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Assessment on Landuse Changes in Coimbatore North Taluk using Image Processing and Geospatial Techniques

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ABSTRACT

The landuse and land cover is important for many planning and management activities and is considered an essential element for modeling and understanding the earth as a system. The base map of Coimbatore North Taluk has been created using Survey of India toposheet for the year 1988. The current landuse map was prepared by using ASTER Satellite imagery in open source software environment. The landuse changes were predicted by using image processing and GIS analysis. The results indicate that severe land cover changes have occurred in agricultural (-19%), urban (234%), waterbodies (-0.7%) and forestry (-4.5%) areas in the region between 1988 and 2011. It was seen that the landuse changes were mostly occurred in urban areas.

Keywords- **Image Processing, Landuse, Geographical Information System (GIS), Remote sensing, Open source software**

1. INTRODUCTION

The world's cities continue to grow in population size with and without planned development. This urban revolution has triggered a number of environmental problems at multiple scales, including the loss of natural vegetation, open spaces, wetlands, and wildlife habitat, the change of local and regional climates, and the increases in pressure on water, energy, and infrastructure [1].

Knowledge of landuse and land cover is important of many planning and management activities and is considered an essential element for modeling and understanding the earth as a system. Land cover maps are presently being developed from local to national to global scales. The use of panchromatic, medium-scale aerial photographs to map landuse has been an accepted practice since the 1940s. More recently, small- scale aerial photographs and satellite images have been utilized for landuse/land cover mapping [2].

Remote sensing and GIS-based change detection studies have predominantly focused on providing the knowledge of how much, where, and what type of landuse and land cover change has occurred. Only a few models have been developed to address how and why the changes occurred, and even fewer studies have attempted to link satellite remote sensing and GIS to stochastic modeling in landscape change studies[3].

Geographic information systems (GIS) integrate modern information acquisition, storage, analysis, and management tools in applications that solve problems related to geospatial information. Among the special tools that GIS use are remote sensing tools, which use a variety of devices(such as aircraft and satellites) and methods(such as photography and radar) to gather information on a given object or area from a distance. Geography tools, to study the features, inhabitants, resources, and evolutions of the Earth and its environment [4].

GIS is emerging as an integrated technology that can tackle many problems in nature and society, especially at the global scale.

Land cover classification is an important application of remote sensing data. A number of image classification algorithms have been developed to extract information from a variety of remote sensing datasets [5]. In general, these algorithms are able to produce classifications with high accuracy. However, the performance of these degrades rapidly when one or multiple types of imperfections occur in raw images due to a number of human, environmental, and instrumental factors [2].

The term land cover relates to the type of features present on the surface of the earth. Corn fields, lakes, maple trees, and concrete highways are all examples of land cover types. The term landuse relates to the human activity or economic function associated with a specific piece of land [2].

This study aims at analyzing landuse changes using satellite imagery and GIS in Coimbatore North taluk. In order to achieve this objective, topographic sheets (published on 1988) and ASTER Satellite data (acquired on 2011) were used. Geo-processing techniques and change detection comparison strategy was employed to identify landuse changes.

2. STUDY AREA

Coimbatore North Taluk is located in Coimbatore district, Tamil Nadu (India). It has an area of 868 sq. km, the latitude and longitude extension of the study area is $76^{o}44'21"$N to$77^{o}10'27"$N and $10^{o}59'13"$E to $11^{o}20'35"$E respectively and is altitude 398m above mean sea level. The mean maximum and minimum temperatures during summer and winter varies between 35°C and 18°C. Highest temperature ever recorded is 41 °C and lowest is 12 °C. The

entire western and northern part of the district borders the Western Ghats with the Nilgiri biosphere as well as the Anaimalai and Munnar ranges. It is the third largest district of Tamil Nadu. This district is known as the Manchester of South India and is known for its textile factories, engineering firms, automobile parts manufacturers, health care facilities, educational institutions, and hospitality industries. The hill stations of Ooty, Coonnor and Valparai are close to the city making it a good tourist attraction throughout the year. The district is situated on the banks of the Noyyal River and is close to the Siruvani Waterfalls [6].

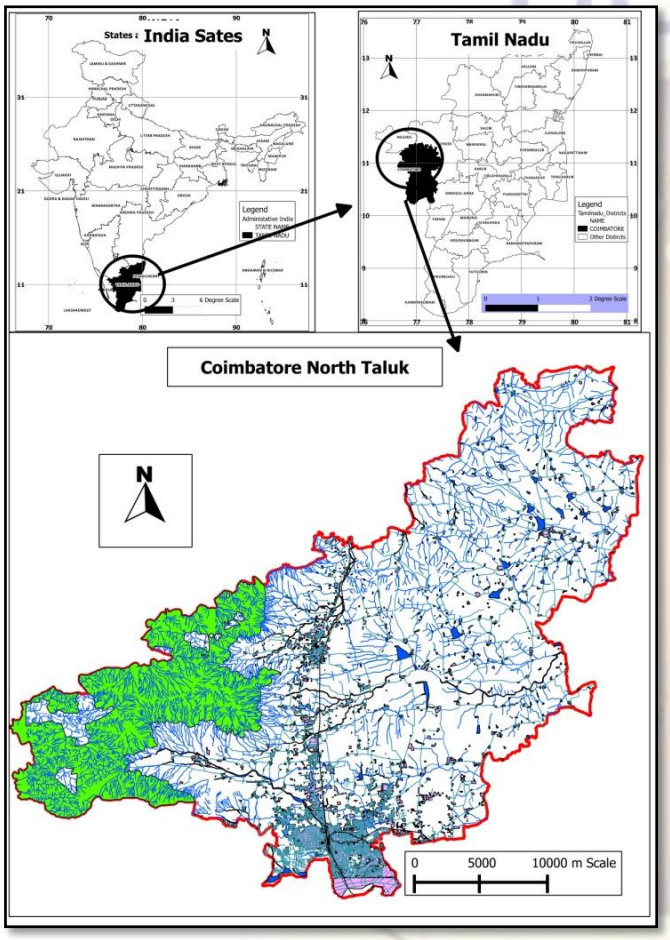

Figure 1: Study Area map

3. SOFTWARE USED

The Open Source GIS are those software where the source code is accessible to the user. Hence the GIS tool can be customized by the user according to the need of the study. These software are cost free and are have several modules for GIS Analysis[7].

This study utilizes the Open Source GIS Software called System for Automated Geoscientific Analyses (SAGA GIS), Quantum GIS (QGIS), and Geographic Resources Analysis Support System (GRASS GIS). These are free Image Processing and Geographic Information System (GIS) software used for geospatial data management and analysis, image processing, graphics maps production, spatial modeling, and visualization. In this study the SAGA GIS, QGIS, GRASS GIS were used for Image preparation, data creation and analyzing, topology building and error fixing respectively.

4. METHODOLOGY

The following figure 2 depicts the methodology of the entire study. Each and every process in the methodology is explained further.

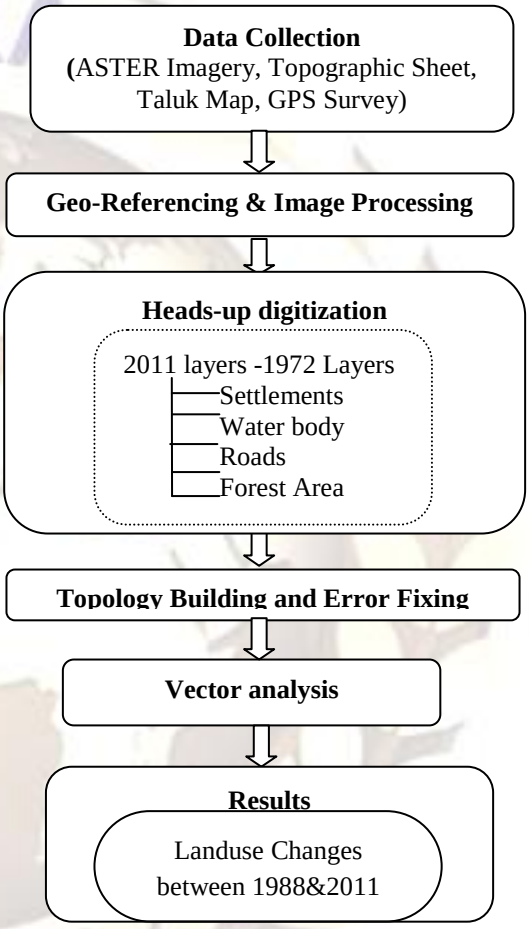

Figure 2: Methodology flow diagram for Landuse assessment

4.1 Data Collection

Spatial data collection is one of the fundamental steps in the creation of a geographical information system. Survey of India Toposheets 58E03, 58E04, 58A16NW, 58A16NE, 58A16SE, and 58A16SW were collected. Name of the data, scale, resolution and sources are illustrated in table 1. ASTER (Advanced Space-borne Thermal Emission and Reflection Radiometer) Satellite imagery was used in this study. The ASTER data image (26 Jan 2011) was downloaded from USGS Earth Resources Observation

Systems data centre. The dates of images was chosen to be as closely as possible in the vegetation season. 40 X 47 km of subset was used from these Landsat images. ASTER Satellite imagery has 15 m spatial resolution. All visible was included in the analysis. Remote sensing image processing was performed using SAGA GIS.

Table 1: Name of the data and sources

Name	Scale /Resolution	Source
Topographic sheets	1:50000	Survey of India
ASTER Imagery	15m	USGS data centre
Taluk map	1:75000	Government of Tamil Nadu

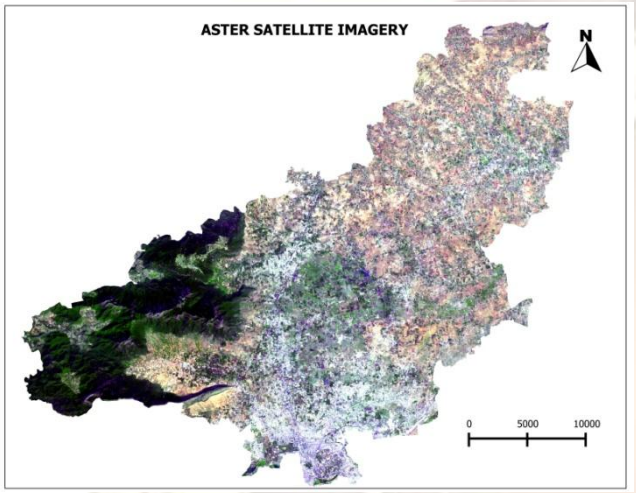

Figure 3: satellite Imagery of Study Area

4.2 Geo-referencing

Geo-referencing means to define the position of earth surface or establishing its location in terms of map projection or coordinate systems. It is essential to make various data sources (table1) into common referencing or projection system i.e. World Geodetic System (WGS 84), Universal Traverse Mercator (UTM), zone 43N.

4.3 Image Processing

Digital Image Processing is largely concerned with four basic operations: image restoration, image enhancement, image classification, image transformation. Most of the image processing operations were completed by using SAGA GIS environment. Geometric Correction is essential that any form of remotely sensed imagery be accurately registered to the proposed base map. Image enhancement is concerned with the modification of images to make them more suited to the capabilities of human vision. Regardless of the extent of digital intervention, visual analysis invariably plays a very strong role in all aspects of remote sensing. Digital Filtering is one of the most intriguing capabilities of digital analysis is the ability to apply digital filters. Filters can be used to provide edge enhancement, to remove image blur, and to isolate lineaments and directional trends, to mention just a few [8].

4.4 Heads-up digitization

Heads-up digitizing is manual digitization by tracing a mouse over features displayed on a computer monitor, used as a method of vectorizing georeferenced raster data. Table 2 depicted the various layers was created based on heads-up digitization. This study assessed the landuse changes between year 1988 and 2011. Landuse vector layers (1988) were created by using Survey of India topographic sheets. Landuse vector layers (2011) were created by using ASTER satellite imagery. Less than 1% decrease noticed in water bodies.

4.5 Topology building and Error fixing

Creation of topology is necessary to make the spatial data usable. Errors were edited which included arc, label, move and intersect. The topology was constructed by using GRASS GIS commands. The topology was reconstructed when errors were found.

Table 2: Various Layers and types

Layer name	Layer type	1988	2011
Roads	Polyline	✓	✓
Railway	Polyline	✓	✓
Water Body	Polygon	✓	✓
Stream Lines	Polyline	✓	✓
Settlements	Polygon	✓	✓
Forest Area	Polygon	✓	✓
Agriculture	Polygon	✓	✓
Administrative Boundary	Polygon	✓	✓

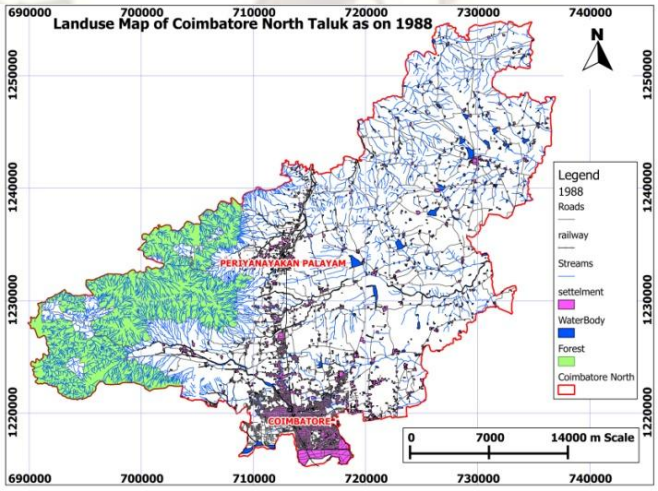

Figure 2: Landuse Map of Coimbatore North Taluk for 1988

4.6 Vector analysis

Area of each category was calculated in QGIS software environment. The flow diagram indicating the methodology for landuse mapping is given in Fig 2.The procedure adopted in this research work forms the basis for deriving statistics of

landuse dynamics and subsequently in the overall, the findings. The difference between landuse 1988 and 2011 were predicted by using geo-processing tools present in QGIS software environment. The difference has been shown in table 3.

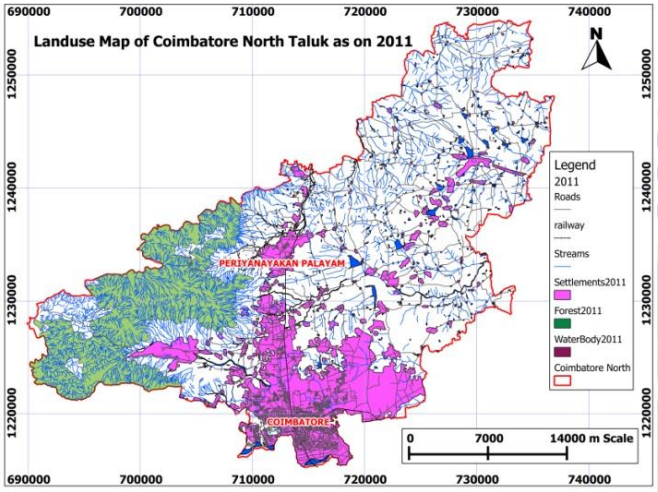

Figure 3: Landuse Map of Coimbatore North Taluk for2011

5. RESULTS AND DISCUSSIONS

The results of landuse assessment based on manual interpretation for two different years of data between 1988 and 2011[7]. It has a total area of about 868 sq. km. In 1988 landuse coverage as settlements is 6 %, forest area is 19%, Agriculture is 73% and water body is 2% from the net sown area. It is shown in figure 6.

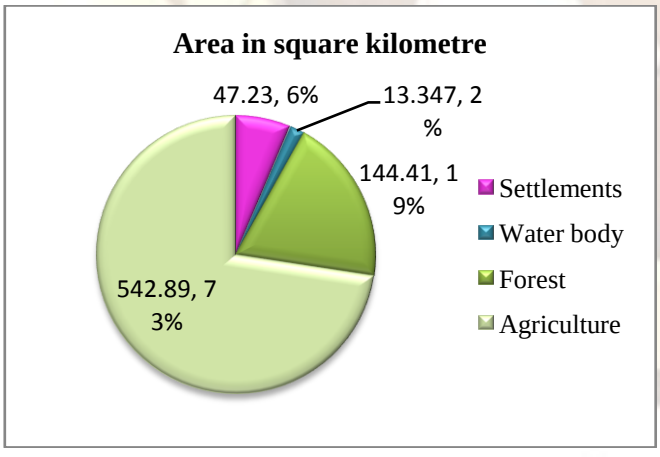

Figure 4: Landuse Class percentage for 1988

Similarly, in 2011 landuse coverage as settlements is 21 %, forest area is 18%, Agriculture is 59% and water body is 2% from the net sown area. It has been shown in figure 7. In short the most common variable explaining the changes in landuse and land cover in Coimbatore North Taluk is population growth. The variations in area covered under agriculture and fallow land attributed to changes in crop rotation, harvesting time and conversion of these lands into plantation. The landuse difference has been shown in Figure 8. Table 3 illustrates name of the layer, their type and total coverage area.

Table 3: Landuse of Coimbatore North Taluk from 1988 to 2011

Layer Name	Type	Area in sq.km	
		1988	2011
Settlements	polygon	47.23	157.97
Water body	polygon	13.35	13.25
Forest	polygon	144.41	137.82
Agriculture	polygon	542.89	439.68
		Length in kilometre	
Road	polyline	133.97	133.97
Railway	polyline	378.00	378.00
Streamline	polyline	212.39	212.39

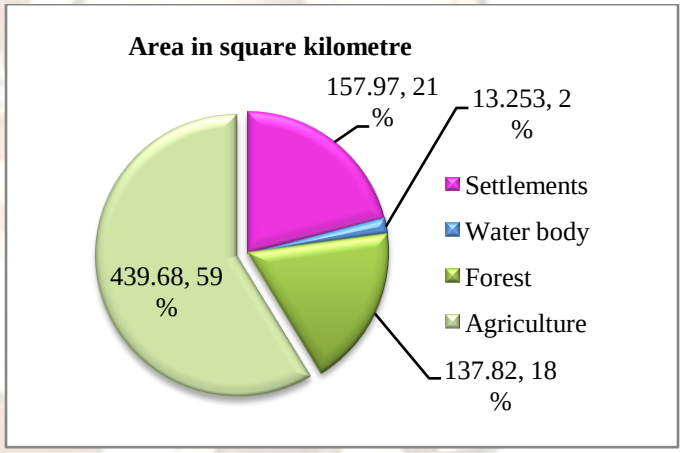

Figure 5: Landuse Class percentage for 2011

The results indicate that severe land cover changes have occurred in agricultural (-19%), urban (234%), water bodies (-0.7%) and forestry (-4.5%) areas has been experienced in the region between 1988 and 2011. It was seen that the landuse changes were mostly occurred in urban areas

6. CONCLUSIONS

As part of the primary objective, present landuse map of Coimbatore North Taluk was created from satellite imagery. Overall changes in the landscape show an increased trend for urban development (234%) with non-forested vegetation and water bodies. Such development is guided or often times constricted by various environmentally sensitive or protected areas (e.g. Reserve Forests.) and existing high-density development. The study has revealed that satellite data has the unique capability to detect the changes in landuse quickly. From the analysis it is found that the satellite data is very useful and effective for getting the

results of temporal changes. With this effective data it is found that the agriculture land is decreasing at the rate increasing the settlements.

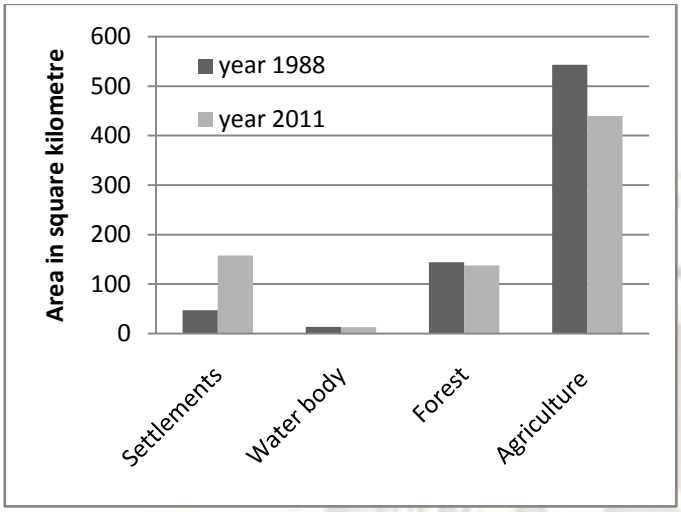

Figure 6: Comparison chart of Landuse changes between 1988 and 2011

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