Asian Journal of
Earth Sciences

ISSN 1819-1886

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Earth Sciences 8 (3): 64-73, 2015
ISSN 1819-1886 / DOI: 10.3923/ajes.2015.64.73

Assessment of Land Use/Land Cover Change in Hirpora Wildlife Sanctuary, Kashmir

[1]Fayaz Ahmad, [2]Zahoor ul Hassan, [1]Sameer Farooq and [3]Javaid Ahmad Shah
[1]Department of Environmental Sciences, SP College, MA Road, Srinagar, Jammu and Kashmir, India
[2]Department of Geography and Regional Development, University of Kashmir, Hazratbal, Srinagar, Jammu and Kashmir, India
[3]Centre of Research and Development, University of Kashmir, Hazratbal, Srinagar, Jammu and Kashmir, India

Corresponding Author: Javaid Ahmad Shah, Centre of Research and Development, University of Kashmir, Hazratbal, Srinagar, Jammu and Kashmir, India

ABSTRACT

The human interference and modification of landscape has occurred globally but has increased incidence and consequences in the developing countries mostly due the population growth, fragility of landscape and unplanned development. The aim of the study is to detect the land use changes between 1990-2010 using satellite images of IRS-IC LISS-III (2010) and LANDSAT TM (1990) and SOI topographic maps. During the 20 years all the three sites have shown major land use changes. Among these, site I has undergone positive changes into Cropland 46 ha (14.64%), Horticulture land 12 ha (3.82%), Built-up 2 ha (0.63%) while, the areas of site II has shown an alarming decrease in pasture land with 7 ha (2.22%), Sparse forest land 12 ha (3.82%). However, the site III has shown a remarkable decrease in the area of Dense forest land 56 ha (17.82%), water bodies 5 ha (1.59%) as well as depicts marked increase in the area of Scrub land 136 ha (43.31%), Pasture land 65 ha (20.70%). These changes have clearly established that the Hirpura wildlife sanctuary is under an imminent threat to its very existence. Thus, it becomes imperative that the government should prepare working plans for its conservation which has not taken yet.

Key words: Kashmir, land use/land cover, wildlife sanctuary, remote sensing, GIS

INTRODUCTION

Land use and land cover are two essentials unfolding the terrestrial environment in connection with both natural as well as anthropogenic activities (Bender *et al*., 2005; Mendoza *et al*., 2010). Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil and/or artificial structures (Ellis and Pontius Jr., 2006). Turner *et al*. (1995) believe land use involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation-the purpose for which the land is used. Lambin *et al*. (2007) differentiate between land cover (i.e., whatever can be observed such as grass, building) and land use (i.e., the actual use of land types such as grassland for livestock grazing, residential area). The Land Use Land Cover (LULC) is an amalgamated term consists of both categories of LU and LC and as such analysis of these changes become imperative to study and understand many social, economical and environmental problems (Pelorosso *et al*., 2008). The LULC change analysis has emerged as an important research question, because LULC change has been identified as a key factor which stands responsible for environmental modification worldwide (Xiao *et al*., 2006). Further, LULC change is known as a complex process which is caused

by the mutual interactions between environmental and social factors at different spatial and temporal scales (Rindfuss *et al*., 2004; Valbuena *et al*., 2008; Iqbal and Khan, 2014; Hassan *et al*., 2015). Vitousek (1994) notes that three of the well-documented global changes are increasing concentrations of carbon dioxide in the atmosphere, alterations in the biochemistry of the global nitrogen cycle and on-going land-use/land-cover change.

Though many studies were undertaken to understand the land use and land in different parts of India, not much studies were carried out in Hirpora Wildlife Santuary Shopian. So, a preliminary study was carried out to understand the present overlay of land use and land cover. Though, it is possible to monitor LULC changes by involving traditional surveys and inventories but Satellite Remote Sensing (SRS) apart from being advantageous in terms of cost and time saving for regional scale also provides large scale data on LULC changes with information about their geographic distribution (Yuan *et al*., 2005). Geographic Information Systems (GIS) and Remote Sensing (RS) have proved to be useful tools for assessing the spatiotemporal dynamics of LULC (Hathout, 2002; Herold *et al*., 2003; Serra *et al*., 2008). The study focuses on the effectiveness of satellite data for land use/land cover change of the study area.

MATERIALS AND METHODS

Study area: The present study was carried out on land use/ land cover changes at Hirpura Wildlife Sanctuary. It is located in Shopian district of Kashmir, 70 km South of Srinagar at an around 33°39' 55" N latitude and 74°39' 40" E longitude at an altitude of 2546 m above mean sea level (Fig. 1). This sanctuary was established in 1987 and its total area is 341.25 km², beautified by

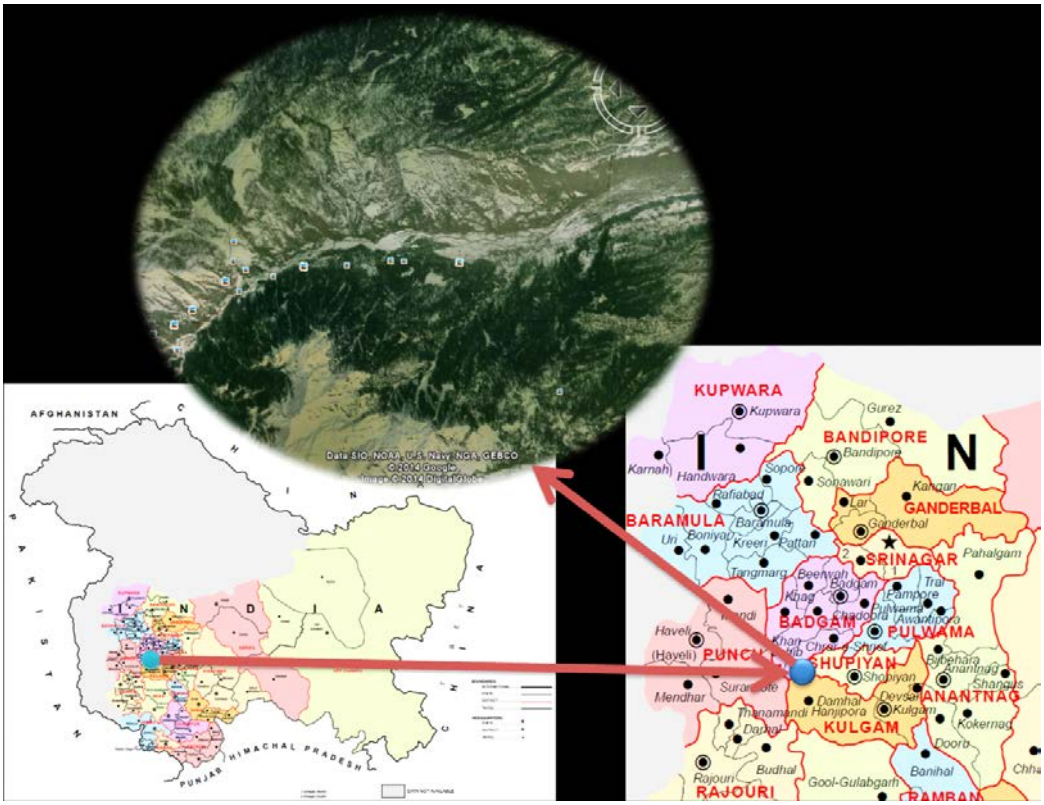

Fig. 1: Map showing the study area

forests, pastures, scrub land, waste land and water bodies. This sanctuary is bounded to the North by lake gumsar, Northeast by Hirpora village, East by Rupri, South by Suransar and to the West by the Pir panjal pass. The vegetation types present within the Sanctuary included Western mixed coniferous forests, deciduous sub-alpine scrub forests and sub-alpine pastures. The Sanctuary is also abode to many species of animals including *Himalayan brown bear*, *Musk dear*, *Leopard*, *Tibetanwolf* and around 50 individuals of critically endangered Pir Panjal *Markhor*. Besides 130 species of birds are also present in the sanctuary.

The climatic conditions of the Hirpora are somehow different from Kashmir valley. The highest day temperature is in between 6-27°C in Summers and the Winters are chilly with heavy snowfall. Its forests comprise of Western mixed coniferous forests and deciduous sub-alpines scrub forests. The presence of pastures and meadows beautify the area and provide a grazing site during Summers. The pastures are situated at an altitude of 2546 m above the mean sea level i.e., Sokh Saria. For the purpose of present study, three study sites were selected for observing the land use/land cover change (Fig. 2).

- **Site I: Hirpura village:** This site lies near the gateway of Hirpura wildlife sanctuary. It lies at an altitude of 2250 m above mean sea level within geographical coordinates of 33°40'30" N and 74° 44' 40"E
- **Site II: Dabjan:** This area lies within the Wildlife Sanctuary in the midway between Hirpura village and Sokh Saria. It is very close to the forest area of the region. It lies at an altitude of 2545 m above the mean sea level within geographical coordinates of 33°40'24" N and 74°40'48"E
- **Site III: Sukh Sarai:** This site is located 8.7 km away from Hirpura village. It lies very close to Rambiara Nallah within the Wildlife Sanctuary. The site lies at an altitude of 2546 m above the mean sea level within geographical coordinates of 33° 39'55"N and 74°39' 40"E

Database and methodology: IRS 1C LISS III with 23.5 m resolution acquired on October 25 2010 and LAND SAT TM data of October 20 1990 were used as source data. The scheme adopted for land

Fig. 2: Location of sampling sites in Hirpora Sanctuary

use/land cover classification is the level I and II of NRSA with local modification. The Hirpur Sanctuary sites were accordingly divided into nine classes namely, Crop Land, Horticulture, Built-up, Dense Forest, Sparse Forest, Scrub Land, Pasture Land, Waste Land and Water Bodies. The remotely sensed data was geometrically corrected using toposheets as reference. On Screen digitization approach was used. During the computation of change detection of area under land use/land cover categories, the percentage change of the total area was calculated which is the change of area in a particular category divided by total area of Catchment multiplied by 100.

RESULTS AND DISCUSSION

The land use/land cover maps of 1990 and 2010 of all the three sites is given in Fig. 3, the statistics have been presented in Table 1 and depicted in Fig. 4. The Results have been analyzed in two ways, one is the site wise dynamics of LULC and the other is the LULC category wise change in all the three sites.

Site wise land use land cover dynamics

Site I (Hirpura village): The data reveals that the cropland has shown marked increase from 30 ha in 1990 to 46 ha in 2010, which constituted about 14.64% of the total area at present and thus registering an increase of 5.0% from last two decades. The horticultural land in the area

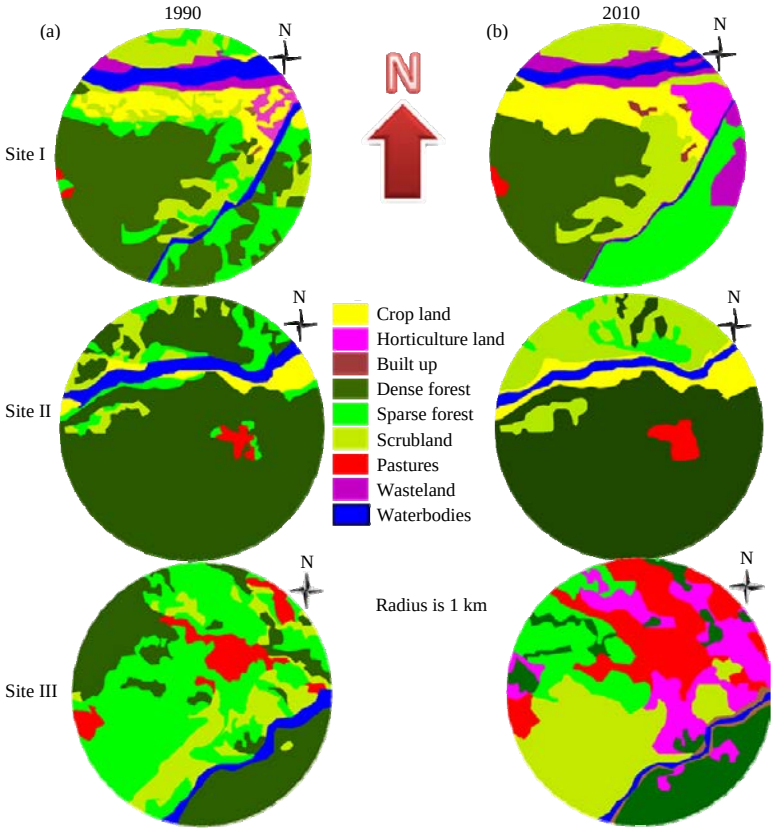

Fig. 3(a-b): Land use/land cover change in three sites of Hirpora Wildlife Sanctuary, (a) Classified from Landsat TM-1990 and (b) IRS P6 LISS III-2010

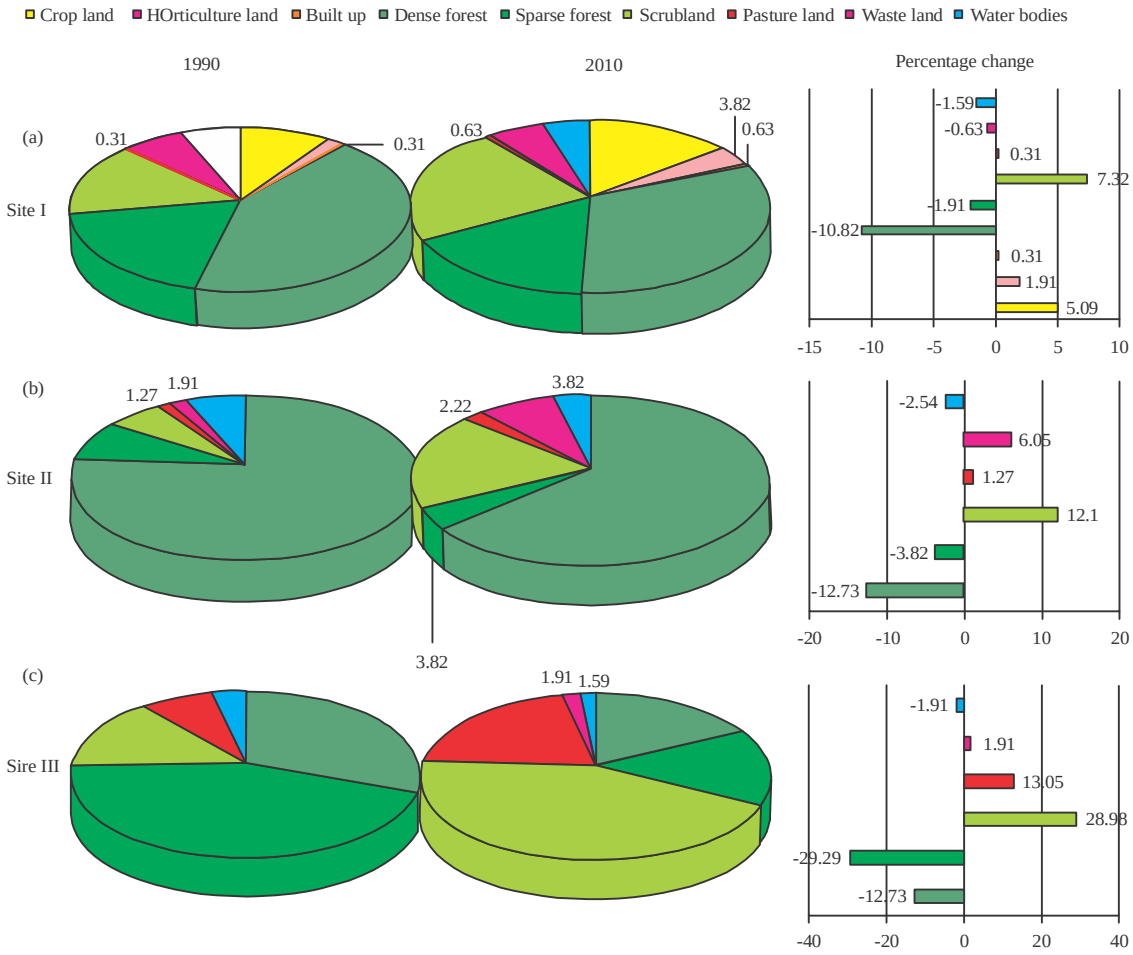

Fig. 4: Land use/land covers change in three sites of Hirpora Wildlife Sanctuary, (a) I, (b) II and (c) III

Table 1: Land use/land cover change in three sites of Hirpora Wildlife Sanctuary

LULC	Site I			Site II			Site III		
category	1990	2010	Change (%)	1990	2010	Change (%)	1990	2010	Change (%)
Crop land	30 (9.55)	46 (14.64)	16 (5.09)	-	-	-	-	-	-
Horticulture land	6 (1.91)	12 (3.82)	6 (1.91)	-	-	-	-	-	-
Built up	1 (0.31)	2 0.63)	1 (0.31)	-	-	-	-	-	-
Dense forest	132 (42.03)	98 (31.84)	-34 (-10.82)	240 (76.43)	200 (63.69)	-40 -12.73	96 (30.57)	56 (17.82)	40 -12.73
Sparse forest	58 (18.47)	52 (16.56)	-6 (-1.91)	24 (7.64)	12 (3.82)	-12 -3.82	138 (43.94)	46 (14.64)	-92 -29.29
Scrub land	46 (14.64)	69 (21.97)	23 (7.32)	20 (6.36)	58 (18.47)	38 12.10	45 (14.33)	136 (43.31)	91 28.98
Pasture land	1 (0.31)	2 (0.63)	1 (0.31)	4 (1.27)	7 (2.22)	3 1.27	24 (7.64)	65 (20.70)	41 13.05
Waste land	20 (6.36)	18 (5.73)	-2 (-0.63)	6 (1.91)	25 (7.96)	19 6.05	0	6 (1.91)	6 1.91
Water bodies	20 (6.36)	15 (4.77)	-5 (-1.59)	20 (6.36)	12 (3.82)	-8 -2.54	11 (3.50)	5 (1.59)	-6 -1.91

Source: Calculated from Landsat TM-1990 and IRS P6 LISS III-2010, The figures in the parenthesis represent the percentage and the unit of measurement is Hectares

consists of apple trees mostly. This sector has shown a sharp increase from 6 ha in 1990 to 12 ha in 2010, which contributed about 3.82% of the land area of the region and thus experiences an increase of 1.91%. The sharp increase can be attributed to the economic values of the cash crops. The area under built up has shown an increase from 1 ha in 1990 to 2 ha in 2010 (Fig. 3).

Dense forests have witnessed drastic and alarming decrease from 132 ha in 1990 to 98 ha in 2010, which constituted about 31.84% of the total area at present and thus accounting for 10.82% decrease. The sparse forest have shown a marked decrease in this area. The area has decreased from 58 ha in 1990 to 52 in 2010. The area under scrub land has increased from 46 ha in 1990 to 69 ha in 2010, which constituted about 21.97% of the total area at present.

The water bodies in this area have shown a marked decrease from 20 ha in 1990 to 15 ha in 2010. The area under waste land has shown a small decrease from 20ha in 1990 to 18ha in 2010, which contributed only 5.73% of the total area in 2010. The area under pastures constituted a small portion of the total area and the change over two decades is not so significant.

Site II (Dabjan): A perusal of data in Table 1 indicates that area under scrub land have shown a drastic increase from 20 ha in 1990 to 58 ha in 2010. There has been an increase of 18.47% of total area. The presences of lush green forest suffice the local needs of the people and contribute to the tourist attraction. In 1990, the area under dense forest was 240 ha, which constituted 76.43% of the land area of the region. The areas have declined to 200 ha in 2010, which constituted 63.69% of the total area at present and thus registering a decrease of 12.73%. From the past decades the area under sparse forest has decreased from 24 ha to 12 ha which constituted a small area (3.82% of the total area).

The study further indicates that the area under water bodies has shown a sharp decrease from 20 ha in 1990 to 12 ha in 2010, which contributed 3.82% of the total area at present and has shown a decrease of 2.45% from last decades. The area under waste land has shown an increase from 6 ha in 1990 to 25 ha in 2010. The area under pastures has shown a small increase from 4 ha in 1990 to 7 ha in 2010.

Site III (Sukh Sarai): The findings reveal that the dense forests constituted 30.57% of the total area in 1990, which declined to meager 17.82% of the total area in 2010. This depicts a decrease of over 12.73% from last two decades (Table 1). The sparse forests have shown a huge and alarming decrease in this area. The area has decreased from138 ha in 1990 to 46 in 2010. The area under scrub land has increased from 45 ha in 1990 to 136 ha in 2010, which constituted largest area comprises of 43.31% of the total area at present. This depicts increase of over 28.98% from the past two decades.

One of the striking findings of the study is that the water bodies in this zone have shown the largest decline in the past two decades. The area in this sector have declined from 11 ha in 1990 to 5 ha in 2010, which constituted only 1.59% of the total area at present and thus registering a decrease of 1.91%. The area under waste land has shown an increase from 0ha in 1990 to 6 ha in 2010. The presence of pastures has magnified the beauty of the wildlife Sanctuary in particular to Sukh Sarai at an altitude of 2546 m above mean sea level. The pastures are present have shown a largest increase from 24 ha in 1990 to 65 ha in 2010, which constituted an increase of 13.05% from last decades. The pastures once provide an excellent site to grazing in summers.

Category wise land use land cover dynamics

Scrub land: It was analyzed that area under scrub land is mostly present at site III (43.31% of the total area) also this site has shown greater increase in scrub land area compared to site I and site II which have 21.97 and 18.47% of the total area respectively. Scrub land area has increased in site I, site II and site III from the past two decades which may be at the cost of decrease of forest cover (Olsson *et al*., 2000).

Dense forest: Comparing the three sites, dense forests at site I, site II and site III have shown a decreasing trend. Site II has the largest forest cover area at present because of fencing (63.69% of the total area) followed by site I (31.84% of the total area) and site III (17.82% of the total area). This decrease in the forest area is mainly due to natural factors, population pressure and increasing demands of people for timber, fuel wood, land for settlement, roads (Mughal road), agriculture etc have lead to declining of the forest area (Sharma and Roy, 2007; Farooq and Rashid, 2010).

Sparse forest: Sparse forests at site I, site II and site III have shown a decreasing trend from 18.47% in 1990 to 16.56% in 2010, 7.64% in 1990 to 3.82% and 43.94% in 1990 to 14.64% in 2010 respectively. Site II has shown largest decrease in the sparse forest area compared with site I and site III. This decrease in sparse forest is mainly due to population expansion, increasing demand of the people for firewood, fuel wood and other minor forest products. These findings are in conformity with findings of Sen (2002). Lack of employment opportunities also compels the people to depend on forests (Sharma *et al*., 2009).

Crop land: Crop land of the three sites constitutes a very small portion of the total area. Crop lands at site II and site III are absent because of absence of permanent settlement while, it has increased from 30 ha in 1990 to 46 ha in 2010 at site I. Site I has only crop land area compared with other two sites. This increase is due to conversion of forest land, grassland and woodland into cropland (Houghton, 1994; Williams, 1994; Kaul *et al*., 2009).

Horticulture land: Horticultural land of the three sites contributes a very small portion of the total area. Horticulture land at site II and site III are absent because of absence of permanent settlement while it has increased from 6 ha in 1990 to 12 ha in 2010 at site I (Fig. 4). The increase in horticulture land area can be attributed to the fact that people are shifting towards the cultivation of cash crops and this has uplifted their socio-economic status (Rigterink, 1989; Uhlig and Kreutzmann, 1995).

Water bodies: Comparing the three sites, water bodies at site I, site II and site III (Fig. 4) have decreased from 20 ha in 1990 to15 ha in 2010, 20 ha in 1990 to 12 ha in 2010 and 11 ha in 1990 to 5 ha in 2010, respectively. Site III has shown the largest decrease in the water bodies' area compared with site I and site II. This decreasing area of the water bodies may be due to land transformations. These findings are in conformity with the findings of (Fazal and Amin, 2011). The shrinking of water bodies can also be attributed due to climate change as was witnessed by Pielke *et al*. (2002).

Pasture land: Comparing the three sites, pasture lands at site I, site II and site III have shown an increasing trend from last two decades. Site III has the largest pasture land at present (20.70% of the total area), when compared with site II and site I which comprises of 2.22 and 0.63% respectively. The area of site III acts as a grazing site in summers as the tribal's and nomads drive their livestock to these areas because of pleasant temperature. This increase in pasture land is mainly due to the conversion of grass land, woodland and forest into pastures (Houghton, 1994; Williams, 1994; Sang *et al*., 2013).

Waste land: Waste lands at site III and site II have shown an increasing trend from last two decades. While, site I shows a decreasing trend from last decade. Waste lands have increased from 0 ha in 1990 to 6 ha in 2010 at site III and 6 ha in 1990 to 25 ha in 2010 at site II. Site II has largest waste land area compared with other two sites. This increase is due to the conversion of forest land into waste land by way of deforestation. These findings are in collaboration with the findings of (Kaul *et al*., 2009). Site I has shown a decline trend of pasture land from last decade (20 ha in 1990 to 18 ha in 2010). The reason behind this decrease is mainly due to conversion of waste land into agriculture to fulfill the needs of growing population (Roy, 1988).

CONCLUSION

The study has irrevocably established that the human induced changes have triggered the processes of environmental degradation. The human activities in the area can be broadly categorized as, a) the fragmentation of the forests by construction of roads which not only brings ecological changes but also makes them vulnerable to the timber smugglers, b) conversion of blank forests/flood plains into agriculture and allied activities which is detrimental for forest renewal and disturbs the ecosystem and c) extending the built up into the sanctuary by encroaching the area is causing a huge pressure on the sanctuary in terms of fuel wood and grazing. The major processes of degradation include the conversion of dense forests into the sparse forests, decrease or degradation in the pasture land, decrease in water bodies, increase in agriculture and horticulture and increase in shrub land. These changes have clearly established that the Hirpura Sanctuary is under an imminent threat of massive degradation particularly of those induced by humans. Thus it becomes imperative that the government should prepare working plans for the effective management of the land needs to take steps for the establishment of nurseries, farm forestry and regeneration of forests that can help in the sustainable development of the area and implementation J and K Wildlife (Protection) Act, 1978 for the conservation of Hirpura Wildlife Sanctuary.

ACKNOWLEDGMENTS

The authors acknowledge the facilities provided by Prof. M. Yaseen principal Sri Pratab College and contribution of Dr. Zubaida, Head Department of Environmental Sciences, Sri Pratab College in the completion of the present study.

REFERENCES

Bender, O., H.J. Boehmer, D. Jens and K.P. Schumacher, 2005. Using GIS to analyse long-term cultural landscape change in Southern Germany. Landscape Urban Planning, 70: 111-125.

Ellis, E. and R.G. Pontius Jr., 2006. Land-use and land-cover change encyclopedia of earth. Environ. Protect., 2: 142-153.

Farooq, M. and H. Rashid, 2010. Spatio-temporal change analysis of forest density in Doodhganga forest range, Jammu and Kashmir. Int. J. Geom. Geosci., 1: 132-140.

Fazal, S. and A. Amin, 2011. Impact of urban land transformation on water bodies in Srinagar city, India. J. Environ. Protect., 2: 142-153.

Hassan, Z.U., J.A. Shah, T.A. Kanth and A.K. Pandit, 2015. Influence of land use/land cover on the water chemistry of Wular Lake in Kashmir Himalaya (India). Ecol. Process., Vol. 4. 10.1186/s13717-015-0035-z

Hathout, S., 2002. The use of GIS for monitoring and predicting urban growth in East and West St Paul, Winnipeg, Manitoba, Canada. J. Environ. Manage., 66: 229-238.

Herold, M., N.C. Goldstein and K.C. Clarke, 2003. The spatiotemporal form of urban growth: Measurement, analysis and modeling. Remote Sens. Environ., 86: 286-302.

Houghton, R.A., 1994. The worldwide extent of land-use change. Bioscience, 44: 305-313.

Iqbal, M.F. and I.A. Khan, 2014. Spatiotemporal land use land cover change analysis and erosion risk mapping of Azad Jammu and Kashmir, Pakistan. Egyptian J. Remote Sens. Space Sci., 17: 209-229.

Kaul, M., V.K. Dadhwal and G.M.J. Mohren, 2009. Land use change and net C flux in Indian forests. For. Ecol. Manage., 258: 100-108.

Lambin, E.F., H.J. Geist and E. Ellis, 2007. Causes of Land-Use and Land-Cover Change. In: Environmental Information Coalition, National Council for Science and the Environment, Cleveland, C.J. (Ed.). Encyclopedia of Earth, Washington D.C., USA.

Mendoza, M.E., E.L. Granados, D. Geneletti, R. Diego, D.R. PerezSalicrup and V. Salinas, 2010. Analysing land cover and land use change processes at watershed level: A multitemporal study in the Lake Cuitzeo Watershed, Mexico (1975-2003). Appl. Geogr., 31: 237-250.

Olsson, E.G.A., G. Austrheim and S.N. Grenne, 2000. Landscape change patterns in mountains, land use and environmental diversity, Mid-Norway 1960-1993. Landscape Ecol., 15: 155-170.

Pelorosso, R., A. Leone and L. Boccia, 2008. Land cover and land use change in the Italian central Apennines: A comparison of assessment methods. Applied Geogr., 29: 35-48.

Pielke, R.A., G. Marland, R.A. Betts, T.N. Chase and J.L. Eastman *et al*., 2002. The influence of land-use change and landscape dynamics on the climate system: Relevance to climate-change policy beyond the radiative effect of greenhouse gases. Phil. Trans. R. Soc. Lond. A, 360: 1705-1719.

Rigterink, P.V., 1989. Tropical fruit trees and rural land use patterns. Land Use Policy, 6: 194-196.

Rindfuss, R.R., S.J. Walsh, B.L. Turner, J. Fox and V. Mishra, 2004. Developing a science of land change: Challenges and methodological issues. Proc. Nat. Acad. Sci. United States Am., 101: 13976-13981.

Roy, B.K., 1988. Are waste lands the last hope of the poor? Geo J., 17: 117-124.

Sang, P.M., D. Lamb, M. Bonner and S. Schmidt, 2013. Carbon sequestration and soil fertility of tropical tree plantations and secondary forest established on degraded land. Plant Soil, 362: 187-200.

Sen, K.K., R.L. Semwal, U. Rana, S. Nautiyal, R.K. Maikhuri, K.S. Rao and K.G. Saxena, 2002. Patterns and implications of land use/cover change. Mount. Res. Dev., 22: 56-62.

Serra, P., X. Pons and D. Sauri, 2008. Land-cover and land-use change in a Mediterranean landscape: A spatial analysis of driving forces integrating biophysical and human factors. Applied Geograp., 28: 189-209.

Sharma, C.M., S. Gairola, S.K. Ghildiyal and S. Suyal, 2009. Forest resource use patterns in relation to socioeconomic status. Mount. Res. Dev., 29: 308-319.

Sharma, S. and P.S. Roy, 2007. Forest fragmentation in the Himalaya: A central Himalayan case study. Int. J. Sustain. Dev. World Ecol., 14: 201-210.

Turner, B.L., D. Skole, S. Sanderson, G. Fischer, L. Fresco and R. Leemans, 1995. Land-use and land-cover change science/research plan. Joint publication of the International Geosphere-Biosphere Programme, Report No. 35, Human Dimensions of Global Environmental Change Programme, Report No. 7, Royal Swedish Academy of Sciences, Stockholm.

Uhlig, H. and H. Kreutzmann, 1995. Persistence and change in high mountain agricultural systems. Mount. Res. Dev., 15: 199-212.

Valbuena, D., P.H. Verburg and A.K. Bregt, 2008. A method to define a typology for agent-based analysis in regional land-use research. Agric. Ecosyst. Environ., 128: 27-36.

Vitousek, P.M., 1994. Beyond global warming: Ecology and global change. Ecology, 75: 1861-1876.

Williams, I.N., 1994. A model of London and the South East. Environ. Plan. B: Plan. Des., 21: 535-553.

Xiao, J., Y. Shen, J. Ge, R. Tateishi, C. Tang, Y. Liang and Z. Huang, 2006. Evaluating urban expansion and land use change in Shijiazhuang, China, by using GIS and remote sensing. Landscape Urban Plan., 75: 69-80.

Yuan, F., K.E. Sawaya, B.C. Loeffelholz and M.E. Bauer, 2005. Land cover classification and change analysis of the Twin Cities (Minnesota) Metropolitan Area by multitemporal Landsat remote sensing. Remote Sens. Environ., 98: 317-328.