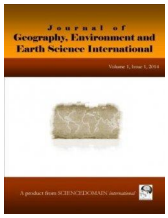

Journal of Geography, Environment and Earth Science International

17(1): 1-9, 2018; Article no.JGEESI.43062
ISSN: 2454-7352

Detection of Land Use and Land Cover Changes: A Case Study of Kumbur River Basin

R. Mahesh[1*], R. Baskaran[1] and R. Anbalagan[2]

[1]Department of Industries and Earth Sciences, Tamil University, Thanjavur, India.
[2]Department of Earth Sciences, Indian Institute of Technology, Roorkee, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author RM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RB and RA managed the analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JGEESI/2018/43062
Editor(s):
(1) Dr. Fombe Lawrence Fon, Regional Planning and Development, Faculty of Social and Management Sciences, University of Buea, Cameroon.
Reviewers:
(1) C. Prakasam, Chitkara University, India.
(2) Fikir Alemayehu, University of Nairobi, Kenya.
Complete Peer review History: http://www.sciencedomain.org/review-history/26153

Original Research Article

Received 6th June 2018
Accepted 23rd August 2018
Published 8th September 2018

ABSTRACT

Kumbur River basin has been one of the bio-diversity areas in India. Land use and land cover study of a particular area has been one of the most important criteria to know about the usage pattern of the environmental conditions. With every passing year, we can see a change in land use and land cover classification in the study area, a part of the Western Ghats located in Tamilnadu. In this study, an effort is made to understand the changes in land use and land cover in the study area over a period of 24 years (1990- 2014). The study has been done through remote sensing tools using Survey of India map (1990) and the Landsat imageries of the study area (January, 1990, January, 2001, February, 2010 and June, 2014). The land use and land cover classification was implemented based on the supervised classification using the maximum likelihood method. Thematic maps were prepared by using GIS software. Accuracy assessment has been done for the classification by ground truth observations. The present study showed that land use and land cover of the study area has experienced a vast change between 1990 and 2014. Mainly Developed areas (built-up and agricultural land) have increased from 13% to 35% of the total area (13.9%, 20.13%, 29.4%, and 35.5% in the specified periods, respectively). Thus, proper management of the land resource is the need of the hour in the study area.

**Corresponding author: E-mail: rsmahesh.r@gmail.com;*

Keywords: Change detection; land use; land cover; satellite imageries.

1. INTRODUCTION

Land use and land cover change could be a major dilemma over the environment change globally. During the 1972 Stockholm Conference on Human Environment, the scientist's community proposed for a functional study of land use changes [1]. International Geosphere and Biosphere Programme (IGBP) and International Human Dimension Programme (IHDP) forms a sector to outline a research plan over the recommend research activity for these types of changes (IGBP REPORT 44). The same was proposed through the UN Conference on Environment and Development also (UNCED, 1992) [2]. Land use and land cover mapping have become a crucial part and the alternative parameters are combined on the basis of needs to come up with the different developmental index for natural resources. Land use describes the man-made activities on the earth and the various uses that happen over the land at a certain period and land cover describes the natural vegetation, water bodies and others observed on the land [3]. Degradation of the land takes place primarily due to increase of population density that leads to intense land use without appropriate management. The migration of livelihood towards highland areas is due to population explosions. When these types of land are occupied without considering the disintegration of rocks and landslide issues, it contributes towards severe deterioration and allied problems. The influence of construction and other similar disturbances of the landscape on erosion and landslides, and other mass movements on the hilly area are widely known.

Remote sensing information is notably helpful in evolving countries where recent and reliable spatial info is lacking [4]. Remote sensing technology and geographic data system (GIS) offer economical ways of analysing land use problems and offer tools for land use designing and modelling. Remotely sensed information has the potential to evaluate the changes in land cover economically and in less time with higher accuracy with the help of GIS that offer an appropriate platform for information analysis, update and retrieval [5]. The amendment in any type of land use is connected either with the external forces and therefore, the pressure settled inside the system [6]. The main objective of this study is to investigate the extent of land use and land cover changes in the study area within the past 24 years and to shed some spotlight on the utmost reasons at the back of these alterations.

1.1 Study Area

Kodaikanal has been one of the most popular hill stations settled on the Palani Mountains within the Dindigul district of Tamilnadu. Kodaikanal has been referred to as the "Princess of Hill stations" and carries an extended history as a retreat and common travelers' destination for many around the globe. The altitude of this hill station is 2560 m on the southern tip of higher Palani Mountains in the province on the Western Ghats. It comprises enhancing waterfalls, mighty rocks, steeper slopes and an attractive lake. The study area is located in the western part of Dindigul district. The coordinates are 10°07'00"N to $10^0$16'00"N Latitudes and 77°16'00"E to 77°21'00"E longitudes, covering an area to the extent of 104.77 sq.km (Fig. 1). Fascinatingly, the Western Ghats are rated as the oldest mountain range in the world, which is mostly composed of rocks (mainly Charnockite).

The study area administratively surrounded with Udumalaippetai Taluk in the north, Bodinayakanur Taluk in the south, Kodaikanal Block in the east and Kerala State in the west. The study area is quasi-temperate. The maximum temperature is around 24°C and a minimum of 13°C during April and May (summer). Winter (December January) temperatures vary between 16°C maximum and 7°C minimum. Rainfall is well distributed throughout the year, with a typical annual precipitation of 1300 mm. The climate of the study area is incredibly distinctive, with a moderate fall, winter, and spring and a gentle summer. The study area also receives a large amount of rainfall every year, creating a perfect environment for cultivation. Therefore, many varieties of fruits and vegetables are grown in the study area, many of which can only be grown here including peaches, cauliflower, potatoes, grapes, plums, guava, jackfruit, garlic, pears, hill banana, carrots, and coffee. Some other species of plants, such as pine, walnuts, blue gum, eucalyptus and fruit trees are also cultivated here. The total human population of the study area is about 13933 consisting of 7131 males and 6802 females according to 2001 census [7].

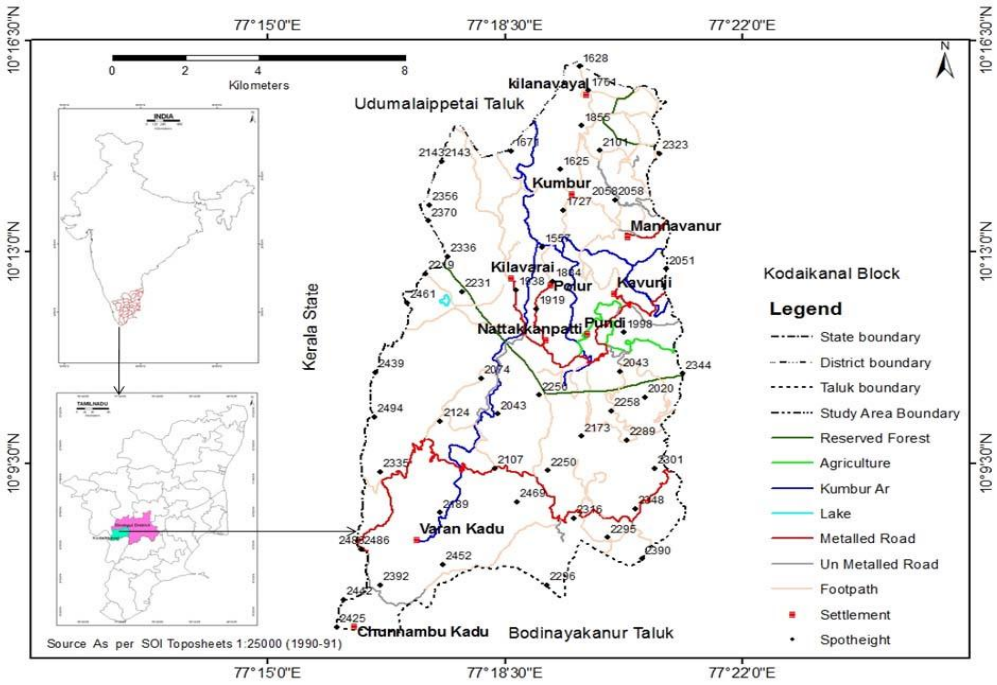

Fig. 1. Location Map of the study area

1.2 Objectives

The objectives of the present study was as follows:

- To analyse the nature and extent of land use/land cover changes in the study area in the past 24 years
- To identify the percentage difference over the years.

2. METHODOLOGY

The following methodology was used for the land use and land cover change detection over the specified years (1990-2014) (Fig. 2).

Maps of Survey of India, Topo sheets, Multi-temporal satellite dataset observed by LANDSAT 7 were used in the study. The scale of the study area map used for the analysis was drawn on 1:25,000 ratio (Table 1). Optical sensors such as ETM, *ESDR* and MSS comprising of 4, 5 and 7 multi-spectral bands ranging between visible and infrared radiations were used [8].

The resolution was 30 meters/pixel. Land use and land cover classifications were carried out using the supervised classification following maximum likelihood method. Based on the field knowledge, ground truth points were used to perform the classification. The land cover/land use layers of the study area and satellite imageries were prepared using GIS environment. The land use and land cover include classes' namely Base soil, Developed Area (agriculture and Built-up land), Low Land, Water Bodies and Vegetation (forest and plantation). Using GPS around a total of 200 points were collected on various land types as ground truth data. Based on this, finally the accuracy assessment has been carried out to know the accuracy [9].

Table 1. Spatial data sources

Data	Month of observation	Spatial resolution / scale
Landsat 7 Enhanced Thematic Mapper Plus (ETM+)	24 January,1990 14 January, 2001	30 m
Landsat 4,5 (MSS), SR ESDR	08 February, 2010 26 June, 2014	30 m
SOI Study area Map	1990-91	1: 25,000

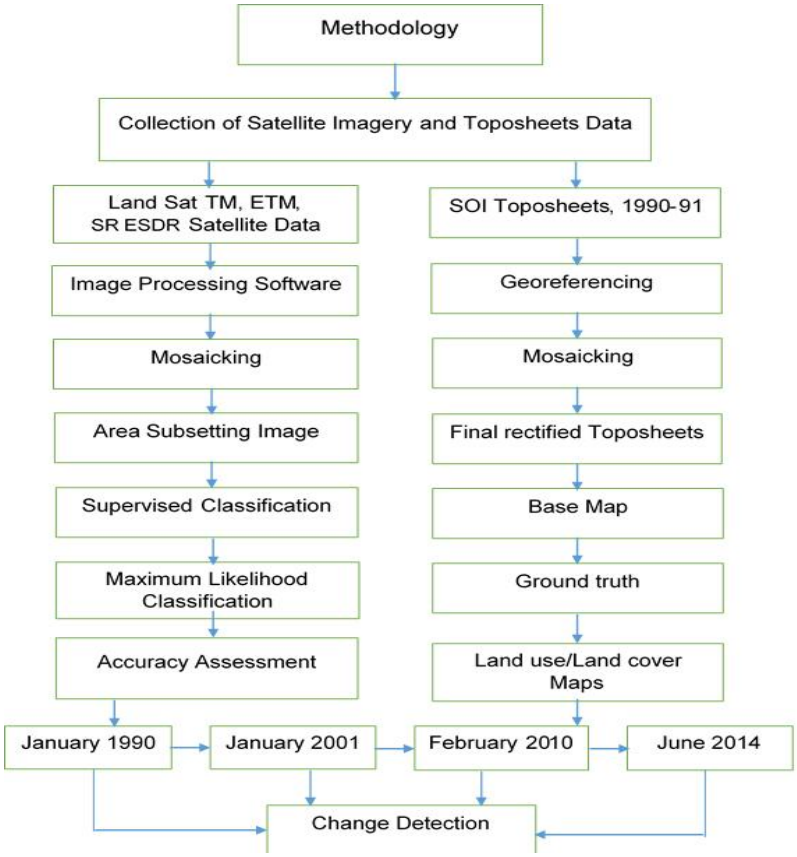

Fig. 2. Methodology

3. RESULTS AND DISCUSSION

The outcomes of the present study are presented in Table 2. The barren lands (Base soil) under the study area were converted to the developed area (settlements, road, and tourist's amenities, agricultural land, etc.). According to the Land Sat Imagery of the year 1990, vegetation -covered almost 46.94 km^2 of the study area (Table 2). This has declined to 41.21 km^2 in 2001, 37.72 km^2 in 2010 and 33.91 km^2 in 2014 over the period of time. It has been found that in the 24 years, almost 40% (Figs. 3, 4, 5, 6 & Table 2) of the vegetative lands have got transformed to harvested and developed area because of the human activities and migration.

The developed area which covered an extent of 14.66 Km^2 of the land in 1990, amplified to 21.10 Km^2 in the year of 2001, to 30.86 Km^2 in 2010 and to 37.21 Km^2 in 2014. From Figs. 3, 4, 5 and 6, it could be perceived that vegetation lands (forests) got converted to developed land for the agricultural plantation to a greater extent [10]. It indirectly shows that some portion of the land has also been occupied for agricultural activities

Table 2. Land use and land cover distribution

		Land use and land cover area in Km^2			
Sl. no.	**Land use and land cover**	**24 Jan, 1990**	**14 Jan, 2001**	**08 Feb, 2010**	**26 June, 2014**
1	Base Soil	3.40	4.42	5.49	5.86
2	Developed Area	14.66	21.10	30.86	37.21
3	Low Land	25.44	26.18	19.89	20.95
4	Vegetation	46.94	41.21	37.72	33.91
5	Water Bodies	14.33	11.86	10.81	6.84
	Total	104.77	104.77	104.77	104.77

which were forests in the beginning. For example, cardamom plantation and mixed plantation has been the major types in the developed area currently, whereas wattle plantation covered Mannavanur, Kumbur, Keelanavyil, Kavunji, Poondi, Polur and Kilavarai during the 1990's. Coffee cultivation is seen in Varankadu, Keelanavyil, Kavunji. Polur and Kilavarai also have cardamom cultivation at present. It is evident that these patterns reveal the transformations of the forest lands to agricultural land and built-up land.

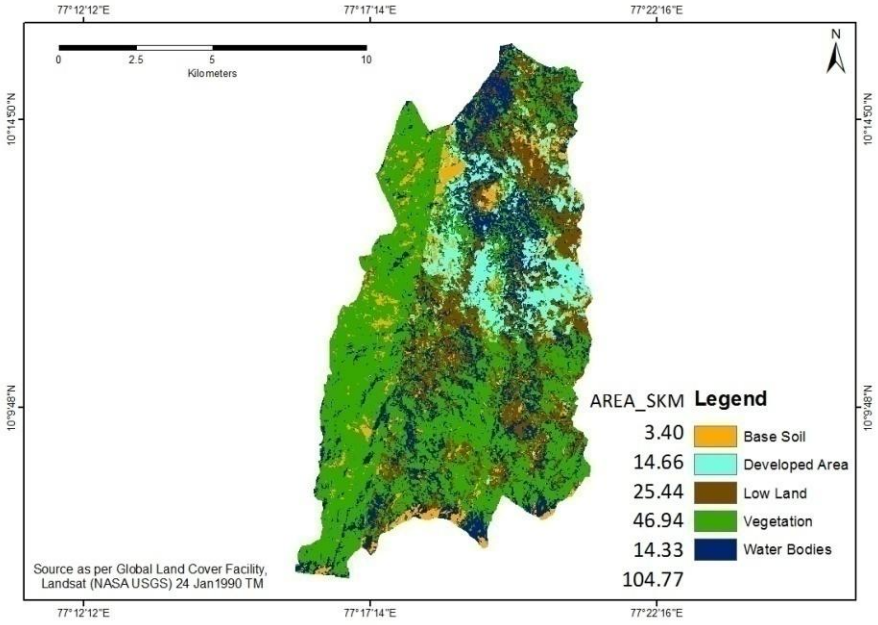

Fig. 3. Land use and land cover map of the study area during 1990

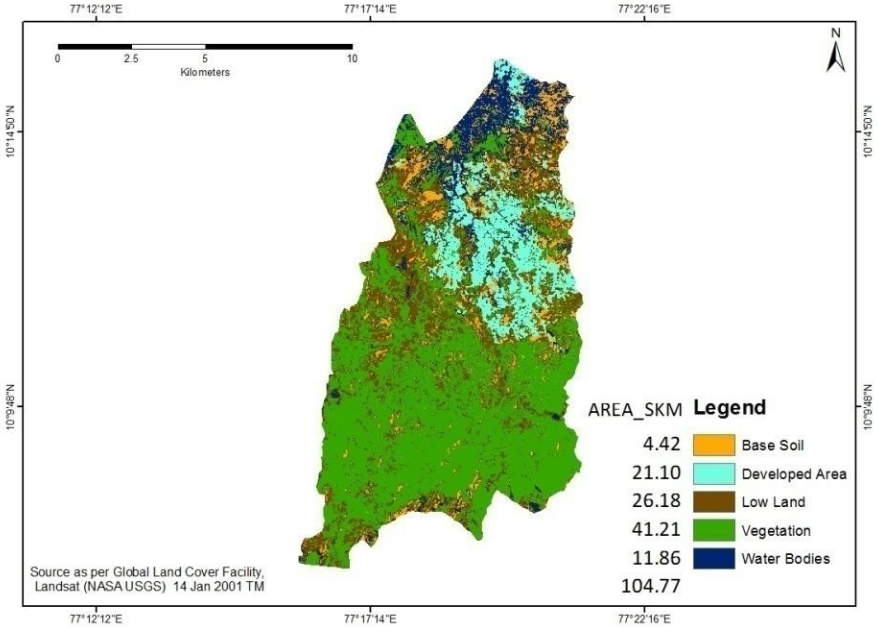

Fig. 4. Land use and land cover map of the study area during 2001

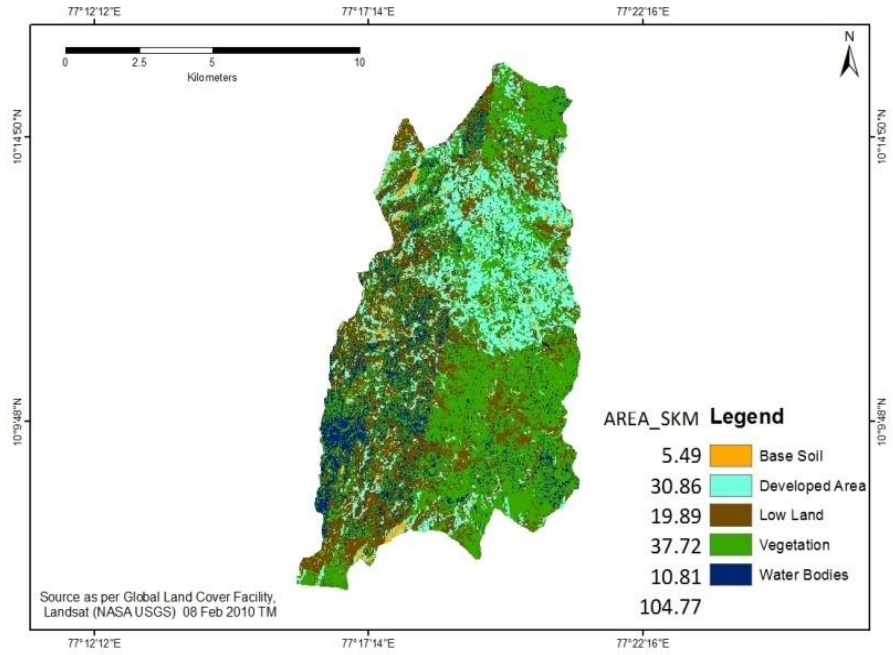

Fig. 5. Land use and land cover map of the study area during 2010

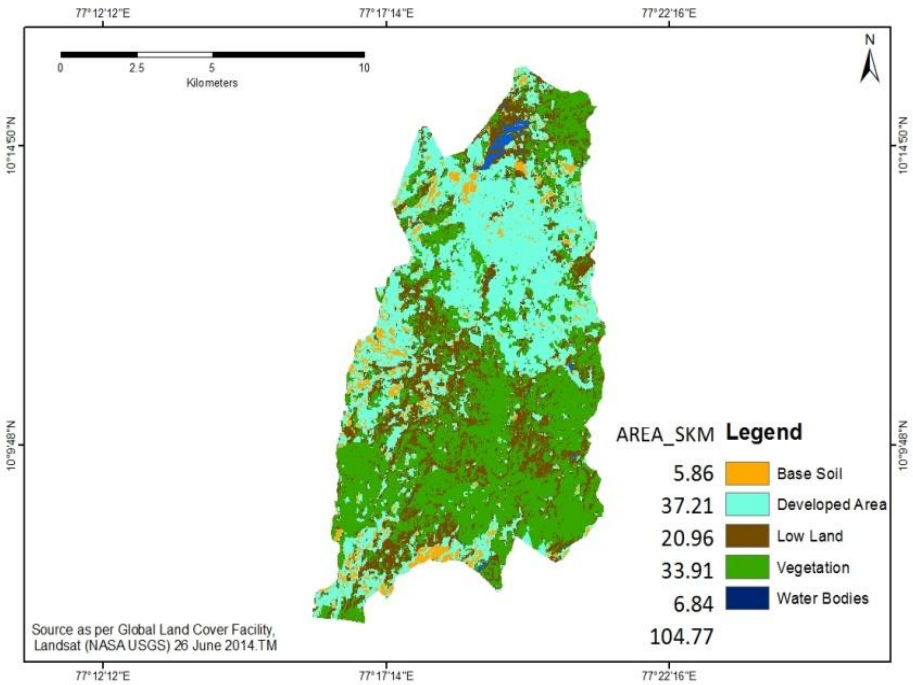

Fig. 6. Land use and land cover map of the study area during 2014

Water Bodies included lakes, reservoirs, ponds, rivers and streams in and around the study area. Water bodies covered around 13.6% of the study area in 1990 and decreased to 11.3% in 2001, further decreased to 10.3% in 2010 and 6.5% in 2014 (Figs. 3, 4, 5 and 6 & Table 2). Low land also had undergone changes in respective years. This variation might be due to the rainfall during

monsoon season. Even waterlogged areas and low land areas in the south-west part of study area might have got categorised under water bodies. The fact that Kumbur river basin, a mountainous regions also act as the catchments of the rivers and streams. Chief water bodies include Kumbur River, Kolusu streams and Ponds. Fig. 7 represents the distribution of land use and land cover distribution during the four selected periods in the study area.

3.1 Accuracy Assessment

This is the most common process in the handling of remote sensing data while using for comparative study. It establishes the information of the resulting data in a reliable manner. Dynamic use of geodata is only promising if the quality of the data is critically known. The complete accuracy of the classified image clearly depicts how the definite land cover conditions are classified from their respective ground truth data versus each of the pixels obtained. Errors of omission are calculated to measure the Producer's accuracy, which denotes the percentage of land cover types classified exactly. Errors of the commission are considered to measure the User's accuracy which denotes the probability of a classified pixel matching the land cover type of its equivalent location.

Based on the assessment, it has been found that the use of land under the study area has endured

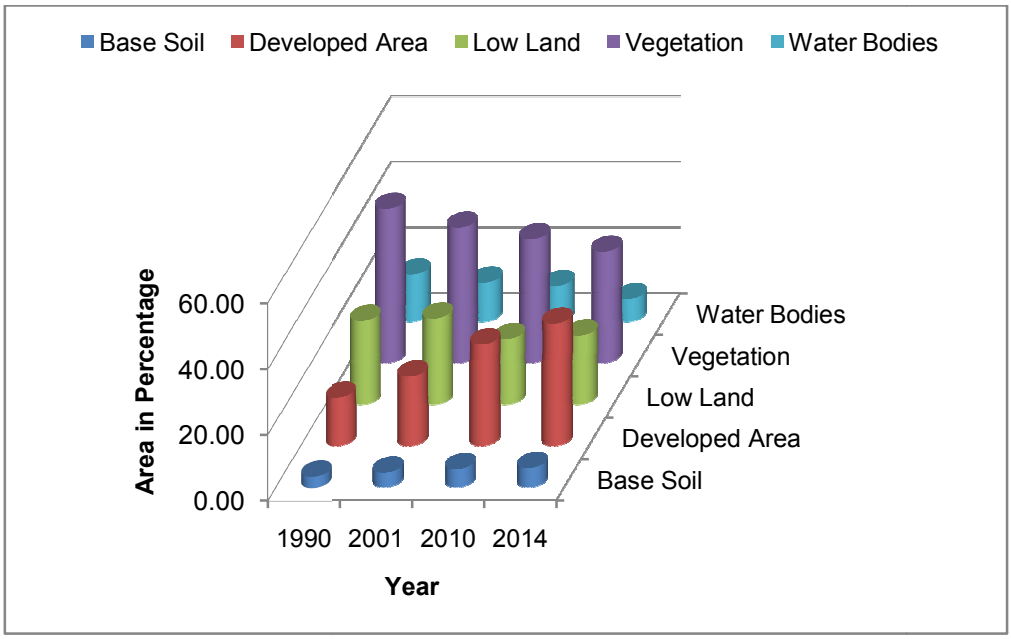

Fig. 7. Distribution of land use and land cover distribution during the four selected periods

Table 3. Accuracy assessment

Accuracy assessment							
Land use and land cover classes	**Base soil**	**Developed land**	**Low land**	**Vegetation**	**Water bodies**	**No. of classified points**	**User accuracy %**
Base soil	**17**	0	5	0	4	**26**	65.38
Developed land	0	**55**	1	0	0	**56**	95.21
Lowland	4	0	**5**	0	6	**15**	73.33
Vegetation	0	0	1	**73**	0	**74**	98.65
Waterbodies	8	1	7	0	**13**	**29**	64.83
No. ground truth points	**29**	**56**	**19**	**73**	**23**	**200**	
Producer Accuracy %	68.62	98.21	86.32	100.00	76.52		
Overall accuracy assessment - 81.5							

a lot of changes. These data have become reliable depending upon the proper classification of each category of the land use. The imageries of the base soil are quite accurate as the section of the image classification was combined with the lowland areas. However, the accuracy assessment turns out to be beneficial in classifying these types of areas. For the water bodies, the classification was highly precise letting to the particular ratio of image classification. These resemblances were verified in the field assessment with the ground truth points. A total of 200 ground truth data were collected and used in this assessment. The ground truth points indicated that the total accuracy of the classification was found to be 81.5%. Users accuracy and producers accuracy differs from 64 to 98% and 68 to 100%, respectively (Table 3). The classification of land use was accurate and almost matching to the real land use. Though, comparable nomenclatures were identified allowing the physical characteristics regardless of the different types of land use.

4. CONCLUSION

The major land use in the study area is vegetation. But it has experienced a lot of changes and inclining towards a decrease in the past twenty-four years. Here vegetation land was converted mostly into the developed land (i.e., built-up and agricultural land). Due to these changes, the natural ecosystem has got affected, thereby disturbing the biodiversity in an alarming way. The rise in agricultural land usage may be a good indication, but the realistic truth reveals that due to the escalation in the cost of cultivation, labour unavailability problems, the supply of low quality adulterated fertilizers and price fluctuation in the market, the farmers prefer to sell their lands to the property developers. Hence, there is a threat of decline in the extent of land under vegetation class in the upcoming years. The huge expansion in the area under built-up lands (i.e., Developed land) may cause a lot of environmental complications. Hence, it is the responsibility of the government and also the society, to come forward to take effective measures to protect the land undergoing vast changes under the study area. To conclude, it could be stated that the study area, which is one of the major biodiversity zones of the country, is under huge threat of ecological and environmental problems due to inadequate and improper land management.

ACKNOWLEDGEMENTS

The authors thanks the USGS, Global Land Survey, United States Geological Survey, Sioux Falls, South Dakota. GLCF: Welcome USGS Earth Explorer: who has provided Download Free Landsat Imagery.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Stockholm declaration. Declaration of the united nations conference on the human environment and the Rio declaration on environment and development. United Nations Audiovisual Library of Inter-national Law. 1972;21:1-11.
2. Madeley J. The united nations conference on environment and develop-ment (UNCED). Land Use Policy. 1992; 9(4):300–302.
3. National Remote Sensing Agency (NRSA) Manual of Nation Wide Land Use/land Cover Mapping Using Satellite Imagery. 1989;(Part 1).
4. Prakasam C. Land use and land cover change detection through remote sensing approach: A case study of Kodaikanal taluk, Tamilnadu, Inter-national Journal of Geomatics and Geosciences. 2010; 1(2):150-159.
5. Chilar J. Land cover mapping of large areas from satellites: Status and research priorities. International Journal of Remote Sensing. 2000;21(6-7):1093–1114.
6. Bisht BS, Kothyari BP. Land cover change analysis of Garur Ganga watershed using GIS/remote sensing technique, Indian Soc. Remote Sensing. 2001;29(3):165-174.
7. GOI Census of India 2001. Provisional population totals. Registrar General and Census Commissioner of India, Ministry of Home Affairs, New Delhi, India; 2001.
8. Blaser TJ, Lyon RJ, Lank K. Updating a land planning database from landsat 5 thematic mapper data: Geographic information systems and mapping practices and standards. ASTM STP 1126, Johnson AI, Pettersson CB, Fulton J, Eds., American Society for Testing and Materials, Philadelphia. 1992; 132-154.

9. Sophia S. Rwanga JM. Ndambuki, accuracy assessment of land use/land cover classification using remote sensing and GIS. International Journal of Geosciences. 2017;8: 611-622.

10. Kachhwaha TS. Temporal monitoring of forest land for change detection and forest cover mapping through satellite remote sensing. In: Proceedings of the 6th Asian Conf. On Remote Sensing. Hyderabad. 1985;77–83.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/26153