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LANDUSE AND LANDCOVER CHANGE DETECTION BY REMOTE SENSING AND GIS TECHNIQUES - A CASE STUDY OF HEBBAL VALLEY, BANGALORE

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ABSTRACT

Human activities have brought out changes on the land surface drastically, in the recent past. Their quest for expansion of habitats has led to changes in land use and land cover patterns. Such studies are important to understand the effect of human interaction with the environment. In the present scenario, though development is essential, it is more important that it should be sustainable. The present study is undertaken in the Hebbal valley of Bangalore, Karnataka to estimate the land use and land cover changes over a period of time, using GIS and Remote sensing technologies. The change in land use and land cover patterns in the study area has been studied from 2001 to 2015. The analysis has been carried out using Survey of India topographical sheets, Satellite imageries and Arc GIS software. The results have shown that the agricultural land extent has been gradually reducing, and has reduced as much as 12.9 percent from the start to end of the study period. At the same time, built-up area extent has shown increases of 7.49 percent and also there is a slight increase in industrial area, in the study area. Simultaneously, a slight reduction in area under water bodies (1.17 percent) has been observed. Furthermore, a negligible decrease of waste lands under barren land/grass land has occurred. The overall results indicate a decrease in agricultural land extent and water, cover year by year.

KEYWORDS: Sustainable, Remote Sensing, GIS, Agriculture

INTRODUCTION

Land is the platform on which, all human activities occur and much of his requirements; may be food, shelter, recreation, resources, etc. are met. Land resources are essential for the socioeconomic development at the national, regional and local levels. Human use of land resources gives rise to "land use", which brings a change in bio-physical characteristics of land itself. It varies with the purposes it serves. The land form pattern changes, especially in urban areas, they have become more dynamic. The changes at times are beneficial, at the same time, are detrimental if are taking place in an uncontrolled manner. There have been no instances in which, people have used the land and its resources without causing any harm. The equilibrium of nature was well maintained, by the availability of all types of land such as forestland, wet land, waste land, cultivable land, etc. in a balanced way. In many of the developing countries, increase in population has been attributed to demand on spaces for shelter and industrial activity. This can be better understood by evaluating land use and land cover changes over a period of time. Land-use and land-cover change (LULCC); is a general term for the human modification of the earth's terrestrial surface. Land cover describes the physical appearance of the earth's surface, while land use is a land right related category of economically using the land. The land use of an area is a result of human

controls over the land resources in a relatively systematic manner. Monitoring and mitigation of the ill effects of LULCC, with sustained use of essential resources have therefore become a big priority of researchers and decision makers around the world.

Land use and land cover change detection are very essential for better understanding of land use dynamics for sustainable development. Knowledge of land use and land cover is considered as an essential element for many planning and management activities. Land use studies and analysis have become a pre-requisite for proposing developmental activities in an area. The demands on a particular land use have resulted in a crisis, leading to indiscriminate land mismanagement. The rate of development of man's economic and social activities can be evaluated by studying LULCC. Land use and land cover change detection is an important process in monitoring and managing natural resources and assessing environmental impacts, which includes detecting the changes that have occurred, identifying the nature of the change and measuring the area extent of the change.

Conventional methods of land use mapping of surveying interpretation are laborious and time consuming. They have many other disadvantages too, in terms of updating changes from time to time. These maps soon become outdated with the passage of time in a rapidly changing environment.

In recent years, satellite remote sensing techniques have been developed, which have proved to be of immense value in preparing accurate land use/land cover maps and monitoring changes at regular intervals of time. By means of integrating of remote sensing with Geographical information system techniques, it is possible to accurately analyze and classify the changing pattern of LULC, during a long time period. The LULC mapping and monitoring using RS and GIS techniques has been previously done by many researchers in different parts of India, as well as world, and is being continued as a very good tool with more advancements taking place. In this context, an attempt has been made to assess the LULCC of Hebbal valley, Bangalore, Karnataka, India from the years 2001 to 2015 to derive few conclusions.

STUDY AREA

The study area is located between 12º50' to 13º 5'N Latitude and 77º 30' to 77º 40'E Longitude forming a part of Cauvery river basin. The study area covers an area of 310.24 $km^2$and drains into river Pinakini in Bangalore district of Karnataka. Physiographically, the area is characterized by undulating topography with plains and shallow valleys. The study area is located at the north east part of Bangalore. Bangalore is the capital of Karnataka state. However, the district does not have any major river flowing. The district falls in the Cauvery River basin. The study area attains maximum elevation of 940 mtrs and a minimum of 880 mtrs above mean sea level. The study area is well connected by highways and other main roads. The average depth of annual rainfall in the study area (Hebbal valley watershed) is 820 mm.

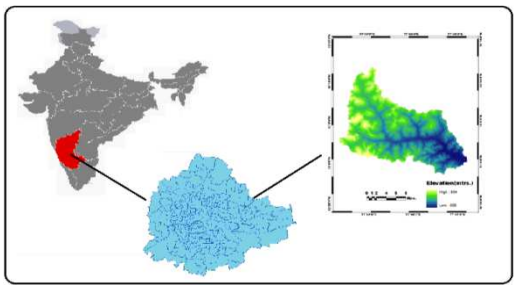


Figure 1: Study Area

OBJECTIVES

The main objective of the present paper is to analyze the nature and extent of land use/land cover changes in Hebbal valley watershed, from May 2001 to May 2015 and to assess the main forces behind the changes.

MATERIALS AND METHODS

- Survey of India (SOI) topographic maps 57 G/8,12,16 and 57 H/9 on a scale of 1:50,000 and IRS-IC-LISS III data acquired and IRS-IC-LISS-III, and LISS, PAN merged data acquired in the year 2001,2003, 2006, 2009, 2012 and 2015 respectively, and the same were used for land use classification.
- Base maps, including road, railway, settlement, village location and watershed boundary, extracted from the topographic sheets and converted into a GIS database, and further, the modifications in the LULC map updated by cross correlating with Remote Sensing Imageries.
- The image elements, correlated with ground truth verification and tonal variation representing the different classes was marked on the hard copy. The functionalities of GIS, namely, overlay analysis were applied to identify the areas of changes taken place.

RESULTS AND DISCUSSIONS

Geographical Information Systems (GIS) can serve as a valuable tool for land use change detection, and has a role to play in improving the Environment. Change detection involves the use of multi-date (time series) aerial photos, top sheets or satellite imageries of the study area, from which land use maps can be generated by visual interpretation or digital image processing. Remote sensing and Photogrammetric products are integrated in a geographic information system (GIS) to better study land use change patterns over time. Remote sensing has provided an efficient method and perfect alternative of data acquisition for land use administration. Total of seven categories of Land use and land cover classes as per NRIS classification have been identified in the study area *Viz.,* Agricultural land, Built-up (urban and rural), Forest plantations, Industrial area, water bodies and waste land. LU / LC maps for the years 2001 to 2015 are shown in the Figures 2 to 7, respectively. Area covered under different categories for the years 2001 to 2015 is shown in Table 1. LU/LC map for the year 2001 shows that about 153.79 km^2 area of study area comes under Agricultural land, which makes up 49.57% of the total area, and it is further divided into four categories –agricultural fallow, agricultural plantations, kharif crop and two crop area. The agricultural land has reduced to 40.66 Sq. km during the years 2001 to 2015. The built upland (Urban and Rural) which covers 128.49 sq.km, in the year 2001 has increased to 149.52 sq. km. Similarly, there is gradual increase in the forest plantations from 7.48 sq. km to 10.6 sq.km in respective years. Other land use classes, like waste land and water bodies have not much suffered from considerable change, however small changes with respect to decrease in their area is noticed (Figures 3 - 8)

Table 1: Statistical Details of LULC (2001 - 2015)

Land use	2001	2003	2006	2009	2012	2015
Agricultural Land						
Agricultural fallow	2.76	3.16	31.65	30.61	13.78	15.69
Agricultural plantation	76.05	74.29	39.90	41.81	46.67	42.81
Kharif crop	51.42	38.46	34.85	39.95	35.49	34.41
Two crop area	23.56	29.51	36.74	18.16	20.57	20.86
Total	**153.79**	**145.42**	**143.14**	**130.53**	**116.51**	**113.77**

Table 1: Contd.,						
Land use	**2001**	**2003**	**2006**	**2009**	**2012**	**2015**
Built Up						
Built up (urban)	115.97	116.81	117.51	121.30	129.61	125.81
Built up (rural)	1.65	1.92	2.49	3.61	4.51	5.59
Industrial	10.87	11.81	12.78	12.96	13.11	13.69
Total	**128.49**	**130.54**	**132.78**	**137.87**	**147.23**	**149.52**
Forest						
Forest plantation	2.33	3.81	5.51	5.69	6.61	6.60
Grassland	2.46	1.86	0.52	0.91	1.53	1.09
Scrub forest	2.69	2.46	2.31	2.96	3.03	2.91
Total	**7.48**	**8.13**	**8.34**	**9.56**	**11.17**	**10.6**
Water Bodies						
Lakes/Tanks	15.35	14.16	13.44	13.01	12.41	12.36
Water logged area	0.54	0.48	0.36	0.29	0.31	0.20
Total	**15.89**	**14.64**	**13.08**	**13.31**	**12.42**	**12.56**
Waste Land						
Barren rocky waste	0.034	0.028	0.019	0.011	0.012	0.009
Ravenous	3.243	2.89	2.34	1.96	1.31	0.86
Stone quarrying	4.210	3.20	2.22	2.11	2.11	1.96
Total	**310.24**	**310.24**	**310.24**	**310.24**	**310.24**	**310.24**

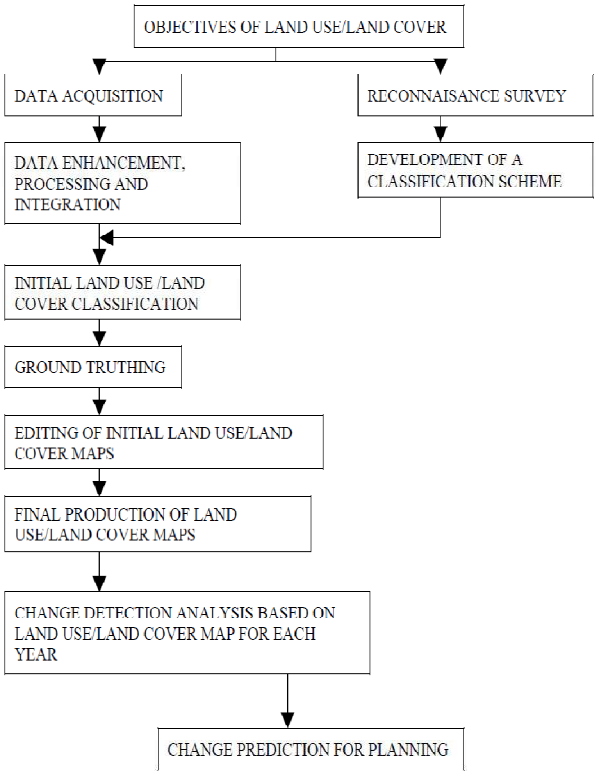


Figure 2: Flow Chart for LULC change detection

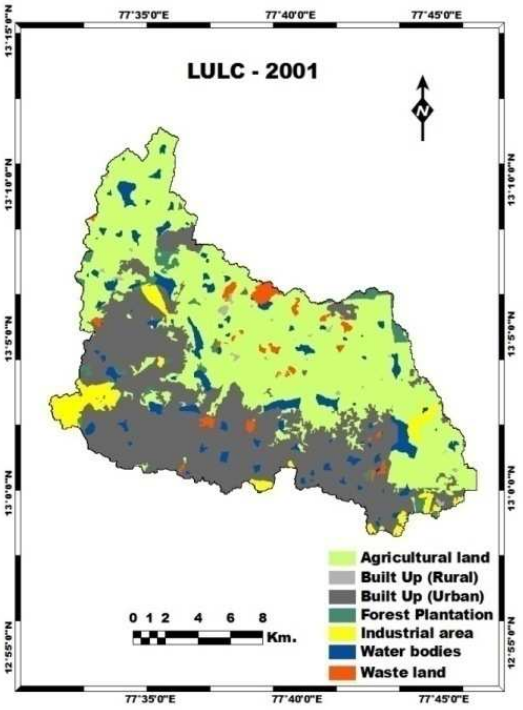
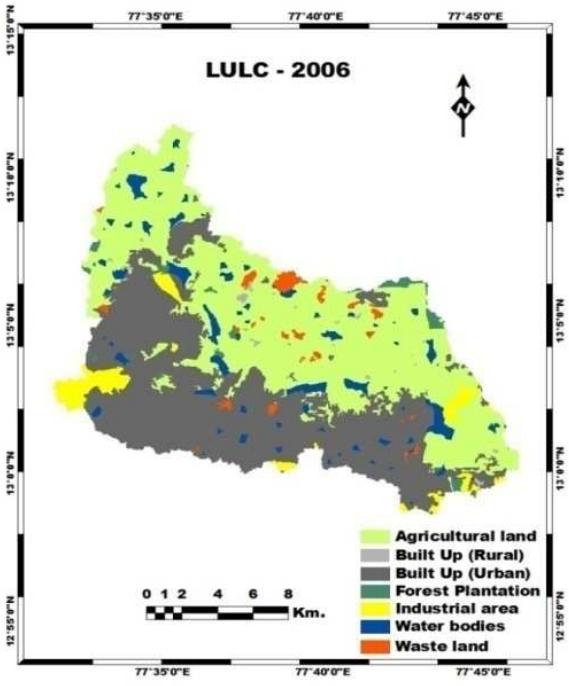


Figure 3



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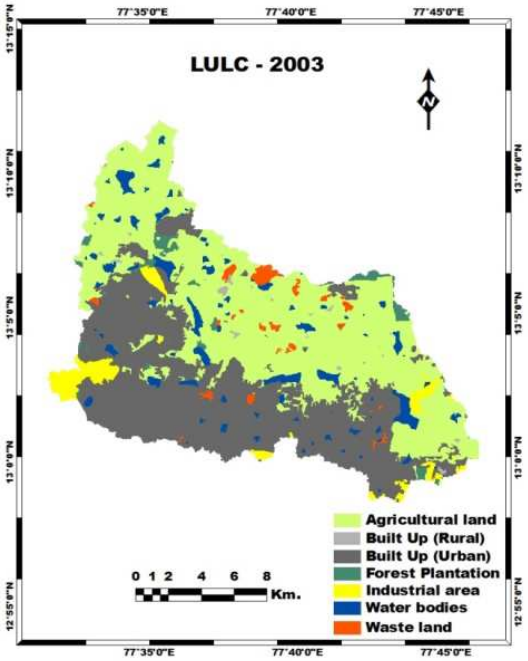

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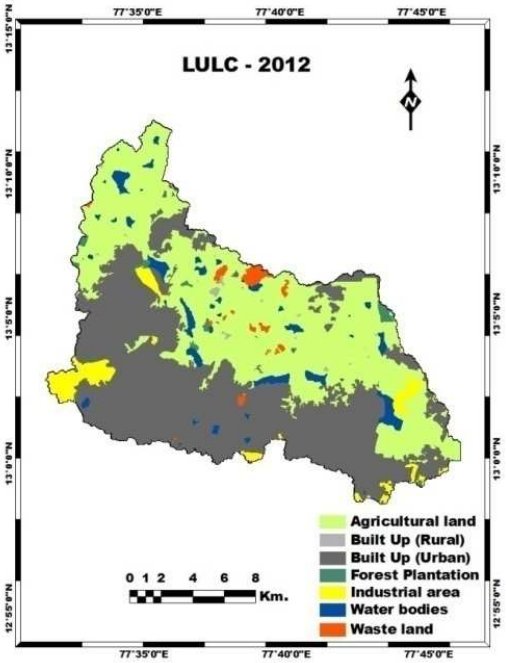

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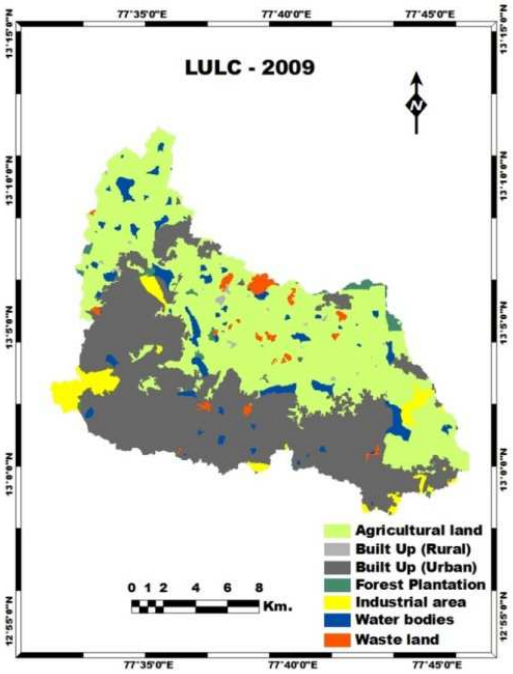

Figure 7

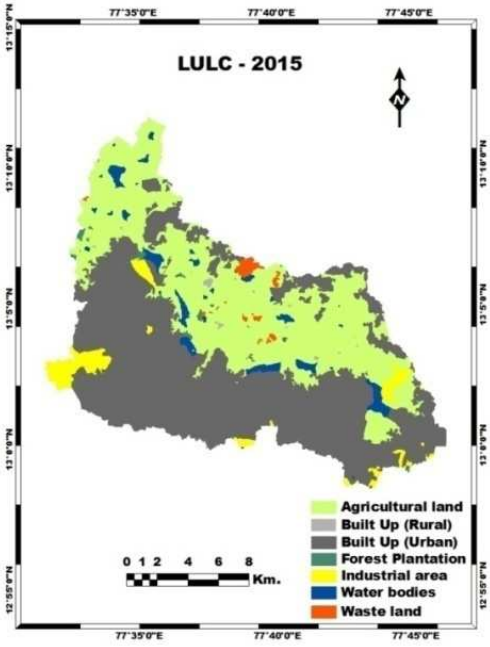

Figure 8

CONCLUSIONS

The LULCC, which has taken place in the study area, has been evaluated from the years 2001 to 2015. The changes in LULC of the study area have been attributed to various factors like increase in population, demand for industrial spaces and spurt in real estate activities. From the current study, it is evident that there is a considerable decrease in the agricultural land and increase in built-up areas. The decrease in water bodies in the study area is due to interference of human activity and failure of governing bodies in protecting natural water bodies. This is very much evident from the Table-1, depicting the overall trend in the land use/land cover change for the period 2001to2015.Thus, it is very much essential to implement sustainable development methods, to conserve and manage the available land resources of the study area.

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