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RESEARCH ARTICLE

Land cover dynamics of Devikulam Taluk - understanding the past scenario

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Abstract

Monitoring land cover change is the most important step in decision making for local or government agencies. Specially for a forest recovery program, understanding of the past scenario of land cover is very essential. It is also very important to understand the past scenario of the land cover for identification of areas for afforestation programs in the country. In this study we have tried to understand the land cover trend before the start of 21st century. IRS LISS-I image of 1989 is the oldest high resolution imagery available, therefore land cover change from 1989. IRS LISS-II imageries for 1993 and 1997 were used by taking into account four year time interval. The imageries were digitally classified and compared to obtain the land cover change statistics. The exact areas were also identified by overlaying the classified imageries. It is observed that an area of about 23790 Ha out of 78721 Ha dense forest in the year 1989 was converted to other land cover category by 1997, which means about 27% of dense forest area was reduced to 19% by 1997. An increase in the built up class was also observed from 1000 Ha in 1989 to about 2074 Ha in 1997. This study has established that a major portion of the forested land were already degraded even before stringent forest Act came into existence. The land cover change pattern also helps in predicting the future land cover trends.

INTRODUCTION

Globally, there are environmental concerns that tropical deforestation continues to be critical. Despite our understanding of it still being nevertheless limited, the implications of tropical deforestation on soil erosion, biodiversity loss, and global climate change cannot be overemphasized (Munthali and Murayama, 2012). The amount, the rate and the intensity of land use and land cover change are very high in developing countries. The human impacts on the land are still very great and increasing. During the last 33 years, the vegetal cover was altered drastically with increasing population pressure (both human and animal), agricultural activities and industrial wood/raw material extraction activities. Restriction on agricultural expansion by transferring large parts of vegetated areas to conservation forestry under government control and unrestrained agricultural expansion on community lands which supported fuel, fodder and manure requirements has resulted in a unbalanced land use. This in turn led to deforestation and environmental degradation (Rao and Pant, 2001). Tropical forests worldwide are undergoing rapid changes due to increasing human populations and varied land use practices. In an effort to protect these forests and their species, the number of protected areas has been increased exponentially in recent decades. Clearly protected areas play a crucial role in conservation efforts and this strategy has been found to be successful in several studies (Mondal and Southworth, 2010). In the Western Ghats, large tracts have been converted into monoculture plantations such as coffee, tea and rubber (MoEF, 2009b). Considering its importance, UNESCO declared the Western Ghats as a World Heritage Site (Natural site) during its 36th session of 21 parties World Heritage Committee panel held at St. Petersburg in Russia on 1st July, 2012 (Senthilkumar et.al., 2014). This study focuses on monitoring the land cover changes over 8 years from 1989 to 1997 to understand the historical anthropogenic impacts on forest in a small part of western ghats region in Kerala. Monitoring protected areas and their surrounds at local to regional scales is essential given their vulnerability to anthropogenic pressures, including those associated with climatic fluctuation. It is also important for management and fulfilment of national and international directives and agreements. Whilst monitoring has commonly revolved around field data, remote sensing can play a key role in establishing baselines of the extent and condition of habitats and associated species diversity as well as quantifying losses, degradation or recovery associated with specific events or processes (Nagendra et. al., 2013). In this study an attempt has been made to analyse the extent of forest degradation using remote sensing technique. On the cusp of the second decade of the 21st century it is evident that recent developments in the geo-technologies of Geographic Information Science (GIS) and remote sensing have had a substantial impact on ecological research, providing spatial data and associated information to enable the further understanding of ecological systems (Rundell et al., 2009)

STUDY AREA

Devikulam Taluk extends from 76°38'20" to 77°18'00" E longitude and 9°57'00" to 10°21'30" N latitude which is about 1800 sqkm and includes 13 villages (fig:1). Devikulam Taluk forms southern part of the Western Ghats, which has pre-dominance of shola forest ecosystem. A number of protected areas in and around this region include the Indira Gandhi Wildlife Sanctuary, Eravikulam Wildlife Sanctuary, Chinnar Wildlife Sanctuary, Parambikulam Wildlife Sanctuary and several reserved forests. The highest peak in south India, Anaimudi 2,695 m is also a part of the range. Different parts of the region experience widely varying annual rainfall, from less than 700 mm in the eastern reaches to over 4,000 mm in the higher and western reaches, as per the Meteorological department of India. It enjoys a tropical to sub-tropical climate due to the effects of elevation, with temperatures between 5°C and 35°C, with occasional frost in winter in the uppermost reaches. All these favourable condition makes it one of the best tourist destinations in south India, especially during summer, it is one of the most nominated sites containing typical high altitude shola-grassland vegetation. The climatic conditions and slope of the area is also very much favourable for tea plantation which is why the area is highly exploited for conversion of forest lands to tea plantation.

METHODOLOGY

Images from 1989 to 1997 were obtained from National Remote Sensing Centre with 4 years time interval. LISS-I image of 1989, LISS-II images of 1993 and 1997 were acquired and pre processed for geometric and atmospheric correction. Other image processing functions such as mosaic and subset were done to obtain the desired area for analysis. These images were digitally classified using supervised classification of ERDAS 2012. A classification scheme was formulated with 11 land cover classes after careful observation of land cover pattern of the area i.e. built up, cropland, dense and open forest, dense and open scrubland, eucalyptus or gum plantations (forest plantation), grasslands, tea plantations, barren rocky and water bodies. Further, refinements in classification were done using region growing tool for a particular class and reclassifying features. An accuracy (kappa accuracy estimates) of more than 85% were obtained for all the images each. These images were then compared with each other and analysed for the change in land cover classes over the years. Ground truth was conducted in January 2014 to validate the interpretation at doubtful areas. The past land cover information was obtained by enquiring with the local people. The statistics of the land cover classes of each image was extracted and compared for know the positive and negative changes. By overlaying the classified images over each other, the areas where land cover changes has occurred were visualised.

RESULTS AND DISCUSSION

It can be summarised that, about 23,790 Ha of dense forest land is converted to mainly open forest, and then later on contribute to increase in cropland and tea plantation. There is an increase of 12729 Ha of cropland and 1074 Ha of builtup from 1989 to 1997 (Table: 1). There is a remarkable increase in the tea plantation area of 10012.8 Ha from 1989 to 1997 of which 8105 Ha increase occurred during 1993 to 1997. By overlaying and analysing the image, the areas of conversion from dense and open forest to tea plantation were identified. The highest land cover change is the conversion of Dense forest to open forest, tea plantation and cropland with its associated builtups. Therefore the statistical area of open forest remains almost same, but the geographical extent has changed, as the open forest is then converted to cropland and builtup. In case of forest plantation, during 1989 to 1993 about 876 Ha were planted, but those areas were also converted to tea plantations or barren area during 1997 resulting in a decrease of area i.e. 414.72 Ha. While analysing the areas during the two year sets, the increase in areas of builtup and barren or rocky class is consistent. There is increase in cropland during 1989 to 1993, whereas from 1993 to 1997, the cropland remains almost the same which is accounted by the decrease in dense scrubland during 1989 to 1993. Similarly the increase in tea plantation is very high during 1993 to 1997, which is accounted by the decrease in area under forest plantation and open forest. The areas under waterbody and grassland remain almost same (fig:2-4). By overlaying the interpreted images, the land cover change of a specific area was examined (fig:5). Also a graph showing the positive and negative change in each land cover categories from 1989 to 1993 and from 1993 to 1997 is depicted as fig:6.

The extensive conversion of tropical forests to other land uses categories, especially, in the last four decades has raised global alarm on the threats posed by continued forest conversion to climatic stability and the hydrological functioning of river basins, next to the well-being of forest dwellers and the conservation of biodiversity. Major background driving forces can be recognised, however, such as rapid demographic expansion, with consequent booming demands for agricultural land and wood fuels, plus a change from a subsistence-based to a market-orientated economy, with the associated heavy pressure on natural resources to fuel economic growth and development or, in some regions, political instability and incurable conflicts. From this complexity of tropical land use dynamics, one single resulting element has been recognized with considerable alarm over the past decades. This is the progressive depletion of natural tropical forests(Drigo, 2005). Therefore area should be selected using mapping techniques and put under afforestation programs. Forest recovery after the abandonment of agricultural land use is largely influenced by the previous land use intensity (Holscher et al., 2005). Using remote sensing we can identify the land use history of a specific area for forest recovery programs.

Table I - Shows the Area statistics extracted from land cover classification of images of 1989, 1993 and 1997.

Land Cover Classes	1989	1993	1997
BuiltUp	1000.31	1365.47	2074.64
Cropland	20629	33458.1	33358.1
Dense Forest	78721.5	66316.6	54930.64
Open Forest	47004.8	49004.8	47869.2
Forest Plantation	2878.29	3755.16	3340.44
Open Scrubland	31843.5	35207.3	34895.1
Dense Scrubland	28009	17122.2	18899.7
Tea Plantation	20462.4	22369.6	30475.2
Grassland	25794.4	25838.4	25919.5
Barren Rocky	24108.3	26013.87	28648.8
Waterbody	6602.21	6602.21	6642.39
Total	**287053.71**	**287053.71**	**287053.71**

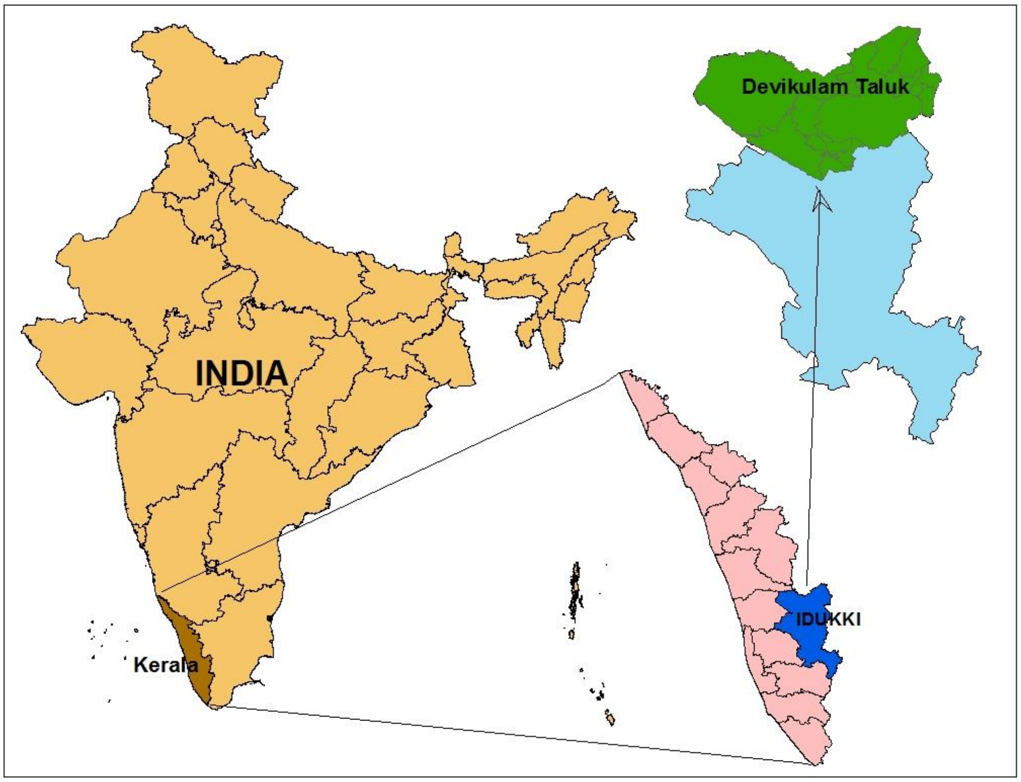

Figure:1 - Map showing the study area

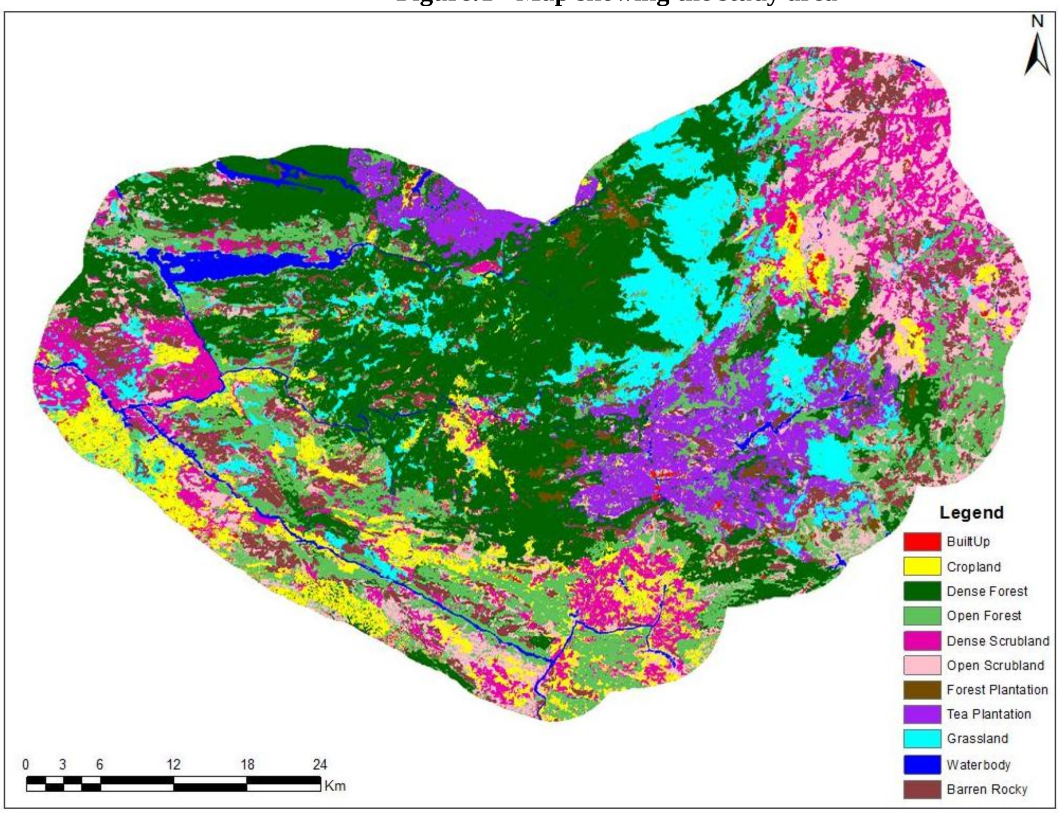

Figure: 2 - Digitally classified image of 1989 into 11 land cover categories

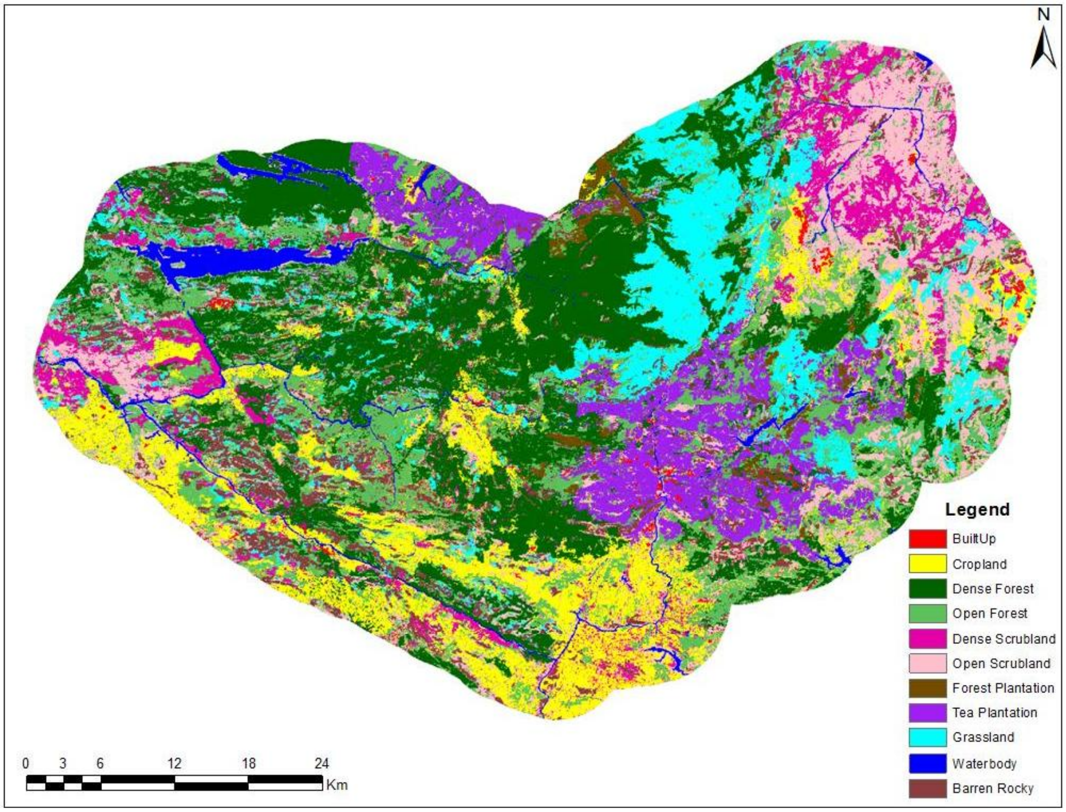

Figure: 3 - Digitally classified image of 1993 into 11 land cover categories

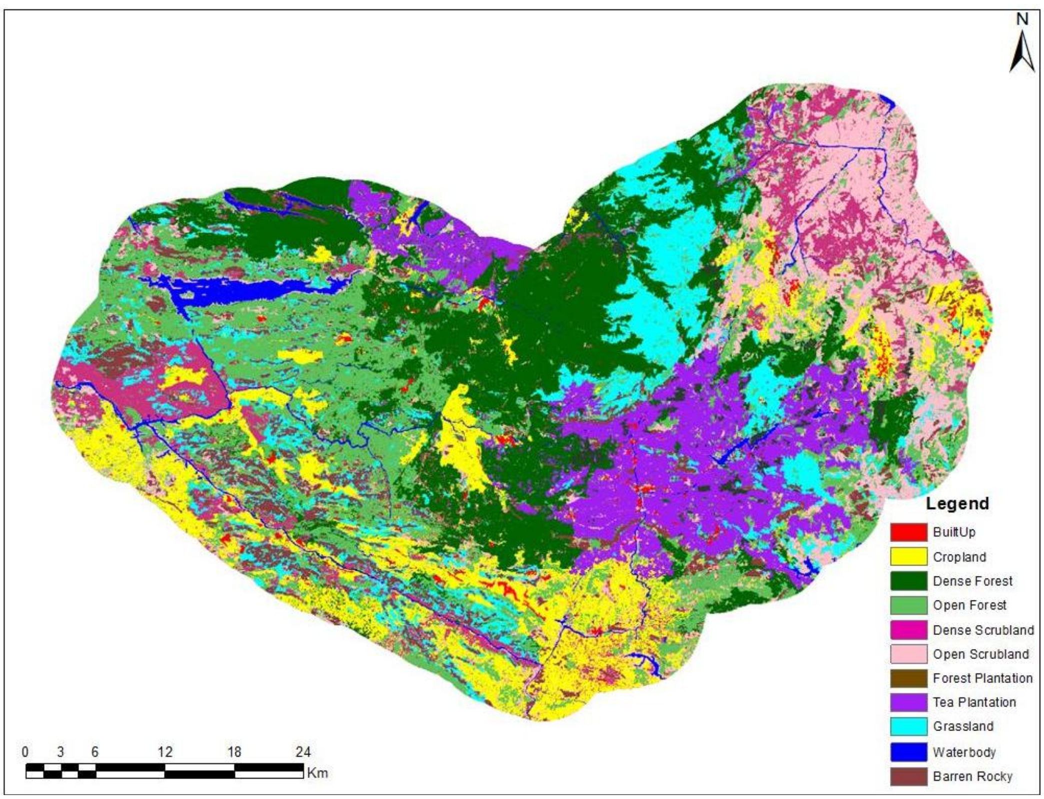

Figure: 4 - Digitally classified image of 1997 into 11 land cover categories

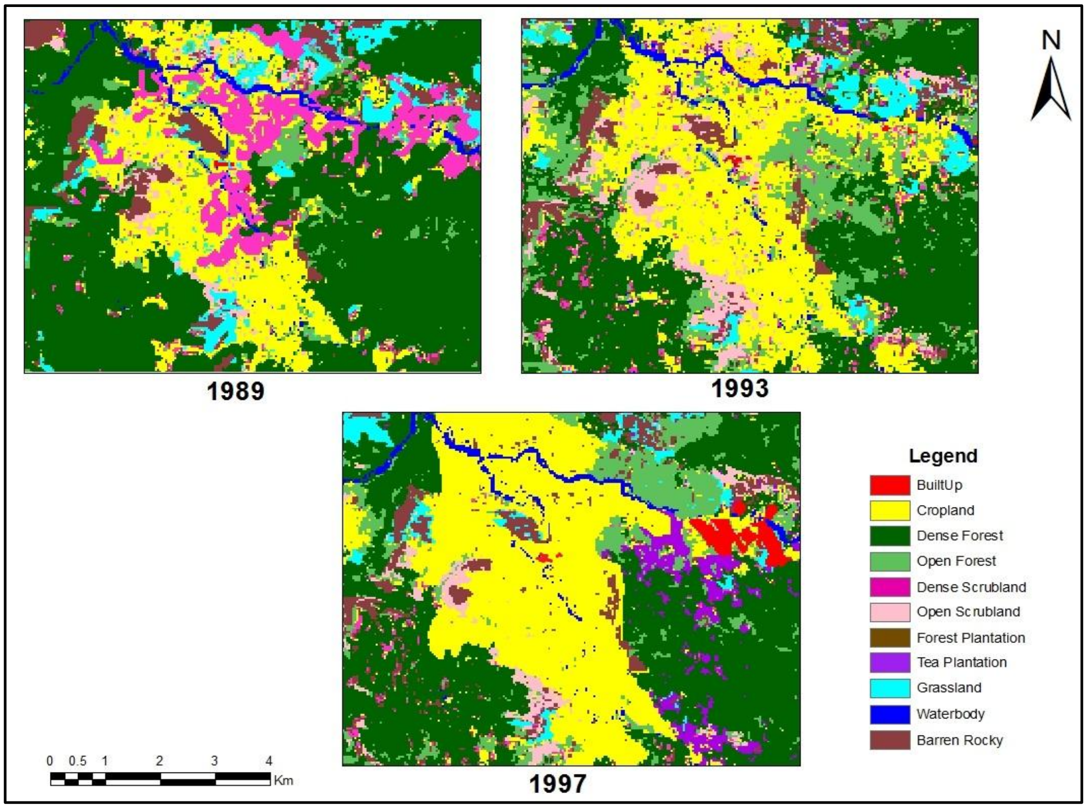

Figure: 5 - Digitally classified images of 1989, 1993 and 1997 showing an increase in cropland and built-up and decrease in dense forest cover, depicting the land cover change.

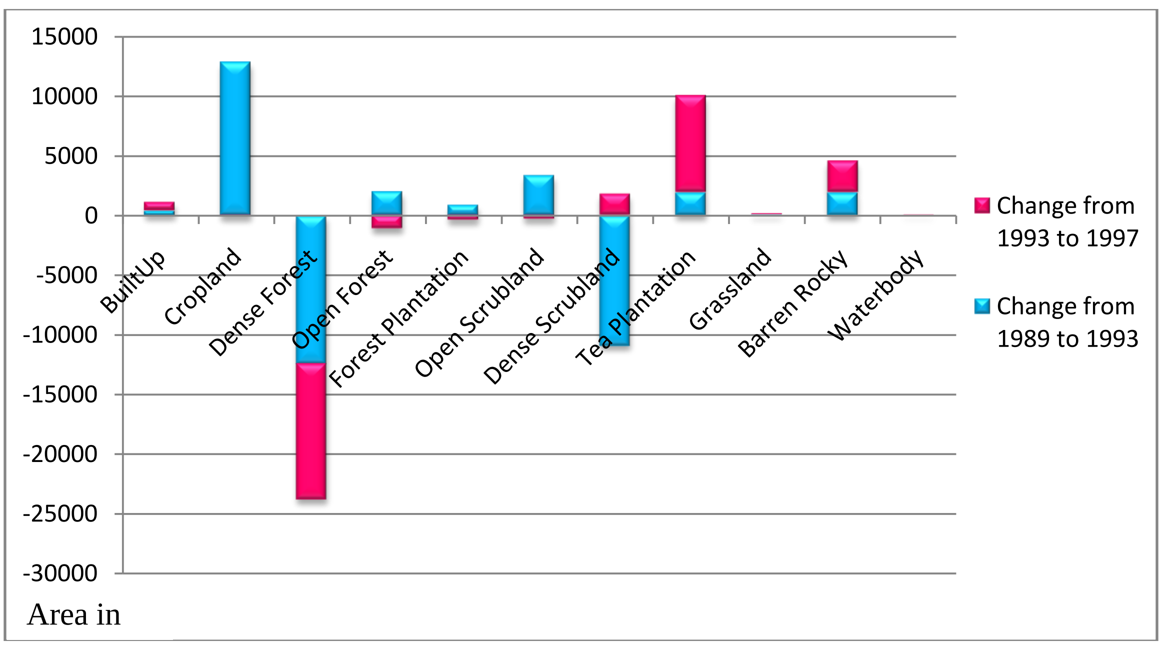

Figure: 6 - Graph showing the change in land cover over a span of 8 years (from 1989 to 1997)

CONCLUSION

Land cover keeps on changing according to the human needs from time to time. The availability of natural resources and the suitable environmental conditions will always attract more and more human settlers. The increase in human settlements will lead to degradation and depletion of natural resources. The tropical rain forests are the most species rich terrestrial environments with two or three layers of tree species and shrub, herb layers. From centuries the forest are being destroyed through active logging and from recent times for agriculture leading to the fragmentation of forest of virgin areas. Such forest fragmentation not only leaves the organisms that remain within them a smaller habitat but also exposes them to stressful environment conditions, particularly at the forest edge, that differ from those deeper within the forest. In India, most of the forested areas are under such treat. Through this study, we can clearly conclude that the degradation and depletion of natural resources in such a great extent has already occurred even much before the stringent forest policies were implemented by the independent Indian government. A lot of land cover change has happened before the 21 century began, which can be mapped using remote sensing and GIS techniques. There are few constraints such as availability of images, available image resolution - spatial and spectral; to carry out the mapping, but still mapping can be done for as much older data as possible to understand the extent of land cover change since years in the forested areas of India. This study represent a very small area in western ghat, this can be carried out for the entire western ghat to find the change in land cover over the past years. this obtained information in combination with the current land cover map can also be used for the re-greening of our forests by the forest department. Human well-being depends on biological diversity and ecosystems, and the goods and services they provide. Unprecedented loss of biodiversity and degradation of ecosystems over the past few decades pose new and urgent challenges. Addressing these challenges necessitates the strengthening of existing models of biodiversity governance and formulating new ones. The future of biodiversity and the very foundations of life on Earth depend on this. The potential sites for conservation can be identified and demarcated from the interpreted images and are to be taken up for necessary action to safe guard from anthropogenic activities and preserve as gene pool. Further the degraded areas are to be restored through intensive afforestation programmes by introducing locally growing plant species thereby protecting biodiversity and also restore the ecological stability to the area under study.

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