mangrove Forest	0	907630.9123	623480.076	623480.0765
Grass Land	2970550.227	2266819.735	46041128.97	43070578.75

the area of water bodies was increased in 1995 when compared to 1985 whereas in the year 2005, it has drastically decreased than both years i.e., (1985 & 1995). Similarly, the spatial data have also been changed (Table 1).

The data were classified according to the International Geosphere-Biosphere Programme (IGBP) classification scheme and Figure 1 shows the LULC maps of Coimbatore city for 1985, 1995 and 2005.

Conclusion

It is concluded that the land cover/land use area have changed drastically. These modifications in the topography of the region have been studied and any other town planning operations could be done accordingly. From the 1985-2005 years observations, it can be concluded that the area of built-up land has been raised significantly due to overwhelming population and water bodies have turned into manmade occupancies. From 2015 LULC data can easily understand that the red color data i.e built-up area was increased due to many parameters and the statistical data were represented in Pie chart in Figure number 2. The series of maps so obtained serves a helping hand for smart city planning as well as necessary developmental measures to be incorporated. Besides, the resources of the regions have been well maintained and preserved from extinction. Thus, it extends a helping hand for both government and people to turn their city into a smarter one.

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