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A review on land use land cover change detection methods

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ABSTRACT.

Land use and land cover (LULC) change is one of the most crucial and easily detectable changes taking place around us. The changes though detectable, assessment of land use and land cover changes has become a challenge to researchers due to the magnitude, diversity and the spatial variance of the changes taking place. Moreover, since most of the LULC changes are directly influenced by anthropogenic activities, they seldom follow standard ecological theories. The Remote Sensing and Geographical Information System (GIS) have been very significant in assessing and analyzing LULC changes. Satellite Remote Sensing, by its state-of-art ability to provide synoptic information of land use and land cover at a specific time and location, has overturned the study of LULC change. The spatio-temporal information on LULC helps in recognizing the areas of change in a particular region. The use of Remote Sensing as well as GIS has enabled us to relate spatial changes to various attributes like demography, climate, etc. which tend to drive these changes.

This has helped the research community to quantify these changes with the help of Geoinformatics and to anticipate various scenarios. This article gives an overview of the recent trends in land use and land cover dynamics and highlights the complexity of land-use/cover change. The review summarizes recent estimates on changes in different land use land cover classes which are essential for sustainable management of natural resources, environmental protection and future resource security

Keywords—Land use, land cover (LULC) change, Remote sensing, GIS, Demography, Climate change, Geoinformatics

1. INTRODUCTION

Land use / land cover is an important fundamental element, which is considered in planning and development of a region. Land cover is meant the physical, chemical, or biological categorization of the terrestrial surface e.g. grassland, forest, or concrete, whereas Land use refers to the human purposes that are associated with that cover, e.g. raising domestic animals, regeneration, or urban living. Concerns about land-use land cover change came forth in the research agenda on global environmental change several decades ago with the realization that land surface processes influence climate. In the mid-1970s, it was recognized that land-cover change modifies surface albedo and thus surface-atmosphere energy exchanges, which have an impact on regional climate[22],[32]. In the early 1980s, terrestrial ecosystems as sources and sinks of carbon were highlighted; this underscored the impact

of land-use/cover change on the global climate via the carbon cycle[31]. Decreasing the uncertainty of these terrestrial sources and sinks of carbon remains a serious challenge today. Later, the important contribution of local evapotranspiration to the water cycle—that is precipitation recycling—as a function of land cover highlighted yet another considerable impact of land-use/cover change on climate, at a local to regional scale in this case [30].

The conventional methods of detecting LULC changes are expensive, labor extensive, low in accuracy, time consuming and present a picture of small area and hence are used infrequently [37]. Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy [24]in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval[9]. Space borne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking[16]. Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. By understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, one is able to develop plans for multiple uses of natural resources and nature conservation. The change in any form of land use is largely related either with the external forces and the pressure built-up within the system[5].

Applications of remote sensing techniques have been extensively used during recent years to monitor LULC and to create change detection maps. Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times[47]. Thus the changes in LULC, due to natural and anthropogenic activities, can be observed using current and archived remotely sensed data. This technique is perhaps the only method for obtaining the required data from inaccessible regions on a cost and time-effective basis[13]. Land cover and land use changes are accepted as chief agents of global change via their interactions with climate, ecological processes, biogeochemical cycles, biodiversity and human activities[30]. Land cover (i.e., biophysical attributes of Earth's surface) and land use (i.e., human purposes applied to these attributes) changes play significant roles in global changes[30]. Land is a most useful resource and human being is utilizing it by various means. Land is the stage on which all anthropogenic activities are being conducted and the source of the materials needed for this conduct. Human use of land resources produces land use which varies with the purposes it serves[6],[35].

This review summarizes the conclusions from an array of analyses and researches related to global level land use change. The focus of this paper is on major trends in land use across the globe. The researchers have debated that land use has substantial impingements on the functioning of socio-economic and environmental systems with crucial tradeoffs for sustainability, food security, biodiversity and socio-economic vulnerability of people and ecosystems.

2. PAST AND PRESENT TRENDS IN LAND USE PATTERNS (IN SOUTH ASIA)

Land use change (LUC) occurs as lands are shifted from one use to another, for example, for urbanization or proliferation of agriculture. Reference [30] discussed the proximate causes and underlying driving forces of land-use and land-cover change. The proximate causes include human activities (land uses) that directly affect the environment and thus constitute proximate sources of change. Underlying driving forces are fundamental forces

that support the more obvious or proximate causes of land-use and land-cover change. They consist of a complex set of social, political, economic, ecologic, technological, cultural, and other variables that constitute initial conditions in the human–environmental relations that are structural (or systematic) in nature.

Majority of the proposed causal variables of land use change are proximate factors, such as immigration, subsistence farmers' impacts, deforestation, or local common property resource management strategies [53] and more remote factors, such as national policies, tend to be difficult to connect in an empirical manner to land use change outcomes [32].

The decadal dynamics in land cover changes at national and sub-national level in Bhutan derived by applying object-based image analysis (OBIA) techniques to 1990, 2000, and 2010 Landsat data. The study provides a baseline information as well as information about the changes in and land cover over the past two decades. The study concludes that the growth in forest area in Bhutan from 1990 to 2010 was much higher than the loss of forest, mainly because of the annual plantation activities throughout the country. Agriculture in the study region is expanding tardily due to the limited population growth[21] .

Reference [1] analyzed spatial and temporal changes in land use/land cover in a typical mountain watershed in Central Nepal. The study provides important insights into the dynamics that occurred in forested area and other major land uses of the study watershed in between 1976 and 2000 and provides a solid quantitative foundation for forest policy and institutional analyses. Reference [54] studied the changing land cover and fragmenting forest in Nepal's Kailash sacred landscape. Object-based image analysis (OBIA) was executed using eCognition developer software to obtain homogeneous image objects through segmentation. Information from the spectral values of image layers, different vegetation indices like Normalized Difference Vegetation Index (NDVI) and Normalized Difference Snow and Ice Index (NDSII) as well as a land water mask was utilized in this analysis. The layers were created by band rationing, slope, and texture information. Study reveals that the vegetated area in the study region is decreasing and non-vegetated area is increasing. Major driver of the land use change and forest fragmentation is cropland expansion.

Illustration of the effect of land use/cover change in Dhaka Metropolitan of Bangladesh by using topographic maps and multi-temporal remotely sensed data from 1960 to 2005. The analysis suggested that the urban expansion of Dhaka Metropolitan resulted in the considerable reduction of wetlands, cultivated land, vegetation and water bodies. The amount of urban land increased from 11% in 1960 to 344% in 2005. There was also the growth noticed in landfill/bare soils about 256% in the same period[45]. Reference [15] used maximum likelihood supervised classification technique to extract information from satellite data, and post-classification change detection method was applied to detect and monitor land use/cover change. The study depicted the decrease in wetlands, cultivated land, vegetation and water bodies whereas a sudden increase was observed in built up areas and agricultural land. Land use land cover changes and urban expansion in Greater Dhaka were analyzed[14] using supervised classification algorithm and the post-classification change detection technique. The analysis revealed that significant growth of built-up areas in Greater Dhaka resulted significant decrease in the area of water bodies, cultivated land, vegetation and wetlands. Urban land expansion was largely driven by elevation, population growth and economic development.

The methodologies adopted to analyze these changes are Maximum likelihood classification and Post classification change detection and in a case study of Simly Watershed, Islamabad in Pakistan[7]. The study

concludes that the land cover/land use practices in the study area have altered significantly in past 20 years. The land use land cover shift in the watershed area was clearly due to decrease in vegetation and waterbody and an abrupt increase in settlements, agriculture and barren land. The major consequence of this expansion caused to suffer Vegetation and Water class to deforestation and water depletion respectively. Supervised classification technique with the algorithm of Maximum likelihood was also used by Reference [20] to assess the temporal dynamics and spatial patterns of land use changes and evaluate temporal & spatial urban expansion of Lahore. The output of the land use and change detection analysis revealed that the areal expansion has been associated with the loss of agricultural land and urban sprawl at the same time major change in land use has taken place in built-up and agricultural areas. However, Different approaches were also adopted for change detection such as use of spatial models build in spatial modeler function in Erdas imagine software. Urban explosion in Lahore by using the spatial modeler evaluated and analysis showed that on an average more than 1200 hectares of agricultural and forest land has converted into urban area every year and this practice is repeating itself since last five decades [42].

Use of sequential aerial photographs in the early era of remote sensing to study land use change in a typical agrarian environment of the Nachchaduwa Tank (Reservoir) Catchment in rural Sri Lanka [8]. Mapping of land use and land degradative features was carried out with the help of black/white Panchromatic photography supplemented by ground truthing. The author spotted the changes over a period of two decades which tend to show a significant increase in all categories of land use. Reference [11] aimed the study at quantifying the extent of changes in land use of Pambala Chilaw lagoon complex (Sri Lanka) by the aid of aerial photography and GIS. Authors concluded the study the recent land-use change has been rapid and the large extent of intensive agriculture has put the mangroves under pressure. Use of multi-temporal satellite data to measure and spatially characterize land use/cover changes in the Jaffna Peninsula, northern Sri Lanka over the two decades from 1984 to early 2004. The land use and cover classification scheme was derived from the Sri Lankan land use/cover classification system. The most commonly used Maximum Likelihood algorithm for supervised classification was used. For change detection, post-classification comparison method was employed. The study revealed significant changes in all types of land use/cover in the Jaffna Peninsula with the evidence of a remarkable drop-off in agricultural land use and concomitant increases of rangeland, marshland and forest[49]. The effects of wetland expansion of land use and land cover changes from 1983 to 2011 in Southern Sri Lanka were assessed and Image classification was done with visual interpretation technique and the data layers were overlaid on each other for change detection calculation. The authors found that marshes and wetland vegetation have significantly increased while there has been a decrease in the agricultural land, water logged area, flood plain and high water wetland areas[17].

3. LAND USE LAND COVER STUDIES IN INDIA

Analysis of the changes and extent of land use and land cover in Tripura using multi-date LANDSAT images with the help of Multispectral Data Analysis System (MDAS). Anderson and Gautam and Narayan land-use and land-cover classification systems were employed for better reliability. Land use categories such as forests, bamboo areas, jhum lands, lunga land (valleys), cherras (streams), rivers, tilla lands, etc., have been represented to the extent of 90 per cent accuracy as compared with ground data[19].Reference[43] explored the land cover

effects of state-sponsored modernization efforts in the semiarid Godwar region of Rajasthan. Land covers those resulted from agricultural intensification, biodiversity preservation, and resource conservation were described using satellite imagery, historical data, household production information, and the discourse of state planners. SPOT satellite images were classified and compared through categorical cross-tabulation. The images were classified using an iterative isodata clustering technique on principal component images produced from raw multispectral data. The study demonstrated that state planners have attempted to physically partition the land uses seen as "social" from those seen as "natural" and thereby impose a modernist purification of land covers. In spite of these efforts, hybrid and "impure" land covers, which mix social and natural characteristics and merge exogenous and indigenous species, have proliferated crossways the landscape. The results of classifying land use/land cover for Delhi using an expert system approach were evaluated and ASTER satellite data was used for this purpose. Manual classification of land cover by using SOI toposheets as well as digital supervised classification was done. Normalized difference vegetation index (NDVI) was calculated and texture analysis was performed. The authors have determined that in the year 2003, 24% per cent of the metropolitan area consisted of high-density urban structures; an amount that is anticipated to increase in the coming years. The authors have also found that the expert system approach to urban land use land cover has proven to be a utile tool for urban analysis and in some respects better than many other methods [54]. Use of geospatial tools in colligation with landscape metrics to assess the impact of coal mining on habitat diversity. They computed the multi-date land use land cover maps for change detection analysis. Classification of land use categories was done with the help of visual interpretation technique. For change detection analysis, vector maps of each representative year were converted into grid data. The rate of change of different classes was computed using the compound interest formula. The authors have observed a significant decline in forest cover especially of the Sal-mixed forests, both in area as well as quality, due to scoffed mining regulations. Reclamation of mined lands has also been observed in some of the areas [33]. The changes in the spatial patterns of land use including crop diversity, the drivers and implications of changes in 11 village ecosystems of southern India were analyzed and data obtained from existing maps, land survey, participatory survey and field measurements were incorporated to quantify changes. On the basis of land survey, land-use maps were generated to represent the land use at the time of survey. Land-use maps for previous periods were rebuilt accounting to the availability of past land records, broad land-use maps and people's information of the changes in land-use pattern. Cluster analysis was performed using drivers such as rainfall deficit, human population increase and management decisions. Authors have found that the impacts of changes were both short as well as long-term and also the implications and trade-offs were linked to the extent of land, type of change and dependence of the communities for livelihood and provisional services [51]. Reference [10] through visual interpretation, intended to attain the information at a range of levels on the Land use land cover pattern in the region south of the River Son, Sonbhadra District, U.P. For this purpose, multi-scale and multi temporal satellite data was used. Final land use land cover maps of the study area on 1:1M, 1:500, 000, 1: 250,000 and 1: 50,000 scales were prepared. The entire data was then digitized into GIS (ARC INFO) and the extent of area under each land use land cover category was acquired in terms of sq.kms. and as simple percentage of the total geographical area of study on the above mentioned scales. The result illustrated progressive increase in the land use land cover categories with increasing scale and have revealed area variations of different land use land cover units. Assessment of the land use land cover changes and urban expansion in mega city Delhi and

spotlight the major impact of rapid urbanization and population expansion on the land cover changes which needed instant consideration. After the preprocessing of the multispectral satellite data, a supervised classification was employed using Maximum Likelihood Algorithm. The results of the study signify expanding city to-wards its marginal region with the alteration of rural regions in to urban sprawl. Built-up area of Delhi witnessed an overall increment of 17% of the total city area during the study period 1997 to 2008 which chiefly originated from agriculture land, waste land, scrub-land, sandy areas and water bodies [36]. Another study on the same area that is National Capital Region (NCR) was performed by Reference [50] and investigation was primarily intended at quantifying the spatial-temporal pattern of the land use land cover change (LULCC) for the period of last two decades (1989 to 2006) in the NCR and recognizing the principal bio-physical factors governing LULCC through contemporary geo-spatial techniques. Multi-temporal classified images were generated through a hybrid unsupervised (Iterative Self Organizing Data Analysis Technique) and supervised (Maximum Likelihood) image classification technique. Classification accuracy was checked using error matrices. Geo-spatial investigation of the data illustrated that the study area experienced a sudden (67.4%) increase in the croplands during 1989 to 1998. This increase was also linked with a similar sheer increase in the built-up areas, urban population, during the same period. The change detection analysis further demonstrated that the same period was associated with change in croplands, built-up, ridge and forest lands, water-bodies, water levels and rainfall, single/ double cropped areas., degraded croplands and in cropping pattern. By way of comparison of above results and collected socio-economic data in this area, the impact of changing land use & bio-physical/ economic aspects on agricultural profitability were analyzed. The result of this study has so led to a thorough and lucid spatial-temporal (quantitative) assessment of the chief bio-physical factors governing agricultural business – profitability and in general food security of the National Capital Region. Authors have analyzed land use land cover of North West of Delhi for the time period of 1972–2003. The remote sensing data used in study is Aster image of 2003 and the ancillary data of 1972 Survey of India (SOI) toposheet at the scale of 1:50,000. Land use land cover maps were prepared with the help of supervised digital classification using maximum likelihood classifier. Change in land use land cover during 1972 to 2003 was detected in ERDAS imagine software using change detection model. Authors have recorded a drastic change during 30 years of time i. e. (1972-2003). Agricultural land shows 27.35% decrease in three decades. Conversely, built up area was 6.31% in 1972, which increased to 34% in 2003. Authors found one of the main causes of this land use change as population growth due to the migration in the district from small cities and rural areas of Delhi. Another study on the pattern of land use land cover change in Sonipat District of NCR was carried out [46]. The current study using IRS-Resourcesat-2 (LISS-III) data illustrated the scope, methodology and upshots of land use land cover change mapping of Sonipat district in Haryana. The land use land cover classes were divided into six categories using hybrid approach. The study witnessed decrease in agriculture and an increase in built up land. The area under waste land category reduced due to increase in agriculture and built up area. The research concluded that with the passage of time built-up increased with raise in human population [54]. The study of land use land cover change detection in Doon valley (Dehradun Tehsil), Uttarakhand with the help of remote sensing and GIS was aimed at detecting the land use changes between 2000 to 2009 using remotely sensed images of Landsat (ETM +, TM, MSS), LISS-III, SRTM and digital SOI topographic maps. Anderson's classification scheme was employed on the study area. This nine-year time period study suggested that the forest area is decreased by 3.75 % and water by 9.5%. The most significant changes took

place in Built-up area resulting in 112.4% growth in less than a decade period [52]. Reference [34] have attempted to map land use and land cover change and quantification of forest deterioration using multi temporal satellite data devikulam Taluk, Idukki District, Kerala. Visual interpretation by means of SOI toposheets and satellite imagery of IRS P6 was carried out. The author has noticed that Devikulam taluk has witnessed remarkable fluctuation in population growth in the recent time period. Also, the differential migration trends have occurred in response to structural changes in the taluk and its neighboring region.

The classification was performed on seasonal features derived from MODIS time-series for the years 2001 and 2009, which allowed the authors to evaluate possible land cover and land use changes. A hierarchical classification scheme derived from the Land Cover Classification System of the Food and Agriculture Organization of the United Nations Environment Program was developed exclusively for Central Asia and applied in this study. The results showed regional distinctive patterns as large scale extend of grassland and rain-fed cultivated areas as well as small scale land cover types like bare areas with salt flats and irrigated areas. The study of changes between both years indicated the inconsistency of land cover in arid and semi-arid regions to water suitability [26]. Reference [28] observed urban expansion and land use/land cover change of Rohtak city within the last 38 years using remote sensing and GIS techniques. Authors used Landsat TM and LISS-III data for the study on which unsupervised classification with maximum likelihood classifier was applied to attain the aims of the study. Interpretation made was validated with the help of historical evidences. Result revealed that the city had experienced rapid changes in land use, particularly in terms of built-up area which had increased about 5 times from the built-up area since last 38 years resulting in a substantial reduction in the area of agricultural land from 11.60 km2 to 2.59 km2 during the same period. Changes in land use land cover resulting from mining associated activities, in Singrauli district of Madhya Pradesh. For land use change analysis satellite imagery from Landsat MSS, TM and IRS LISS-III for the three-time period were used. Visual interpreted was followed by unsupervised classification (ISODATA technique) to map the land use land cover changes. Most commonly used post classification change detection method was employed on classification output in ERDAS software. The results of the study signified that during the period between 1978 and 2010, the pattern of land use land cover classes changed drastically. Area under forest cover reduced significantly as more and more forested lands were converted to cropland, built-up area and mining. Thus the areas under cropland, built-up and mining witnessed increase in area. Forest land estimated to be more prone to fragmentation) [2]. Referece [38] have integrated the application of remote sensing and GIS to detect the land use land cover changes in Golaghat District of Assam. The change was inspected with the help of Landsat ETM and IRS LISS-III satellite data. Digital land use land cover classification was carried out through supervised classification method. Major changes occurred in crop land and scrubland as the area under scrubland is converted into agricultural or crop zone. The authors have noticed that land is becoming a scarce commodity due to immense agricultural and demographic pressure. The use of multitemporal Landsat (MSS, TM, ETM+, LISS-III) data to monitor the land use land cover changes for last two decades in Howrah City. Unsupervised classification techniques have been utilized for delineating five different land classes: agriculture land, built up, vegetation, water body and wet land upon which post classification change detection method was employed. The overall decline in water bodies, wet land, vegetation and agriculture land was observed continuously over the time period [47]. Reference [29] illustrated the use of remote sensing and GIS techniques for mapping and evaluating urban sprawl in the case of Nagpur city,

Maharashtra. Landsat TM satellite data was used to map the land use changes in the city. Supervised classification with maximum likelihood algorithm was applied to prepare the land use maps. The results revealed that the total built-up area of Nagpur city increased up to 50.0 % since 1998 till 2010. Use of multi temporal satellite data Landsat ETM+ for assessment of the land use land cover changes of Poba reserve forest, Assam and Arunachal Pradesh spanning period of five years during 2005 to 2010. Six different types of land use/ land cover were categorized in the prepared land use land cover maps. The study showed area of semi evergreen open forest amplified from 13.43 sq.km to 17.6 sq.km, which is a sign of deforestation and illegal tree cutting. Study indicated that increase in the anthropogenic activities has led to a serious trouble in the region. Ashraf, (2014) [3] aimed their study at understanding the land cover and land use change pattern in Patna Municipal Corporation area in last quarter century with the help of remote sensing and GIS. Landsat TM and OLI images were used to prepare the land us land cover maps. Geometrically corrected satellite data was classified using supervised classification maximum likelihood algorithm and then the outcome was once again reclassified. The results of the study showed that the urban built-up area nearly doubled in the past 25 years whereas water body nearly halved while the forest cover increased. Fallow land decreased due to conversion of this category to settlement and built-up area. In the same way agricultural land also decreased considerably for the same reason [27]. Reference [41] examined the land use land cover response to the processes of urban expansion in the Jalandhar city. The author characterized the temporal and spatial pattern of urban expansion and land use land cover using the census and remotely sensed information. Dynamics of land use land cover were quantified using a supervised classification algorithm. The results revealed that the total population in the city has increased many folds converting the farming land use dominant landscape into urban land use dominant landscape during the last three decades. Reference [4] analyzed inventory of land use land cover records from Department of Economics and Statistics (DES) and remotely sensed data sets obtained from Resourcesat-1, MODIS, Globcover, and HYDE 3.1 for 2005 in India. The land use land cover data sets were obtained from DES records available at state level as well as five remotely sensed based data sets. Results of this study indicated that spatial distribution of agricultural and forest areas estimated by Resourcesat-1 were similar to the DES data sets. However, there has been still discrepancy on the urban areas among the remote sensing data sets in India. Analysis of the dynamics of land use land cover changes using LISS-III data for the years 2007, 2010 and 2013 of Harangi catchment, Coorg District, Karnataka State. Also, the authors have studied the comparisons of three classification techniques such as Parallelepiped Algorithm, Minimum Distance to Mean Algorithm and Maximum Likelihood Algorithm based on the value of overall accuracy and kappa coefficient to check the reliability of the methods in classifying images. Based on the study results, the authors concluded that, among all the three techniques, the Maximum Likelihood Algorithm gave higher accuracy with high kappa coefficient and Minimum Distance to Mean Algorithm gave lower accuracy [18]. Reference [25] integrated remote sensing and geospatial techniques to map the land use land cover changes Saranda forest of Jharkhand. After the pre-processing of Landsat TM and LISS-III images, supervise classification technique was applied to prepare the land use maps of the study region. A change detection matrix was created with the help of ERDAS imagine software. The result of the work revealed the speedy expansion of built-up (mining area), wasteland, open forest, agricultural land and lessening the dense forest area and the water bodies. A quantitative method of land use change studies in Malegaon district, emphasizing on the changes in urban agglomeration, population, land use and land cover; and its correlation with

the population increase, migration and urbanization caused problems related with water and environmental degradation. Unsupervised classification output of the satellite imageries of Landsat TM, ETM, Resourcesat-1 was then validated using visual image interpretation techniques. The study exposed an increase in settlement by 78% from 1989 to 2006 and an increase by 26% from 2006 to 2008, in company with the increase in population, migration from rural areas due to the economic growth and technological returns associated with urbanization [39]. Changes in land use and land cover in Umshing-Mawkynroh, East Khasi Hills District, Meghalaya were studied and integrated remote sensing and GIS approach with the help of satellite data CARTOSAT P5 (2005), LISS III (2011) and SOI toposheet (1966-1967). Land use land cover classes were digitized from toposheets and imageries in ArcGIS whereas change detection was performed by simple comparative method. The results showed that area acquired by North-Eastern Hill University is experiencing great change. The settlement size in this area is increasing with each passing due to overcrowding and expansion of urban sprawl. Most of the forest cover has been cleared for constructional and residential purpose [12].

Reference [44] recommends the utility of their decadal study of land dynamics database for national and regional studies. The database is updated to 2015 as a upholding effort of their study.

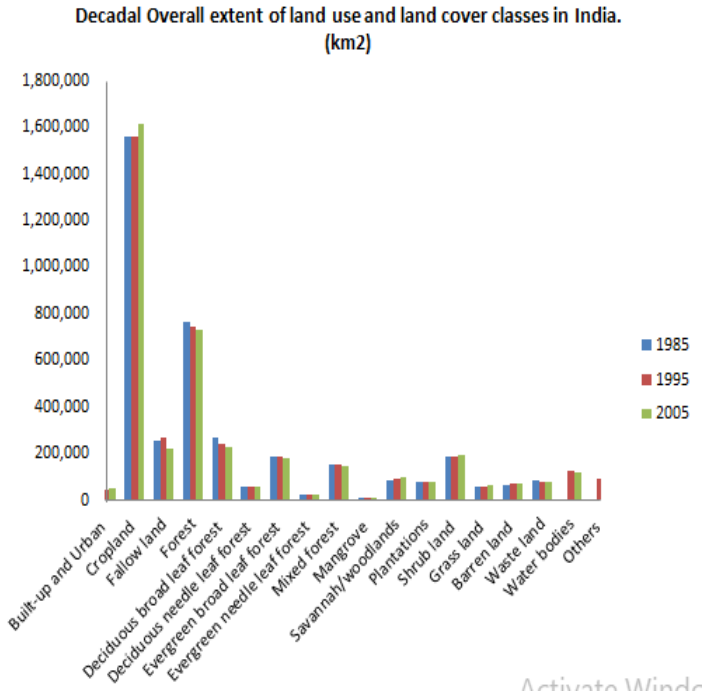

Fig. 1. Decadal Overall extent of land use and land cover classes in India (Data source:Reference 44)

4. CONCLUSION

Study of land use land cover change is becoming very crucial with time as many natural as well as anthropogenic factors are major contributing factors in the degradation of land. The land is speedily degrading due to natural causes like erratic seasonal changes and anthropogenic causes like urban sprawl, industrialization, etc. as explained in the literature. State of the art tools and techniques like remote sensing, GIS and GPS are very helpful in LULC change assessments. Such literature reviews are of great value for policy as well as decision makers in order to manage sustainable development.

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