ISSN: 0976-3031

*Available Online at http://www.recentscientific.com*

*International Journal of Recent Scientific Research*
*Vol. 7, Issue, 7, pp. 12530-12535, July, 2016*

**International Journal of Recent Scientific Research**

**Research Article**

# UNDERSTANDING LAND USE/LAND COVER (LU/LC) CHANGES OVER TWO DECADES IN SEMI-ARID REGION OF YADGIR DISTRICT, KARNATAKA- USING REMOTE SENSING AND GIS TECHNIQUES

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**ARTICLE INFO**

***Article History:***

Received 10th April, 2016
Received in revised form 14th April, 2016
Accepted 08th June, 2016
Published online 28th July, 2016

***Key Words:***

Land use/Land cover, Vegetation dynamics, Semi-arid region, GIS and Remote Sensing, Yadgir-Karnataka.

**ABSTRACT**

Land use land cover studies are an important component to understand human interaction with ecosystem and environment thereby making it essential to detect the changes so as to maintain a sustainable environment and biodiversity. The present study was under taken in semi arid region of Karnataka to understand the land use land cover changes over a period of time with the help GIS and remote sensing technology. The data was analyzed in two points of time from 1990 and 2015. The analysis was carried using survey of India toposheets, thematic imagery and satellite images with the help of Arc GIS software. The results showed that the forest ecosystem and vegetation has reduced by almost 1.53 percent, crop land has decreased by approximately 11.52 percent and fallow land has increased extensively at 17.43 percent. The built-up areas showed a negligible increase of approximately 0.49 percent as compared to 1990s. Simultaneously, a negligible reduction in area under water bodies (0.47 percent) was observed. Furthermore, a decrease of approximately 4.4 percent was observed for area under barren land/grass land primarily due to agricultural activates. The result indicates the decrease in vegetation cover year by year due to human activities.



## INTRODUCTION

Land is the basic natural resources on the earth surface; almost all the needs of human beings for food, clothing, shelter, energy are fulfilled through land. In addition to providing for the basic needs of human welfare, activates that help achieving it also bring about changes in the basic land character based on its utilization (Gursewak, 2013). Land use/land cover changes influences the changes in vegetation dynamics in an ecosystem. These changes mainly occur due to population growth, urbanization, habitat loss, climate change, pollution and resource over exploration and utilization (Prakasam, 2010). In current situation, it is a one of the main driving forces of global environmental changes making it an important factor to ensure sustainable development in a region. It has a wide range of impacts on earth's surface such as environmental, ecosystem changes, resource utilization, water quality, ecosystem functioning and climatic influences (Bhagawat, 2005). Land cover is a basic parameter that describes the Earth surfaces; these parameters play an important role to describe the physical features of environment (Nayana and Bharti, 2013). Remote sensing technique is most effective and an efficient way to look at these changes. It is also an advanced technology method that enables identification of vegetation change detection with spatial data while prociding real time data with temporal resolution. Remote sensing method like vegetation indices among other methods has been reliable in monitoring vegetation change (Koppad and Tikhile, 2013). To analyze the vegetation monitoring through remote sensing one of the most widely used indices was used, i.e. Normalized Difference Vegetation Index (NDVI). NDVI is a digital change detection technique that uses satellite imagery and helps to understand the landscape dynamics in the ecosystem (Rawat and Kumar, 2015).

The origin of Convention on Biological Diversity (CBD) emerged from the Earth Summit held in Rio de Janeiro during 1992; the CBD has mandate the signatory nations to inventory and report the biodiversity using internationally accepted tools including remote sensing techniques (Roy *et al*, 2012). The satellite Remote Sensing technique, which acquires information

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about earth surface and subsurface remotely from sensors, also provides a platform for observation of impact of land use/land cover change, climate change effects on vegetation classes (Shahid and Joshi, 2015). Remote sensing and GIS technology is one of the most efficient approaches for monitoring land cover and its changes over a period of time with a variety of spatial scales (Gong *et al,* 2013). Mapping the distribution of vegetation cover types and land use/ land cover changes provides invaluable information for managing and conserving the landscapes to sustain their biodiversity, structure and function of their ecosystems (Reddy *et al,* 2008). The Arc GIS image processing software is an extremely useful technology for data processing and creating the maps.

The study area comes under semi arid region of southern India and is situated in central Deccan Plateau. Semi arid regions are important ecosystems on earth's surface. They occupy 15.2 percent of total geographical land and are distributed across most continents (Safriel *et al,* 2005). In India almost 53.4 per cent land area comes under arid and semi-arid regions (First NATCOM, GoI, 2004) covering 14 states and 100 districts. Huge land masses of the states of Andhra Pradesh, Tamil Nadu, Karnataka, Telangana, Maharashtra, Gujarat, Madhya Pradesh, Rajasthan, Haryana, Punjab, Uttar Pradesh and Bihar come under this category.

The vegetation diversity in semi arid regions is sparsely distributed having thorny species with limited height. According to Champion and Seth, (1968) dry deciduous vegetation forest covers 28.6 percent of the total forest region in India. Semi arid regions are important ecosystems from ecological, social and cultural prospects. However studies on these regions are highly neglected by the researchers as compared to other tropical ecosystems. In this regard, the present study was under taken to understand the species diversity and their changes over a period of time using remote sensing technology.

**Study Area**

The study was conducted in semi arid region of Yadgir district, Karnataka. The study region is located in north east region of Karnataka, India and it is bounded on the west by Bijapur district, on the north by Gulbarga district of Karnataka, on the east by Maheboobnagar district of Telangana and on the south by Raichur district of Karnataka (Figure 1). The region lies between $76^0$ 17'30"E to $77^0$ 28'30"E longitude and 160 11'30"N to $16^0$ 57'00"N latitude 0 16° 72' 58''N latitude and 76° 74'19''E longitude with an elevation of 1609 ft above the sea level. The district falls under the Krishna river basin with her tributary Bheema. Climatically the study region exhibits high temperature pattern with low rainfall and humidity due to high temperatures; the loss of surface water is very high. The vegetation diversity in the study region is sparsely distributed; the herbaceous species are almost dried during summer regenerating again during monsoon season. The climatic feature is also one of the major causes for losses of biodiversity in the semi arid ecosystems.

The aim of present study is to understand land use/land cover changes in semi arid region over a period of time and its impact on loss of biodiversity.

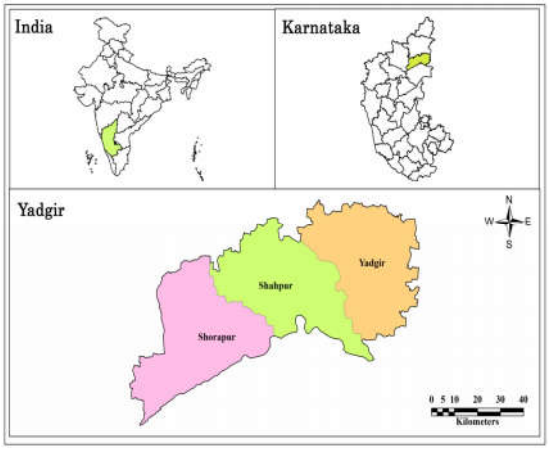


**Figure 1>** Geographical location of the Study area

Since semi arid regions are highly vulnerable for climate change, the present study was under taken mainly with following objectives.

- To prepare land use/ land cover changes maps for two periods of times (1990 and 2015).
- To estimate the LU/LC changes occurrence during the time period.
- To understand the land use/land cover change and its impact on loss of vegetation diversity

## MATERIALS AND METHODS

To prepare Land Use Land Cover (LULC) map of the study region, satellite data was used at temporal dimension. For the present study Landsat satellite data set was used and downloaded from USGS website. For the year 1990, Landsat-5 Thematic Mapper (TM) was used and for 2015, Landsat-8 Operational Land Imager alogn with Thermal Infrared Sensor (OLI/TIRS) data set was used (Table 1). Multispectral satellite imagery have been successfully used in sustainable landscape management, mapping and monitoring of biodiversity hotspots at local to global scales (Limeburner *et al*, 2000; Wang and Moskovits, 2001; Sandstrom *et al,* 2003; Lillesand *et al,* 2004). To acquire LULC map the supervised classification techniques and vector classification methods were used in ERDAS and Arc-GIS environment. The detailed methodology is given in Figure 2.

To understand, compare and contrast the relevance of our field observations across the study area, a holistic approach covering socio-economic, ecological and land use/cover in the context of a chosen conservation approach was developed. The relevance of social and ecological factors observed from our field studies, were linked to the sustainable landscape management including the interactions between anthropogenic and natural resource systems over three decades (Nautiyal and Nidamamuri, 2012).

**Table 1** Data set used for LULC map.

| Sl. No. | Satellite | Sensor | Path | Row | Date | Sources |
|---|---|---|---|---|---|---|
| 1 | Landsat 5 | TM | 144 | 49 | 27-01-1991 | USGS EarthExplorer |
| | | | 145 | 48 | 27-12-1990 | |
| | | | 145 | 49 | 27-12-1990 | |
| | | | 144 | 49 | 18-03-2015 | |
| 2 | Landsat 8 | OLI/TIRS | 145 | 48 | 25-03-2015 | |
| | | | 145 | 49 | 25-03-2015 | |

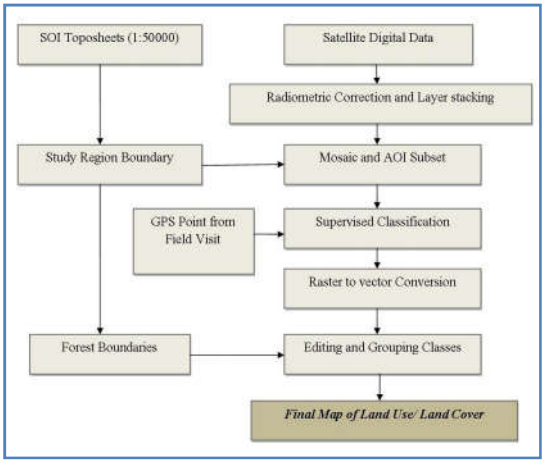


**Figure 2** Flow chart of Methodology

## RESULT AND DISCUSSION

The satellite data sets of semi arid region of Yadgir district were used as spatial datasets. Topographical maps; digital elevation data and satellite imagery pertaining to different periods (starting from 1990 to 2015) were analyzed for preparing land use/land cover maps depicting the impact of various factors that shaped the present landscape.

Semi arid regions have sparse vegetation cover with limited number of tree species having slow growth rate. In these regions one can observe large areas under grass/open lands, agricultural lands with cultivation or as fallow land. The following objectives were mainly classified with help of remote sensing technology, such as *Crop land, Fallow land, Open land/Grass land, Vegetation, Settlements/built-up areas, Water bodies* and *Rivers*. The satellite data used to show the change came from two time periods i.e. 1990 and 2015. Change detection is an important application of Remote Sensing technology, this gives the changes of specific features of objective within a certain time interval. After obtaining the detailed land use and land cover information, the change detection analysis was done by comparing data sets from these two periods of times. The detailed attribute of land use/land cover classification and their changes has been given in Figure 3 and Table 2.

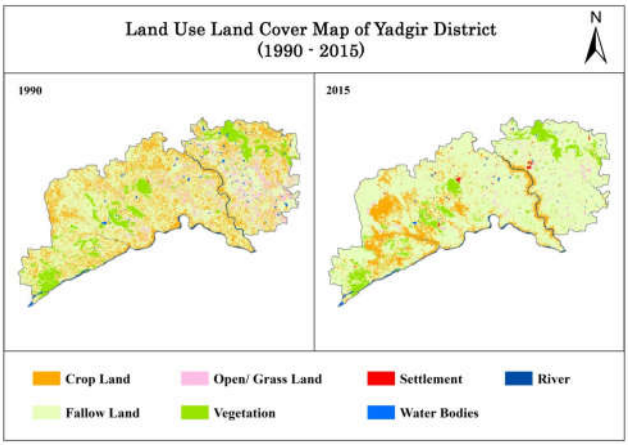


**Figure 3** Classified Land use/land cover image of Yadgir district (1990 & 2015)

**Table 2** LU/LC attribute data of supervised classification of Change detection Images

| S.No | Category | LU/LC_1990 (%) | LU/LC_2015 (%) | LU/LC_Changes 1990-2015 (%) |
|---|---|---|---|---|
| 1 | Crop land | 24.02 | 12.50 | -11.52 |
| 2 | Fallow land | 58.00 | 75.43 | 17.43 |
| 3 | Open land/Grass land | 6.54 | 2.14 | -4.40 |
| 4 | Vegetation | 8.90 | 7.37 | -1.53 |
| 5 | Settlement | 0.21 | 0.70 | 0.49 |
| 6 | Water bodies | 0.92 | 0.45 | -0.47 |
| 7 | River | 1.40 | 1.40 | 0.00 |

### *Land Use Land Cover Change Analysis (1990 and 2015)*

The general land use change of an area depicts an idea of overall aerial utilization of natural resources. The attribute data of land use and land cover changes from the study area between 1990 and 2015 period with regard to various features indicated that significant changes occur in feature classes (Figure 3). Semi arid ecosystems are highly vulnerable ecologically, economically and sociologically. To understand the land use land cover changes over a period of time and its impact on biodiversity and natural resources the present study was under taken Yadgir district of Karnataka.

Land-Use and Land-Cover (LULC) scenario in India has undergone a radical change since the onset of economic revolution in early 1990s (Roy, P.S. *et al,* 2008). These changes involve a series of complex interaction between biophysical and socioeconomic variables. Land use/land cover analysis is a dynamic process to understand the changes occurred by humans and it is a key focus area for the global change community. Human beings have modified almost 83 percent of Earth's land surface due to various land use interferers (Kale *et al,* 2016). Keeping in view, Roy *et al,* (2015) have developed the decadal land use land cover data base for India and it showed significant changes in the LULC e.g. degradation, desertification and biodiversity loss and physical and human forces behind these processes. Several studies were conducted in Indian geographical region and across the global level to understand the vegetation dynamics changes over a period of time. Kushwaha *et al,* (2010) has conducted several studies on vegetation dynamics and its changes across the Indian geographical region. Roy *et al,* (2012) have done extensive work on land use/land cover changes with reference to biodiversity and vegetation change dynamics. Apart from this several other studies has been conducted throughout India and other regions. Hadeel *et al,* (2010) studied on desertification of Iraq and have reported that both natural and anthropogenic causes lead to land desertification. Manshi *et al,* (2016) has studied the land use and land covers analysis of Western Ghats and had stated that forest degradation has decreased due to direct and indirect pressure on ecosystem services. Many other studies have been conducted in the Himalaya regions by Rawal *et al,* 2014, Rawat *et al,* 2010, Nautiyal and Kaechele, 2009, Rawat and Kumar, 2015.

The study was conducted in two different periods of times 1990 and 2015 to understand the land use and land cover changes with various parameters. The result indicates that the crop land was 24.02 percent during 1990s which in 2015 has almost been halved to 12.5 percent, a 11.52 percent reduction. Conversely, an increase of 17.43 percent was observed for fallow land from

1990, when the value was at 58 percent to 75.43 during 2015. Apart from various social and financial reasons, another probable reason is that farmers are leaving their farmlands barren instead of using it regularly for cultivation (Anil *et al,* 2011). The area under open/grass lands was 6.54 percent in the year 1990s showed a three-fold decrease to 2.14 percent in the year 2015; a total net area reduction of 4.4 percent, these due to more and more upcoming built-up areas; where related studies has been done by Koppad and Tikhile, (2012) Kale *et al,* (2016) in Western Ghats and Rawat and Kumar, (2015) in Himalaya regions.

The vegetation parameter/forest area occupied 8.9 percent of total area during 1990, which has now in 2015 reduced to 7.37 percent of total land area, thereby resulting in loss of 1.53 percent of total vegetation cover. It is indicated that the ecosystems are under immense pressure due to various anthropogenic activities and climatic impacts. However, in the semi arid regions the vegetation covers are sparse with less number of species; similar studies have been conducted by Govindu and Hadgu, (2012), Gursewak, (2013) in Siwaliks hills of Punjab, Mahapatra *et al,* 2013 and Prakasam 2010. The area under settlement has marginally increased from 1990 (0.21 percent) to 2015 (0.70 percent); an increase of 0.49 percent of the total geographical area. Several studies support this loss of biodiversity and changes in land use mainly due to increasing settlements (Koppad and Tikhile, 2013; Anil *et al*, 2011).

In dry land ecosystem water bodies play a major role for livelihood improvement of the local people; however due to climatic features the tanks are becoming dry and it is leading to the changes in aquatic biodiversity. In the study region large numbers of water bodies were observed both visually and with the help of satellite images. Satellite data depicted a decline in area under water bodies by 0.47 percent from 1990 (0.92 percent) to 2015 (0.45 percent), incidentally no such changes were observed for area under rivers between the two time periods (Figure 4, 5 and 6).

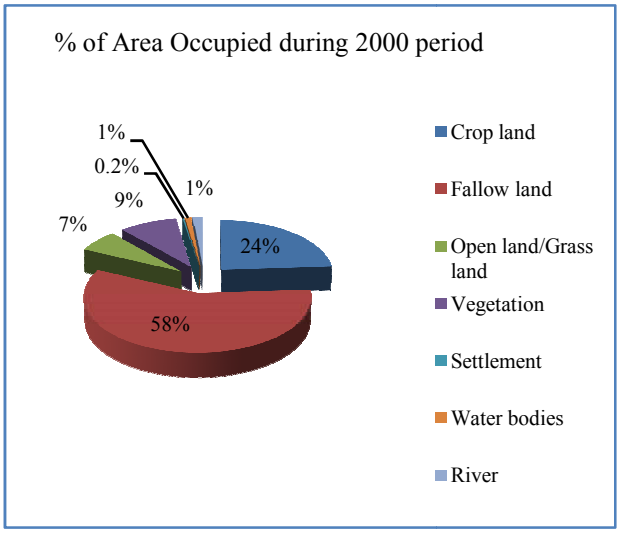


**Figure 4** Land use classification of Yadigir district during 1990's

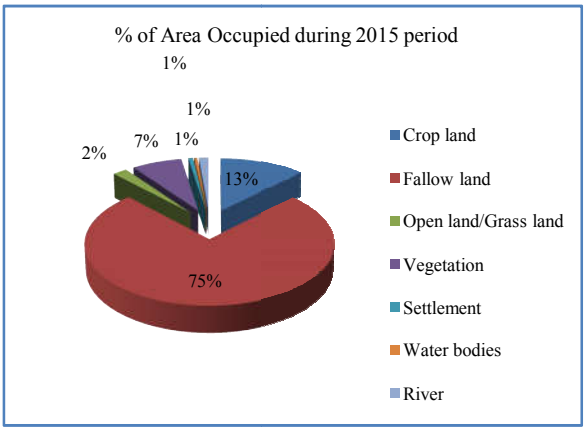


**Figure 5** Land use classification of Yadigir district during 2015

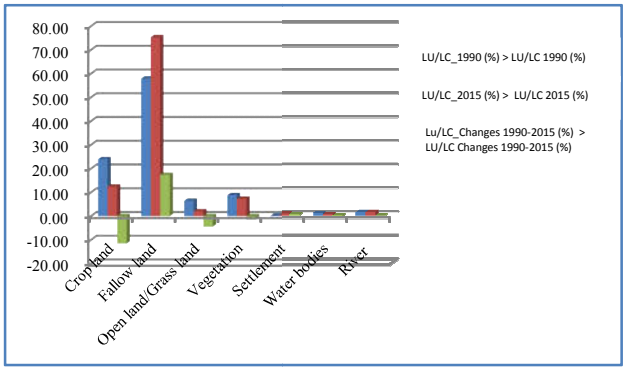


**Figure 6** Percentage of Land use/Land Cover analysis of Study Area

## CONCLUSION

Semi arid regions are highly vulnerable ecologically, economically and sociologically. The GIS and remote sensing technology is an emerging method to understand the land use land cover change analysis across a temporal dimension. In recent days, technology has been used widely to estimate the various environmental and ecological issues. There are many studies available on land use land cover changes in different places across the country to understand the changes over period of times. However, very few of these studies have been conducted on semi arid regions to understand the land use land cover changes with reference to anthropogenic impacts. The present study has revealed that the LU/LC has been changed tremendously over a period of time and has correspondingly resulted in loss of biodiversity.

Semi arid regions are important ecosystems and these are huge shelter for livestock. The results indicated that forest cover/vegetation cover is reducing rapidly due to anthropogenic pressure. Developmental activities are largely taking place in the study region. It is happening especially since Yadgir became a new district. In addition, water bodies are reducing largely due to various factors. The fallow land is tremendously increased due to climatic variations. The study recommends the need to take necessary activities as required to protect the vegetation cover. There is also a need to conserve the biodiversity for environmental balance and sustainable development. In the study region high growth of population, increasing temperature, less rainfall and over consumption of resources are the major threats leading to changes in the land

use pattern. However, these trends need to be closely monitored for the sustainability of environment for future.

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**How to cite this article:**

Katari Bhaskar and Rajanna L.2016, Understanding Land Use/Land Cover (Lu/Lc) Changes Over Two Decades In Semi-Arid Region of Yadgir District, Karnataka- Using Remote Sensing And GIS Techniques. *Int J Recent Sci Res.* 7(7), pp. 12530-12535.