Biological Forum – An International Journal **(SI-AAEBSSD-2021) 13(3b): 134-138(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Land Use and Land Cover Change Analysis using Remote Sensing and GIS Techniques

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(Received 01 July 2021, Accepted 29 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Land use and Land cover (LU/LC) is a result of socio-economic factors, natural factors and their utilization by human being. From multiple researches, it is clear that accurately monitoring of LU/LC changes is important to understand the interactions and bond between natural phenomena and mankind. The combine use of Remote Sensing (RS) with Geographic Information System (GIS) have proved as an important tool which can provide accurate data and information on LU/LC changes. Use of multi-spectral satellite imageries have significant role to classify LU/LC and detect changes because it provides time to time information about where and what changes have occurred and its impact on environment and humans. Several methods are available which can be used for LU/LC classification and change detection. All methods have their own pros and cons but not a single method is optimum. Several National and International studies on LU/LC change analysis using remote sensing and GIS have been carried out throughout the world using different classification methods such as supervised classification, unsupervised classification, visual interpretation, GEE (Google Earth Engine) and NDVI (Normalize Difference Vegetation Index). It is observed that Supervised classification method is one of the most commonly used method throughout the world. It is also concluded that natural, human and socio-economic factors are the major ones due to which changes (conversion of one class into another class) in the pattern of LU/LC have occurred. Timely monitoring of LU/LC changes is very important so that proper control measures can be applied to conserve environment and natural resources.

Keywords: Land use and land cover, Change analysis, Remote sensing, Geographic information system, Supervised classification method.

INTRODUCTION

The information of Land use and land cover (LU/LC) is very important for several purposes such as atmospheric and hydrological modeling, decision making, selection, land use planning and implementation of different schemes for natural resource conservation and management. It is cost effective to get high resolution data since it is not freely available and multi-temporal data from remote sensing satellites can help the researchers to generate information about LU/LC for different years according to their interest and purpose (Tilahun and Teferie 2015; Topaloglu *et al.*, 2016). LU/LC are correlated with each other but having different meanings where, land cover reflects the physical condition of features present on earth's surface such as forest cover, wetlands, grasslands etc. (Rawat *et al* 2013), while land use is defined as the utilization of land by human beings in different way according to their interest such as in the form of residential zones, industrial zones, commercial, agricultural areas etc. (Mondal *et al* 2018). LU/LC are directly proportional to each other as land cover includes the features of land use and can be represented on different scales. The data related to LU/LC of an area can be used as input for watershed management planners (Rujoiu-Mare and Mihai 2016; Rwanga and Ndambuki 2017). LU/LC has changed many ecosystems rapidly and extensively over the past fifty years because of the growing demand for the ever-increasing population for land and other natural resources. LU/LC change is a fundamental to understand the interactions between human activities and the environment (Verburg *et al.,* 2004). The LU/LC is a major driver of environmental problems like siltation and sedimentation in a reservoir, decreased soil quality, water pollution and natural resource scarcity etc. The information about LU/LC is essential for planning and management activities. Assessment of LU/LC change is essential to better understand the present-day condition of the land. Now-a-days LU/LC change has become a central component in the current strategies for managing natural resources of a region. Mapping the changes in the pattern of LU/LC by using traditional methods on large and unreachable areas are very difficult. The remote sensing approaches and GIS technique have emerged as the best tools to monitor changes in LU/LC (Meyer 1995; Pelorosso *et al.*, 2009). Remote sensing and GIS are time saving techniques and satellite data has been proved very helpful to generate LU/LC information at instance of time due to its large vision, real time information and its repeated coverage (Shalaby and Tateishi 2007; Mishra *et al.,* 2019). The continuous usage of remote sensing data has made image analysis quick, easy and powerful but due to the accelerated usage, the complexity also creates which leads to increase the possibilities for error during analysis (Chowdary *et al.,* 2009; Pradeep *et al.,* 2014).

It is very important to have satellite data of two different time periods to perform the LU/LC change analysis of any particular area. Firstly, the LU/LC classification to be done for both these time periods and then comparing it, the occurred changes are analyzed (Brondizio *et al.*, 1994). Remote sensing data combined with GIS is extensively used to achieve LU/LC change analysis objectives. The various methods to detect LU/LC changes with remote sensing and GIS are supervised classification, unsupervised classification, visual image interpretation, NDVI and GEE therefore it was very necessary to review the different techniques used for LULC change detection (Lu *et al.*, 2004; Rogan and Chen 2004; Julien *et al.*, 2011). In this paper several techniques of LU/LC classification and change analysis using Remote sensing and GIS approach used throughout the world by different research workers has been discussed as follows.

Oinam *et al.*, (2005) analyzed land use and land cover changes from the year 1991-2001 in Jahlma watershed of the Lahaul valley, cold desert region of the northwestern Himalaya, India. IRS-1A and IRS-1D satellite data for the years 1991 and 2001 had been used following visual image interpretation method to analyze LU/LC changes. The result showed that the cultivated land within the watershed had been increased from 54.87% in 1991 to 56.89% in 2001, while there was decrease in grassland from 31.41% in 1991 to 29.81% in 2001.

Prakasam (2010) detected land use and land cover change of Kodaikanal over 40 years' period (1969-2008) by using remote sensing and GIS. Survey of India (SOI) map for the year 1969, LANDSAT imageries of the years 2003 and 2008 had been used for this study and GIS software was used to prepare LU/LC classification maps by adopting supervised classification technique. Ground truth data was used for checking the accuracy of classified maps. The result showed that forest area had been decreased from 70% (1969) to 33% (2008), while area under built-up land was increased from 3% to 21% in the study area.

Singh *et al.*, (2010) monitored the changes in LU/LC of Rupnagar district, Punjab by using LANDSAT and IRS LISS-III satellite data over a period of 1989-2006. The unsupervised classification method was used to obtain LU/LC changes. Grouping of four reflective bands of three LANDSAT imageries were carried out by using isodata clustering algorithm with the help of ground truth data. The results showed that there was decrease in cropland by 225.97 km^2, dense forest 128.57 km^2 and waterbody 11.69 km^2, while there was increase in settlement by 93.5 km^2 and salt affected land 9.74 km^2.

Singh and Khanduri (2011) detected LU/LC changes of Pathankot and Dhar Kalan tehsil, through remote sensing and GIS over a period of 1991-2006. In this study, Satellite images of IRS-IA and D, LISS-II, LISS-III, LANDSAT (TM and ETM+) for the years 1991-2006 and digital topographic maps of Survey of India (SOI) had been used by applying on screen visual image interpretation method in EDRAS imagine and ArcGIS software. The results showed some major changes in land cover where, 104.02 km^2 area had been converted into cropped land and built-up from forest and fallow land. Incredible increase in the area of crop land by 69.23 km^2 had also been observed.

Rawat *et al.*, (2013) applied geospatial techniques for LU/LC classification of Ramnagar located in the foothill zone of the Uttarakhand over a period of time 1990-2010. LANDSAT TM (Thematic Mapper) of 1990 and 2010 which had been taken from earth explorer to classify different categories of LU/LC and detect the LU/LC changes using supervised classification in ERDAS software. Study area was classified into five classes for both the years 1990 and 2010. The results showed that area under built up and sandbar have been increased by 8.88% and 3.98% respectively, while the area under vegetation, agriculture and waterbody is decreased by 9.41%, 0.69% and 2.76% respectively.

Anees *et al.*, (2014) analyzed spatio-temporal land cover change during the period of 2001-2011 in Makhawan watershed, MP through remote sensing and GIS techniques. Satellite data of IRS-1D LISS-III for the year 2001 and IRS-P6 LISS-III for the year 2011 had been used following visual image interpretation technique in ArcGIS to analyze LU/LC changes. The result showed that the uncultivated land, dense forest and waste land had been decreased from 26.96% (2001) to 11.17% (2011), 9.03% (2001) to 7.87% (2011) and 7.19% (2001) to 3.12% (2011) respectively, while cultivated land, built-up and open scrub had increased from 19.83% (2001) to 23.17% (2011), 4.57% (2001) to 11.15% (2011) and 27.65% (2001) to 41.64% (2011) respectively.

Poongothai *et al.*, (2014) detected LU/LC changes in Kiliyar sub-watershed of Tamilnadu which is located partly in Thiruvannamalai and Kanchipuram districts using remote sensing and GIS. Temporal land use and land cover maps of the study area were made through visual classification method to analyze the nature and degree of LU/LC changes. Satellite imageries of LISS and toposheets were used as data sources collected from IRS, Anna University, which were geo-referenced to get the LU/LC maps for different years (1995, 2003 and 2009) using ArcGIS software. The results showed that there was increase in waste land by 2.53%, while there was decrease in agriculture land by 0.46%, forest area by 0.82% and water bodies by 1.14%.

Pradeep *et al.*, (2014) detected LU/LC changes for the area Usilampatti block in Madurai district over a period of 1990-2001 using remote sensing and GIS. LANDSAT-5 TM (1990) and LANDSAT-7 ETM+ (2001) data had been analyzed by using visual interpretation techniques to identify major changes in LU/LC. The results showed the significant changes in the major categories, where agricultural land had been increased from 105.35 km^2 (1990) to 115.56 km^2 (2001), wasteland from 68.37 km^2 (1990) to 76.23 km^2 (2001) and built-up 1.97 km^2 (1990) to 2.68 km^2 (2001), while the area under vegetation was decreased from 86.5 km^2 (1990) to 67.28 km^2 (2001).

Rawat and Kumar (2015) classified LU/LC map of Hawalbagh block of Almora district, Uttarakhand over a period of time 1990-2010 using remote sensing and GIS. LANDSAT satellite imageries of two different time periods: LANDSAT data of the years 1990 and 2010 had been used which were collected from Global Land Cover Facility Site (GLCF) as well as earth explorer site and used them into ERDAS 9.3 software to identify the changes. The supervised classification methodology had been used to categorize the features into five different classes for both the years 1990 and 2010. The results showed that area under vegetation and built-up has been increased by 3.51% and 3.55% respectively, while the area under agriculture, barren land and waterbody decreased by 1.52%, 5.46% and 0.08% respectively. Overall accuracy for LU/LC classification was found to be as 90.29% and 92.13% with Kappa values as 0.82 and 0.91 respectively.

Satyawan *et al.*, (2015) prepared LU/LC maps of Sahaspur block in Dehradun district, Uttarakhand using geospatial technique. Satellite data of Landsat of the year 1976 and IRS-1D LISS-III of the year 2009 had been analyzed in ERDAS imagine software using visual interpretation classification methodology and categorized into different classes for both the years. The results

showed that the area under built-up, forest dense, forest open, tree clad and wasteland increased by 2.44%, 5.52%, 2.53%, 0.11% and 0.04% respectively while, area under agriculture, agriculture plantation, forest plantation, forest scrub and water bodies decreased by 0.22%, 0.08%, 0.99%, 8.11% and 0.04% respectively.

Meshesha *et al.,* (2016) analyzed LU/LC change dynamics in Beressa Watershed Ethiopia by using remote sensing and GIS approach. Satellite data of Landsat-5 (1984 and 1999) and Landsat-8 (2015) was used by adopting Unsupervised classification method to prepare LU/LC maps using ArcGIS and ERDAS Imagine software. There was total six LU/LC classes i.e., farmland, grazing land, barren land, settlement, forest and water body have been demarcated. From the results it has been observed that areas under settlement and farmland have increased by,while area under grazing land and barren decreased. In case of forest cover it is noticed that it has decreased as 5 ha from 1984 to 1999 but it increased as 15.6 ha from the year 1999 to 2015.

Huang *et al.,* (2017) mapped the major land use dynamics in Beijing. Satellite data of Landsat series have been used to classify seven LU/LC classes i.e., cropland, built-up, grassland, shrub forest, waterbody and barren land by using NDVI methods in GEE. Study was conducted to detect changes in the pattern of LU/LC from the year 1985 to 2014. Results showed the average increment of 84.64% in the areas of built-up and urban lands. Similarly, gains and loss has also been observed in overall vegetation by 109038 ha and 140228 ha respectively with 86.61% overall accuracy.

Prasad and Inayathulla (2017) detected LU/LC changes in Hebbal valley of Bangalore, Karnataka over a period of 2001-2015 using remote sensing and GIS technologies. The patterns and analysis of LU/LC changes in the selected region had been carried out using Survey of India toposheets, satellite imageries of IRS-IC-LISS III for the years 2001, 2003, 2006, 2009, 2012 and 2015 and ArcGIS software by adopting visual interpretation technique. The results showed that there was decrease in agricultural land by 12.9% and water bodies by 1.17%, while there was increase in built-up area by 7.49% with minimal increase in industrial zone.

Reddy *et al.,* (2017) detected LU/LC changes on Kanchinegalur sub-watershed of Dharma watershed, Hangal taluk, Haveri district over a period of 2003-2015 using remote sensing and GIS technologies. Survey of India (SOI) toposheets, LANDSAT-7 for the years 2003 and 2015 and IRS-P6 LISS-III for the year 2012 had been used and processed in ArcGIS software by following supervised classification technique to detect LU/LC changes in the study area. The result showed that there was increase in human settlement by 23.92% and agro-forestry/horticulture by 91.55%, while there was decrease in cultivable waste land by 81.24%.

Shafiq *et al.,* (2017) analyzed LU/LC changes from the year 2002-2014 in Lolab watershed of Kashmir valley, western Himalayas using remote sensing and GIS. IRS-1C LISS-III satellite data had been used by following standard visual/digital image interpretation techniques. The LU/LC maps had been prepared with the help of GIS software. The result showed that the forests area had decreased from 45.3% (2002) to 44.61% (2014), agricultural land 35.03% (2002) to 33.99% (2014) and waterbodies 7.20% (2002) to 7.48% (2014), while there was increase in horticultural area from 8.05% (2002) to 9.91% (2014).

Bashir *et al.,* (2018) classified LU/LC maps using remote sensing and GIS techniques in upper Jhelum basin between years 2008 and 2015. LANDSAT satellite data for both years had been used for LU/LC classification. There were fourteen LU/LC classes: agriculture, forest, horticulture, built up, barren land, aquatic vegetation, plantation, scrubs, pastures, river bed, water bodies, exposed rocks, snow and kare was had been delineated using supervised classification technique in ERDAS imagine software. The results showed that area under Agriculture, forest, river bed and snow has been decreased by 5.02%, 0.41%, 0.006% and 0.57% respectively while, the area under Horticulture, built-up, plantation, barren land, exposed rocks, pastures, scrubs and karewas increased by 4.01%, 0.46%, 0.36%, 0.10%, 0.56%, 0.32%, 0.07 and 0.01% respectively.

Sushanth *et al.,* (2018) conducted a study on temporal land use change in Patiala-Ki-Rao watershed of Shivalik foot-hills situated in the Mohali district of Punjab. Landsat data for the years of 2006 and 2016 and supervised classification method were used for the change detection in watershed. Study concluded that due to urbanization the agricultural and forest land had been decreased by 64.57 ha and 194.90 ha respectively. The overall accuracy and Kappa value are found as more than 90% and 0.9 respectively.

Bukhari (2019) studied spatial and temporal LU/LC dynamics in Ningli watershed of Jehlum catchment in Kashmir valley, north western Himalaya from the years 1992 to 2017 using remote sensing and GIS. Landsat for the years 1992 and 2008 and Landsat 8 for the year 2017 satellite data had been used by following supervised classification technique to map the LU/LC classes and analyze changes for the period 1992-2017. The results showed that the area under horticulture, settlement and barren had increased by 15.16%, 3.02% and 3.37% respectively, while there was decrease in agricultural land by 15.03%. The overall accuracy of LU/LC classification found to be as 87%, 89.5% and 91.3% for the years 1992, 2008 and 2017 respectively.

Mishra *et al.,* (2019) prepared LU/LC classification maps in Sikkim, India for periods 1988-1996, 1996-2008 and 2008-2017 using remote sensing and GIS techniques. Landsat-5 and Sentinel 2A satellite data had been used by adopting supervised classification technique to prepare LU/LC maps of watershed. There were six major LU/LC classes: agriculture, barren land, built-up, dense forest, open forests and waterbodies which had been demarcated for the years 1988, 1996, 2008 and 2017. The results showed interment in the areas under built-up, dense forest and water bodies by 2.13%, 16.40% and 0.11% respectively while, area under agriculture, barren land and open forest decreased by 2.83%, 1.82% and 13.98% respectively.

Chowdhury *et al.,* (2020) assessed the accuracy of LU/LC classification of Halda watershed, Bangladesh, over the last forty years (1978-2017) using remote sensing and GIS. The multispectral data had been taken from LANDSAT-2 (MSS) for 1978, LANDSAT-5 for 1999 and LANDSAT-8 for 2017 and were analyzed in ERDAS imagine and ArcGIS software. The watershed had been classified into five major classes: agriculture, bare soil, settlements, vegetation and water body by using supervised classification method. In the results it has been observed that the class vegetation as 35.1% and waterbodies as 85.47% were converted into agricultural land, bare-soils and built-up areas. The overall accuracy of LU/LC classification is found to be as 88%, 88.64% and 89.22% with kappa (K) coefficient as 0.78, 0.80 and 0.84 for the years 1978, 1999 and 2017 respectively.

Vivekananda *et al.,* (2020) studied multi temporal image analysis for LU/LC classification and change detection in Ananthapuramu, Andhra Pradesh using remote sensing and GIS. Satellite data of Landsat-8 (1978) and Landsat-5 (2018) have been used to classify LU/LC by adopting Supervised classification method. There was total five LU/LC classes were identified i.e., waterbody, built-up, forest, barren land/other land and agriculture. The results showed that area under waterbody, forest and

agriculture is decreased by 73.04%, 31% and 61.84% respectively, while area under built-up and barren land/other land is increased by 454.33% and 104.7% respectively.

CONCLUSIONS

The study was conducted to review various methods on LU/LC change analysis using Remote sensing and GIS techniques throughout the world. These techniques are supervised classification, unsupervised classification, visual image interpretation, GEE and NDVI. It has been noticed that from all above methods Supervised classification method used predominantly for LU/LC classification and for change detection. No doubt, resolution of satellite imageries has also played important role in the selection of classification method. LU/LC classes viz. agriculture, built-up, barren land, forest (dense, moderate and degraded), waterbodies, shrublands were identified in most of the researches. Moreover, advanced Remote sensing and GIS approach proved as best and effective tools for detailed change analysis in LU/LC. The overall conclusion from the study says that information and data related to LU/LC and changes obtained from Remote sensing and GIS techniques are very helpful to the agencies which are working on land management, environment monitoring projects as it gives the clear information about where and what kind of changes have occurred.

Acknowledgement. We acknowledge Punjab Agricultural University, Ludhiana and Punjab Remote Sensing Centre, Ludhiana, Punjab for their support, facilities and materials required for this work.
Conflicts of Interest. There is not conflict of interest.

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