Assessment of land-use and land-cover changes using geospatial techniques in Southern Haryana: A case study of Mahendragarh District

Munesh Kumari

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Abstract The surface of the earth is undergoing unprecedented land-use/land-cover since last few decades because of various socio, economic and natural activities. It causes great environmental threats to the humanity including climate change, deforestation, water depletion, soil degradation and pollution of water and air. It is necessary to monitor, manage and mediate the negative consequences of land use and land cover changes. The main aim of this paper was to gain a quantitative understanding of land use and land cover changes in Mahendragarh district over the period 1985-2015. Supervised classification with maximum likelihood algorithm in ERDAS imagines has been applied for change detection. The study area was classified into five different classes viz. Built up areas, wasteland, agriculture, forest cover and water bodies. A significant shift has been observed from some classes to others. The results indicate that since the three decades, built-up area and agricultural land of the district have been increased about 2.9% (i.e., 54.6 km²) and 2.5% (i.e., 48.0 km²), respectively, while area under other land use categories such as wasteland, forest cover and water bodies have decreased about 1.3% (i.e., 24.8 km²), 4.0% (i.e., 76.0 km²) and 0.1% (i.e., 1.8 km²), respectively. The study reveals that the built-up area is expanding on the cost of forest cover and water bodies and affect the climate, water, flora, fauna and economy at large of the southern Haryana people.

Keywords Land use; land cover; climate; change detection

Munesh Kumari

Department of Geography, Delhi School of Economics, University of Delhi, Delhi – 110007
memunesh@gmail.com
Introduction

Land use/land cover change is a general term used for alteration of the earth’s surface. Although humans have been modifying it for thousand years for livelihood (Hassan, 2016) but current rates, intensities and extents are far greater and are responsible for unprecedented changes in natural ecosystems. It is because of the evolving social, economic and biophysical conditions (Lebow, 2013.) These changes cause the greatest environmental concerns for human populations today, leading to climate change, biodiversity loss, urban expansion, water depletion, soil degradation, and pollution (Weng, 2001). Thus periodical monitoring of the land use/land cover changes has become very important for researchers and policy makers to mediate the negative consequences of land cover changes.

Land use and land cover choices affect local, regional and global climatic process. Natural ecosystems have become vulnerable to these changes in the climate. (Brown et.al., 2014). Land use change, i.e., the change of vegetation cover at the interface between the surface and the atmosphere, influences climate through changes in surface albedo, land roughness, and soil hydrological and thermal features. These result in changes of surface solar and long wave radiation fluxes, and fluxes of momentum, sensible heat, and latent heat. Soil is important for sequestering atmosphere CO2 (Rai, 2009). When the land is used for ploughing, it releases gases like carbon dioxide, methane and nitrous oxide in the atmosphere. Carbon dioxide, methane, and nitrous oxide are greenhouse gases, which contribute to global warming (Arnfield, 2003). Land use change affects the hydrological cycle by altering the process of evaporation, precipitation and evapotranspiration. These effects alters the recharge and discharge rates plus changes in quantity and quality (Singh, 2010) of water in aquifers and thus results in large-scale changes in water present in glaciers, rivers, lakes, oceans, etc. Thus Change in the landscapes can have devastating effects on natural vegetation, habitat loss, land degradation and biodiversity of the region. (Seki, 2017).

Land use/land cover are two distinct terms used interchangeably. Land cover refers to the physical conditions of the surface of the earth including soil, water, mountains and vegetation (Turner, 2009). On the other hand land use includes, how land is used for social and economic purposes which alters the hydrology, biochemistry and biodiversity of land surface. Land change has become crucial to understand innumerable economic, social and environmental problems (Pelorosso et. Al., 2009). So it is important to inquire the causes and consequences of land use/land cover change. LULC change is a complex process which is caused by mutual interactions between environmental and social factors at various spatial and temporal scales (Valbuena et.al.,2008; Iqbal and khan, 2014;Hassan et. al., 2015).

Change detection is an important process for managing and monitoring natural resources because it provides quantitative analysis of spatial distribution of the
phenomena of interest. It requires the integration of both social science and scientific methods to determine which activities are occurring in different types of landscapes. Change detection means to extract the differences in the state of the object of interest in different time periods (Singh, 1989). A number of change detection techniques are available. It has diverse applications such as change analysis of land use, shifting cultivation, deforestation, snow melting, shifting avalanches and other environmental changes. Manual handling of change detection data through sequential images is an intense work (Adniyi, 1980) but with the help of digital satellite images, it is easily manageable for computer based analysis. Digital change detection process has been used widely for interpretation of the prevalent changes in land use and land cover based on multi-temporal remotely sensed data. The main reason for using this data for detecting change is its ability to find uncharacteristic change between two or more dates.

Remote sensing along with Geographical Information system is one of the most popular methods for detecting land use land cover change because of accurate geo-referencing, repetitive data acquisition, digital format which enables fast processing for computers and is cost affective (Nunez et. al., 2008; Torahi and Rai, 2011; Rahman et. al., 2011). The present study demonstrates the use of multi-temporal satellite imageries in defining land use land cover dynamics of Mahendragarh district, located in south haryana in the foot hill zone of the Sivalik hills.

**Study Area**

Mahendragarh district lies between 27° 47' 50" N and 28° 28' 00" N latitude and between 75° 54' 00"E and 76° 22' 11" E longitude. It has a geographical area of 1899 square kilometres comprising 1866.02 square kilometres of rural area and 32.98 square kilometres of urban area. It is located in southern part of the State in north-south elongated shape, makes bulge in Rajasthan State in Southern and Southwestern part of Haryana State. The district makes northern boundary with Charkhi dadri district, its upper eastern side is bounded by Rewari district. Rest of the district is bounded by Rajasthan State from all the remaining sides. Physiographically, district is the domain of plains interrupted by barren low hills and dry land topography. It abounds in sand dunes and barren low hills of great Aravalli Range. The slope of the district is towards north in which direction the rained streams of the district flow. These streams bring rain water during monsoon from Rajasthan. Dohan and Krishnawati are important seasonal streams of the district. The district falls in sub-tropical and semi-arid region, lying not very far from Thar Desert. The climate of the district is characterised by its dryness and extremes of temperature and scanty rainfall. The mean annual rainfall in the district is 571.9 mm.
Administratively, the district is divided into two sub divisions, namely Mahendragarh and Narnaul. Narnaul city is the administrative headquarters of the district. Mahendragarh owns the distinction of being few districts in the country where the name of the district and its administrative towns are different. There are eight development blocks in the area namely Ateli, Kanina, Mahendragarh, Nangal Choudhary and Narnaul, Sihma, Nizampur and Satnali. The district is comprised of 370 villages and 5 towns with the population of 9,21,680 souls as per 2011 census.

Figure 1 Location of the study area

Database and Methodology

Data acquisition

To detect LULC changes in the study area, two multispectral satellite images of the year 1985 and 2015 were acquired. These land sat images were obtained for the month of May to avoid cloud cover from United States Geological Survey. Apart from high-resolution imagery, additional data, including ground truth data, aerial photographs and topographic maps was also collected. The ground truth da-
ta was collected using Geographical Positioning System with reference data points.

**Image Processing**

Satellite images as well analog images are lacking in brightness because of illumination and other reasons. It can create different types of noise or error in images. The noise can be created either during capturing or transforming the image (Chitradevi and Srimathi, 2014). Image processing simply means removing noise and irregularities caused due to atmosphere or error in sensor related to geometry and brightness values of the pixels by use of digital computer. These errors are corrected using appropriate mathematical models (Zahniser, 1981). Image enhancement is the alteration in image by improving the pixel brightness values to enhance overall visual impact. It involves an assemblage of different techniques to improve the quality of an image that can be better interpreted human or machines. Image enhancement improves the quality of image which help in feature extraction and the results of the image analysis. In order to establish a more direct amalgamation between the acquired data and biophysical features satellite images are pre-processed before change detection (Abd El-Kawy et. al. 2011). Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc.

**Image Classification**

Supervised classification-maximum likelihood algorithm in ERDAS imagine was applied in this study to detect land use/land cover changes observed in the study area using multispectral satellite data obtained from Landsat 7 for the years 1985, 2015. The district was classified into five major Land use land cover classes viz. Built up, wasteland, agriculture, forest cover and water bodies. Change detection analysis was performed to compare the change in quantities of land cover class conversions between two time periods. Then Quantitative areal data between 1985 and 2015 are compiled for the overall land use/cover changes. The results revealed gains as well losses in each category.

**Table 1** Area and amount of change in different land use/cover categories in Mahendragarh district during 1985–2015
Table 1.1 and Fig. 1.2 and Fig. 1.5 reveal that in 1985, about 2.1% (or 40.6 km²) area of study area was under built-up land, 3.4% (or 65 km²) under wasteland, 88.4 % (or 1679.2 km²) under agricultural land, 0.2% (or 3 km²) under water body and 5.9% (111.2 km²) area was covered by forest. During 2015 the area under these land categories was found 5.0% (or 95.2 km²) under built-up land, 2.1% (or 40.2 km²) under wasteland, 91% (or1727.2 km²) under agricultural land, 0.1% (or 1.2 km²) under water bodies and 1.9% (or 35.2 km²) under forest cover.
Land use/cover change

The data presented in Table 1 and Fig. 1 depicts that both positive and negative changes occurred in the land use/cover pattern in the study area. During the last three decades, the built-up area has increased at very fast rate from 40.6 km² in 1985 to 95.2 km² in 2015 which accounts for around 3% of the total sprawl area. The wasteland has been decreased from 65.0 km² in 1985 to 40.2 km² in 2015. This decrease in wasteland accounts for -1.3% of the total study area. But the significant increase has been witnessed in agricultural land from 1679.2 km² in 1985 to 1727.2 km² in 2015 which accounts for 2.5% of the present total area. The water body has also been decreased from 3.0 km² in 1985 to 1.2 km² in 2015 which accounts for -0.1% of total land cover area. Sharp decline has been noticed in the forest area from 111.2 km² in 1985 to 35.2 km² in 2015 which accounts for -4.0% of the total study area.

Figure 2 (A)  Figure 2 (B)
Conclusion

The study conducted in the Mahendergarh district of southern Haryana for the assessment of land use/land cover change. Analysis revealed that built up and agricultural areas were increased during 1985-2015 resulting in reduction of forest area and wasteland and waterbodies. Major driving forces for expansion in built-up are population growth and economic development. Increase in agricultural land is because of green revolution which enhances the production capacity as well in the remuneration of the farmers. The conversion of forest and wasteland and water bodies to built-up and agriculture has caused varied and extensive environmental degradation in the study area and the major negative outcomes are seen on soil, groundwater and climate. Hence, in order to use land optimally, spatial monitoring of land use/land cover is prerequisite. It is possible with the help of geospatial technology. The present study demonstrated the potential of GIS and remote sensing techniques in measuring the change pattern of land use/cover.

References


