Evaluation of land use/land cover changes in the Coimbatore Corporation of Tamil Nadu using remote sensing and GIS

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Abstract : The present study is to assess Land use/land cover changes in Coimbatore Corporation for the period of 2005 and 2010. The study area is located in Coimbatore district, Tamil Nadu state and geographical area is 257 km^2. To analyze land use/land cover changes, a temporal satellite images Landsat 7 (2005) Sentinel-2 (2010) was used. The change detection analysis has been performed for year's 2005 and 2010 post classified images. ERDAS Imagine 2015 and ArcGIS 10.0 software's were sued to classify the satellite image and assess the land use/land cover changes for the above periods. The results of the study have indicated that Coimbatore Corporation has experienced rapid modifications in LULC, particularly in terms of built-up area. In past 5 years, built-up areas have increased by 19.6 km2, resulting in a significant drop in the area of agricultural land and vegetation cover. We have found urban areas are increased 334% due to population growth cum rapid economic progress. Agriculture is cover decreased 60% due to conversion into urban features. Water bodies in area increased to 24% due to eradication of encroachment. Urban growth has accelerated towards north-eastern parts, where national highways exist. The land use/land cover change detection analysis revealed that built up area was increased compared to 2001 and all other classes decreased. Finally it concluded of this study urbanization is the most important cause of the land use and land cover changes for the Coimbatore Corporation area.

IndexTerms **- Landsat, ERDAS, Land use/land cover, 2005 and 2010, Coimbatore Corporation.**

I. INTRODUCTION

The terms land use and land cover is often used interchangeably, but each term has its own unique meaning. Land cover– refers to the characteristics and surface cover of Earth's surface, as represented by natural elements like water, vegetation, impervious surface, bare earth, and other physical features of the earth. Identification of land cover establishes the baseline information for activities like thematic mapping and change detection analysis (Chung et. al 2018; Sashikumar et.al 2017a and b; Selvam and Sivasubramanian 2012; Venkatramanan et. al 2015) . Land use–refers to the activity, economic purpose, intended use, and/or management strategy placed on the land cover type(s) by humans or land managers. Changes in intent or management practice likewise constitute land use change. When used together the phrase Land Use / Land Cover generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based on established scientific and statistical methods of analysis of appropriate source materials (Fritz et. al 2017; Selvam 2012a,b,2013a,b; Venkatramanan et. al 2016). Land cover is the physical material at the surface of the earth. Land use is the description of how people utilize the land for the socio-economic activity – urban and agricultural land uses are two of the most commonly recognized high-level classes of use. At any one point or place, there may be a multiple and alternative land uses, the specification of which may have a great dimension. Hence, Land use is the activity for which land is used by the man (Selvam 2014; Verburg et. al 2011; Venkatramanan et. al 2017). Remote Sensing data and techniques and Geographical Information System (GIS) provide efficient methods for analysis of land use and land cover aspects and tools for Land Use Land Cover planning and modelling. Satellite Remote Sensing data is usually the most accurate and up-to-date map available for study the Land Use and land cover which leads to detection of change. Especially with fast growing towns and cities in India, it is best method that can follow up the urban growth/sprawl. With geographical information system flexible geographical database can be generated for the land use and land cover issues. Hence this tool is immensely helpful to bring out the results along with socio – Economic Survey (Spatial and Non Spatial data). Knowledge of both land use land cover is important, for proper planning information on both the above aspects (Selvam et. al 2014a-c: Selvam 2015; Venkatramanan et. al 2018a).

Land use / land cover of the earth is changing dramatically because of human activities and natural disasters Muttitanon (2005). The rapid industrialization and urbanization of an area require quick preparation of actual land use / land cover maps in

order to detect and avoid overuse and damage of the landscape beyond the limits of sustainable development. Fuller et al (2003). Changes in land cover and the way people use the land have become recognized over the last fifteen years as important global environmental changes in their own right. Turner (2002). Land use and land cover categories have important semantic differences that can serve as barriers to the integration of social and ecological information, perspectives and models (Selvam et. al 2015a-c; Venkatramanan et. al 2018b). The widespread use of Geographic Information Systems (GIS) in land management and planning and the increasing demand for land use and land cover scenarios call our attention to these differences and the need to bridge them (Selvam 2016; Selvam et.al 2016, 2017; Singaraja et. al 2015,2016a,b; Tsendbazar et. al 2015) . The distinctions between land use and land cover are particularly important in urban environments, where the terms 'developed', 'urban', or 'residential' indicate the actual or intended use of the land, which can also include a full range of possible land cover combinations and patterns (e.g. trees, impervious, grass, wetlands) Brown and Duh (2004).

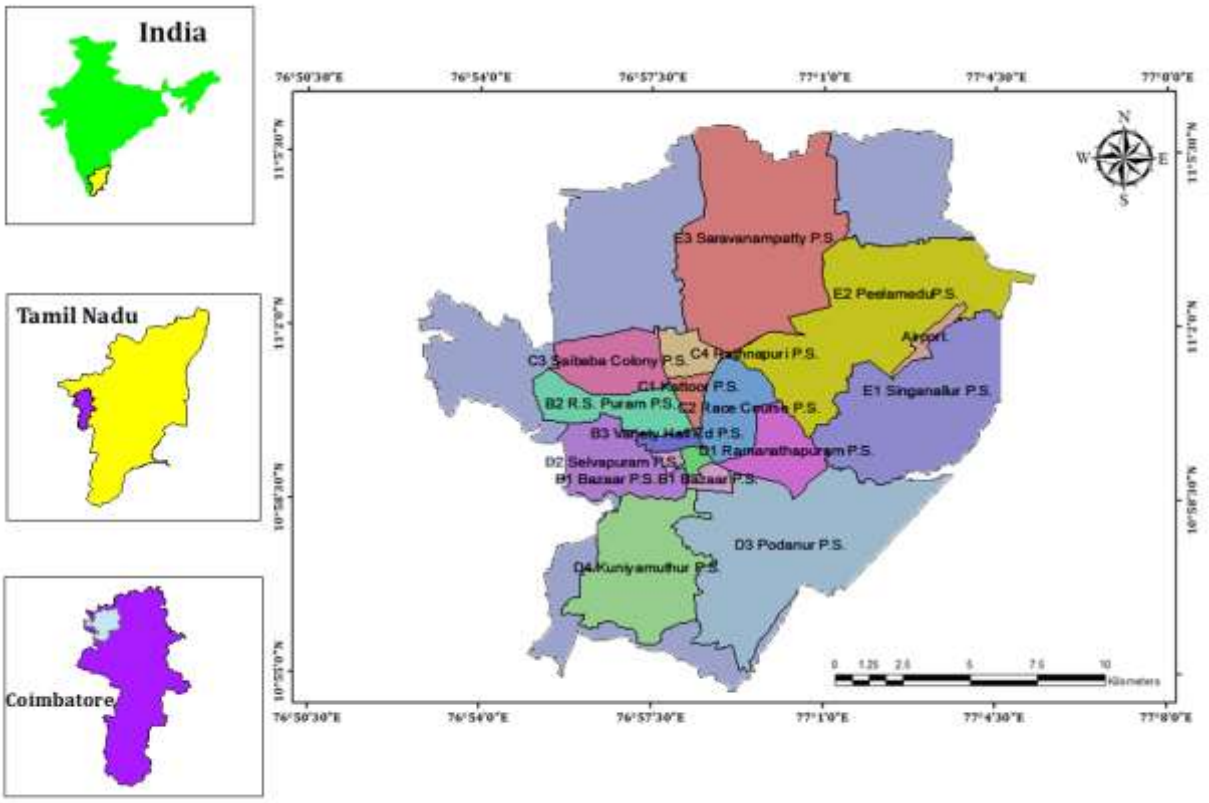

Figure 1: Location map of the study area

1.1 Geographical setting

Coimbatore also known as Kovai is a major city in the Indian state of Tamil Nadu. Located on the banks of the Noyyal River surrounded by the Western Ghats, it is the second largest city in the state after Chennai and 16th largest urban agglomeration in India. It is the largest city in the Kongunadu region. It is administered by the Coimbatore Municipal Corporation and is the administrative capital of Coimbatore district. The longitude of Coimbatore lies between 76º65' E – 77º 29' E. The latitude lies between 10 º 22' N – 11 º 41' N. The total area of Coimbatore Corporation is 257 square kilometers (Fig. 1). Coimbatore is naturally filled with eco-system such as hills, plains, forests, evergreen fields, drought prone areas, river bodies and tanks. The district is covered with mountains. Hence, most of the cities of Coimbatore are benefited by the south-west monsoon. The climatic conditions of Coimbatore for the past 10 years. The temperature in Coimbatore is moderate throughout the year. However, September to March is the best time to visit the place. It is not very cold during winter (December to February) and the temperature may be between 15 °C and 33 °C. However, the summers (March to May) are hot and the temperature is about 40 °C but there will be light cool wind flows through the district which makes it a pleasant season. Monsoons are strong here during the months of June to August due to the presence of the mountain pass.

The geology of Coimbatore mainly consists of hornblende gneiss covering major portions of the Coimbatore region. Fluvial covers the western regions of Coimbatore and Kohndalite and limestone are concentrated in small regions in south of Coimbatore (Fig. 2). The black soil is suitable for the cultivation of cotton. Red loam is also found in Avinashi and Coimbatore taluks. The soil in Coimbatore taluk is enriched with organic matter from the hill ranges. There are rich tracts of red loam in

Palladam and Pollachi taluks. The soils in Pollachi taluk are mostly of sandy loam often mixed with gravel. The red soils around the Anamalai are fertile.

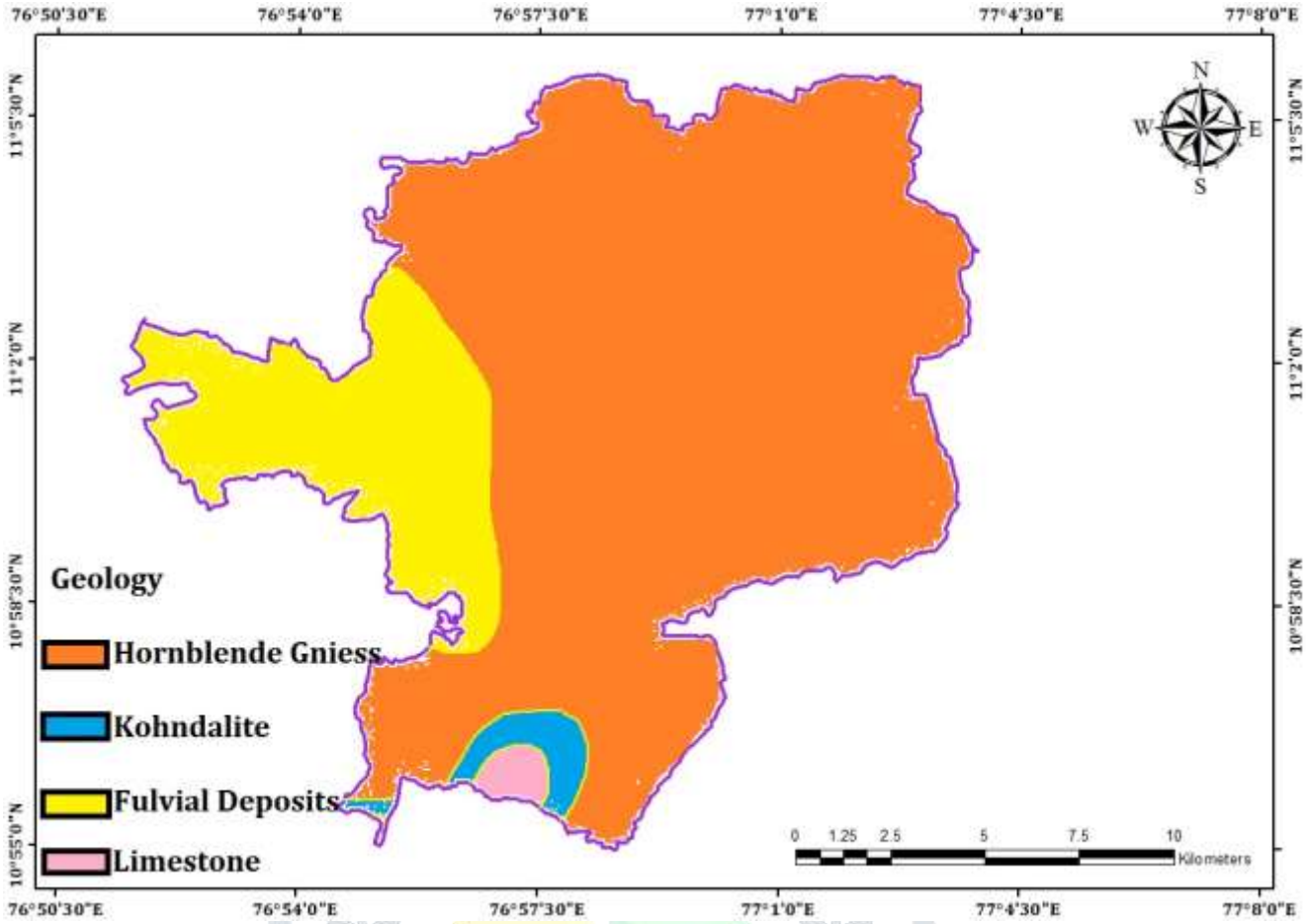

Figure 2: Geology map of the study area

II. MATERIALS AND METHODS

2.1 Data collection

The study area boundary was extracted from the survey of India (SOI) toposheets serious of 1:25000 scales. Landsat and Sentinel-2A satellite images were collected from USGS Earth Explorer for the period of 2005 and 2010 respectively. In addition to the above data, various ancillary data are also collected and used as collateral data for this study. Global Positioning System (GPS) was used to collect reference points from different land use land cover categories.

2.2 Pre-Processing

Pre-processing of satellite images prior to actual change detection is an important process and has a primary unique objective of establishing a more direct relationship between the acquired data and biophysical phenomena. Using ERDAS and ArcGIS applications, data are preprocessed for geo-referencing, composite bands, mosaicking and extracting raster image using the mask (Area of Interest). Also, Different raster functions were used to improve visualization and identify the different objects on the imagery.

2.3 Image Classification

Image classification is a procedure to categorize all pixels in an image into land cover classes or themes. Based on the image spectral reflectance or emissivity characteristics the pixels are grouped together in classes that are assumed to represent specific categories of earth features. Different spectral band combinations and raster functions were used to improve the

visualization of various objects in Landsat and Sentinel-2A imagery. A hybrid supervised classification approach was used to classify satellite images into land use/land cover classes. This approach is a combination of automated and manual classification techniques. Initially, the images were classified using Unsupervised classification process with 75 classes. Next, the unsupervised classified image was refined and edited using visualization and comparing with reference images. After classification, ground verification was done to improve the accuracy of land use / land cover

2.4 GIS analysis

The base map of Coimbatour Corporation digitized from survey of India toposheet using ArcGIS 10.0 software. The precise locations of sampling points were determined in the field using GARMIN 12 Channel GPS and the exact longitudes and latitudes of sampling points are imported in GIS platform. Inverse Distance Weighted (IDW) interpolation technique was used for spatial modeling. IDW is an algorithm used to interpolate data spatially or estimate values between measurements. Each value estimated in an IDW interpolation is a weighted average of the surrounding sample points. Weights are computed by taking the inverse of the distance from an observation's location to location of the point being estimated (Burrough and McDonnell 1998).

2.5 Land-use land-cover mapping

The land-cover transformations in an area have an important bearing on the water quality of the surface as well as ground water. Changes in the location and extent of potential pollution sources of groundwater can significantly affect the groundwater quality scenario in a watershed. For the present study, land-cover mapping was carried out for two different periods (2005 and 2010) to assess the changes in the land-cover patterns using multispectral satellite images from LISS III sensor onboard the Resource sat-I (IRS 1D) satellite.

III. RESULTS AND DISCUSSIONS

The present study we have compare the classified image for different LULC classes in the last two decades we come across certain observations that are alarming. Comparison of LULC derived from images of 2005 & 2010 (Fig. 3 and 4). The area covered by Built up area, Agricultural area, Barren Land, Industries, Scrub Land, Forest, Water bodies. After classification the comparison among different landuse and land-cover showed either a decrease or increase in area. The area agricultural land, scrub land, water bodies and forest shows a total decrease of 15.7 km^2, 2.2 km^2, 1.7 km^2 and 0.3 km^2 respectively (Table 1). The effect of gradually increasing influence of green revolution is continuously being manifested in the form of escalating area under salinisation; the total increase being registered is around 3.78 km^2. The accuracy assessment of the unsupervised classification was conducted and it was found that the accuracy of classified image was 88% derived from the error matrix, which can be considered good as per the criteria by Anderson et al. (1976). A decrease in the water bodies area by 17% was observed due to an increase in the area of settlement. A phenomenal increase as high as 160% was observed in the number of settlements because of population increase and also improved quality of life. There was a decrease in the area of agriculture plantation by 13%, and an increase of agriculture fallow land by 7.98%. The increase in the area of fallow land suggests less rainfall. The agriculture cropland area decreased because of an increase in the population. The fertility of the soil changed due to excessive use of fertilizers. Salt affected land has increased by 13% owing to the green revolution in Coimbatore Corporation. The enormous use of groundwater, fertilizers and pesticides could be the reason behind the increase of salt affected land. The area occupied by water bodies showed a decrease of around 8.9%.

Comparison of LULC derived from images of 2005 & 2010 (Fig. 5). The area classified as built up area in this case also shows a pessimistic trend; a sharp increase of about 8% of the total study area. Recent flood plain being the youngest surface in the area is still in the process of building up and is liable to annual flooding. It is covered by swamps and cut off meanders at places. Due to annual floods, recent floodplain is not suitable for agriculture. Therefore, it can be better developed as pasture land for cattle and can also be used for fodder cultivation. The area covered by swamps and cut off meanders can be developed into tanks for pisciculture.

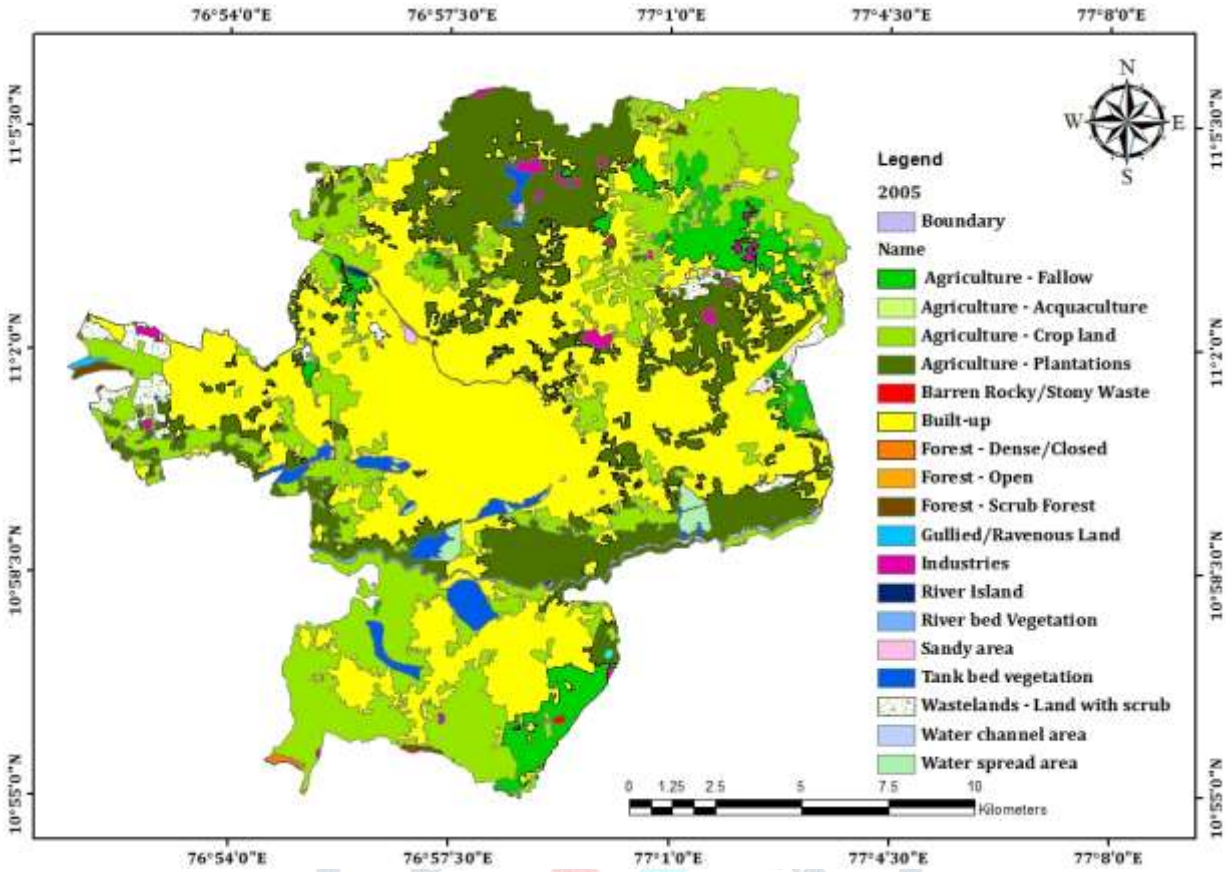

Figure 3: Landuse/ Land cover map of the study area 2005

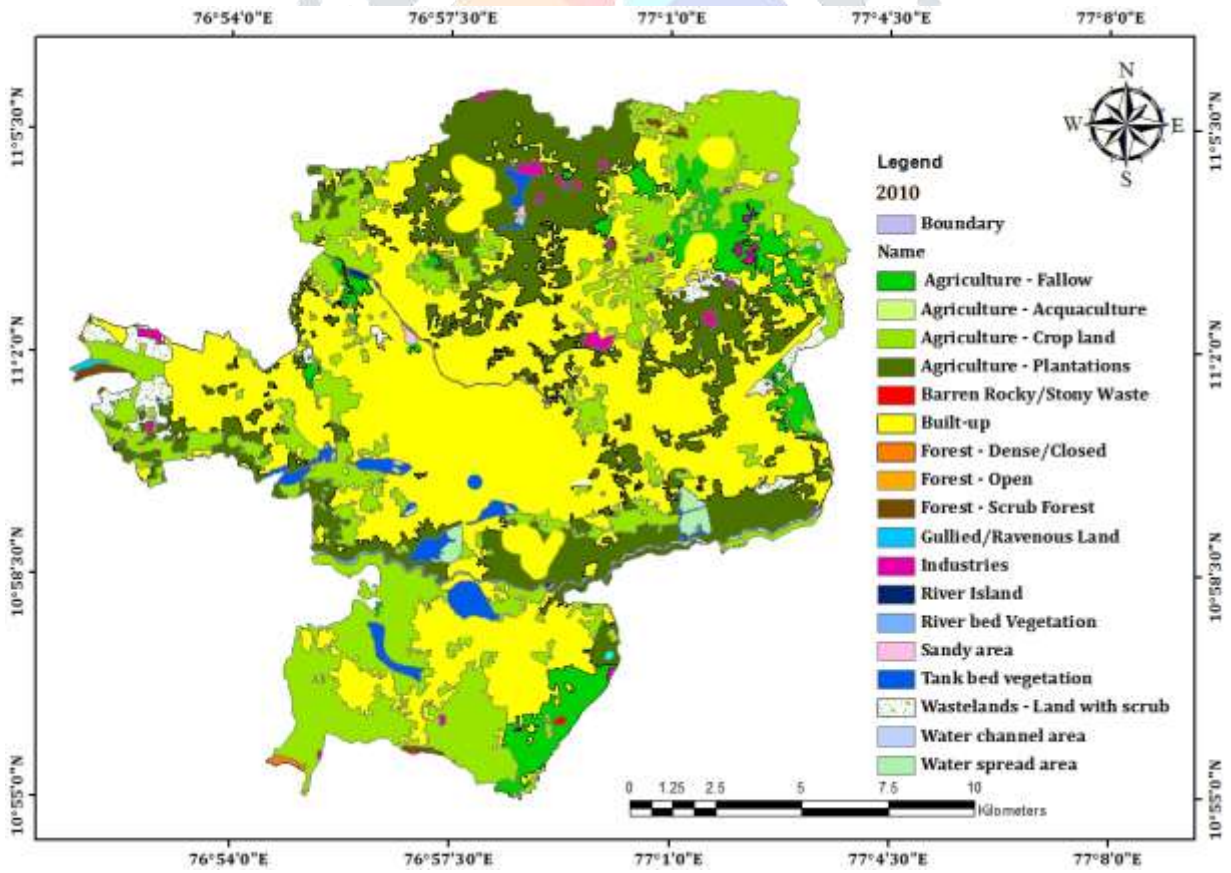

Figure 4: Landuse/ Land cover map of the study area 2010

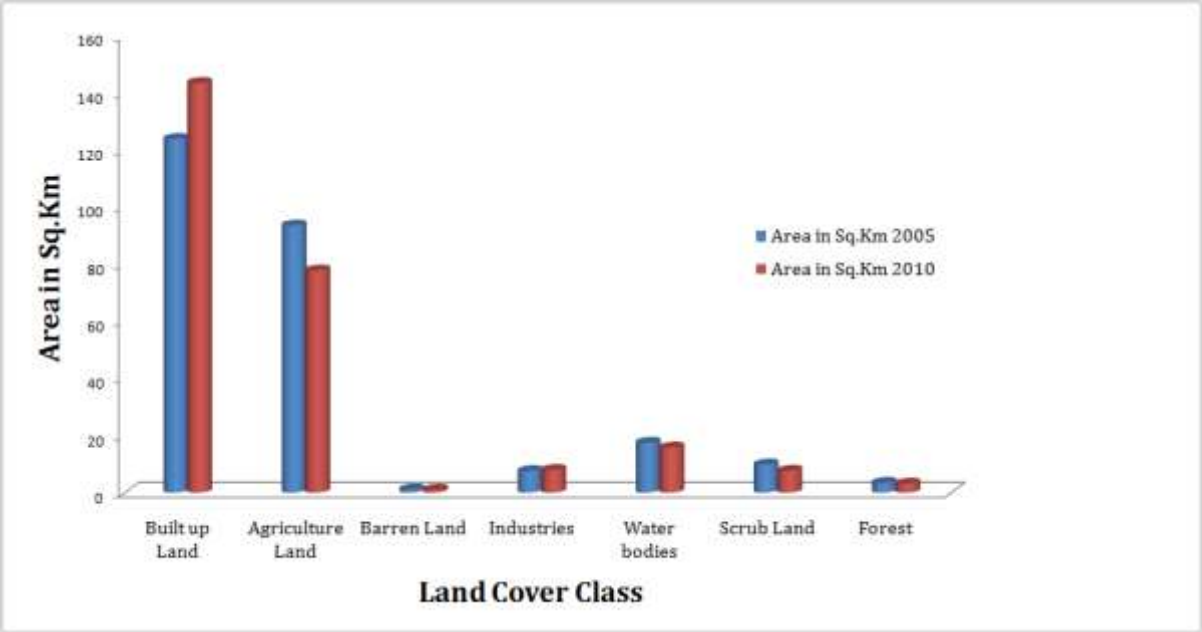

Figure 5: Landuse/ Land cover change graph 2005 and 2010

Table 1: Changes in respective classes in years 2005 & 2010

Land use Cover	Area in Sq.Km	Percentage	Area in Sq.Km	Percentage
Built up Land	123.8	48.17121	143.4	55.79767
Agriculture Land	93.5	36.38132	77.8	30.27237
Barren Land	1.2	0.466926	1.1	0.428016
Industries	7.6	2.957198	8	3.11284
Water bodies	17.5	6.809339	15.8	6.14786
Scrub Land	9.9	3.85214	7.7	2.996109
Forest	3.5	1.361868	3.2	1.245136
	257	**100**	**257**	**100**

IV. CONCLUSION

Conclusion derived from LULC study from 2005 to 2010 within the period studied; there was a continuous decrease in the area of agriculture land (60%), water bodies (24%), scrub land (11%) and a significant increase in the area of settlement (334%). The main reason for this pattern of land-use and land-cover change may be the increase in population size and per-capita requirement of natural resources. The land with industries increased considerably (112%) over the period, while land without scrub registers a decrease of 21%. The area under water bodies and under seasonal streams displays a negative trend and the total decrease is 17%. Figure 5 indicates the overall changes over the time period studied. The major adaptation occurred in agriculture land to built-up land category due to different anthropogenic reasons. The decrease of water bodies may be due to inadequate rainfall, non-perennial water flows in the river and infringement. This study supports that hybrid supervised classification of temporal satellites is very useful to detect the land use/land cover changes and analyze the collision of in the ecological unit.

V. ACKNOWLEDGMENT

Authors are grateful to Shri A.P.C.V.Chockalingam, Secretary and Dr.C.Veerabahu, Principal, V.O.Chidambaram College, Tuticorin for his support to carry out study.

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