Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 2, No. 9, p. 26-32, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Flulc mapping and assessment of a typical sub watershed of Central India using IRS-P6 LISS *3* data

Ajay K. Singh*, S. S. Singh

Department of Forestry, Wildlife and Environmental Sciences, Guru Ghasidas University, Bilaspur, Chhattisgarh, India

Received: 21 August 2012
Revised: 09 September 2012
Accepted: 11 September 2012

Key words: FLULC, Chornai sub watershed, NDVI, IRS-P6 LISS-III

Abstract

The forest land use/ land cover (FLULC) mapping and assessment of Chornai sub watershed has done by using IRS P6 LISS3 data of 2008 dataset. The study area is located in the eastern part of the Hasdeo river basin, Chhattisgarh, Central India. The sub watershed covers an area of the 1792.30 km². This area has subjected to different kind of ecological degradation by man and nature. The data shows that this sub watershed has total 37.97% area as dense forest, 11.14% area is open forest, 12.57% area is non forest (Agriculture land without crop recorded 62.56% and agriculture land with crop 37.44%) and 38.32% area is water bodies. The Normalized Difference Vegetation Index (NDVI) of the sub watershed has also been analysed for vegetation.

***Corresponding Author:** Ajay K. Singh ✉ aks.ggu@gmail.com

Introduction

Forest Land cover is continually moulded and transformed by land-use changes. for example, when a forest is converted to pasture or crop land. The underlying driving forces like forest, water etc however; can be traced to a host of economic, technological, institutional, cultural and demographic factors. Humans are increasingly being recognized as a dominant force in global environmental change (Moran 2001, Turner 2001, Lambin *et al.,* 2001). Forest ecosystem plays an important role to provide the essential services for life support system at local and global scale (Sarma *et al.*, 2006, Rao and Pant, 2001, PMR, 1996).

The Hasdeo river basin is situated in the Maikal range of Central India and it covers the major portion with natural resources varying from 200 msl to 1200 msl altitude with important peaks of this basin and have fragile environment. The present study deals with the vegetation analysis and land use pattern in Chornai sub watershed by using RS data and ground (Singh and Singh, 2010, Singh *et al.*, 2011, Singh and Singh, 2011).

The NDVI technique has applied for vegetation changes monitoring in any kind of areas viz. forest, agriculture, drought, wet, snowy etc. (Malplica, 2007, Steven *et al.*, 2003). The surface vegetation index is an important index in the monitoring of forest across the world (Liu *et al.*, 2001). Tucker *et al.* (1984) analysed the composite NDVI values of the Sahara desert during 1980 to 1992 to study the vegetation area variation. Normalized difference vegetation index is sensitive to the presence of green vegetation (Joshi, 2001) and has been successfully used in numerous regional and global applications for studying the state of vegetation. Changes in land use are likely the most ancient of all human-induced environmental impacts, and the first to obtain a magnitude to warrant the title 'global' (Gibson and Power, 2000, Anderson *et al.*, 1976, Jenson, 2007). According to Long *et al.* (2008) urban landscapes are exemplified by the large concentration of population and fast expansion of urban zones which lead to alteration in the land use and land cover configuration that consequently impacts the landscape environment. Prakasam (2010) studied the land use and land cover change in Kodaikanal region of Western Ghats in Tamilnadu State of India to observe changes during a span of 40 years from 1969 to 2008, using Landsat satellite data and performing supervised classification techniques. He has found that 70% of the region was covered under forests in 1969 but has decreased to 33% in 2008. Zubair (2006) utilized remote sensing and GIS technologies to detect the land use and land cover changes in Ilorin, Nigeria from 1972 to 2001 through Landsat TM images of 1972, 1986 and 2001.

Materials and Methods

The IRS-P6 LISS-III (10.10.2008) satellite data (103/56-57; path/row) has been used in the present study. The topographic map having scale 1: 50,000 have been used. The ERDAS IMAGINE version 10.0 software has used for the study. The satellite imagery has used to prepare the forest land use/land cover map using supervised classification.

The Chornai sub watershed (Fig. 1) is situated between 22°22' North to 22°47' North latitude and 82°39' East to 83°4' East longitude. This sub watershed covers 1792.30 sq km area. Chornai river originates from the eastern part of the Korba and covers 87 km length. This river is a perennial source of water. Most of the part of Hasdeo- Bango dam is distributed in this sub watershed and influence the maximum forest area and local populace. The elevation ranges between 500m to 800m above mean sea level.

FLULC	% area
Dense forest	37.97
Non Forest	12.57
Open Forest	11.14
Scrubland	0.00
Water bodies	38.32

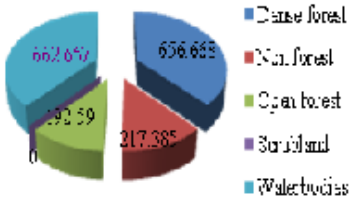

Table 1. Area percentage under different classes of forest land use/land cover.

Table 2. Non Forest land use/land cover (NFLULC) distribution in sub watershed.

NFLULC classification	Area (in sq. Kms.)	% area
Agriculture land without Crop (ALWC)	135.983	62.56
Agriculture land with Crop (AWC)	81.402	37.44

Fig. 1. Location map of Chornai sub watershed and its LULC pattern.

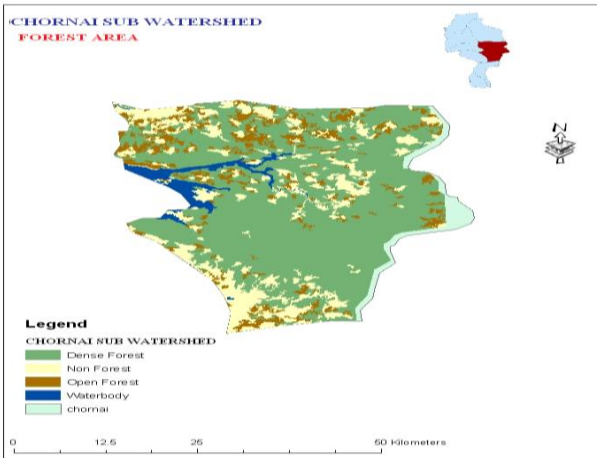

Fig. 2. FLULC area in Chornai sub watershed.

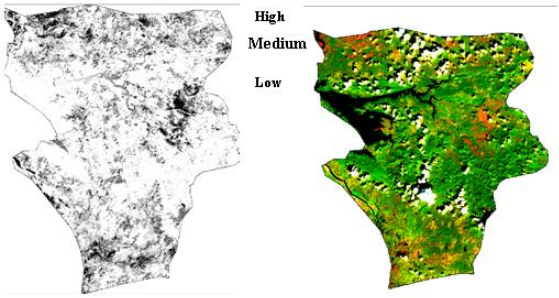

Fig. 3. The estimation of Forest area from NDVI.

The climate is sub tropical with cool temperature during November-February ranging between 14°C to maximum 26°C and during April-June it varies 25°C to maximum 44°C. The rainfall occurs due to south-east monsoon between June to September. Average annual rainfall is about 1250 mm in the sub watershed. The interpretation of 2001 India census (CoI, 2001), the Chornai sub watershed had a population of 286,785 within the rural and the urban area. Male constitutes 51% of the population and females 49%. The average literacy rate of the area is approx 38%. The sub watershed has the comparatively shape of forest compare to the other nearby sub watershed but this is also deteriorating very rapidly. Major dominant tree species in this sub watershed is *Shorea robusta,* which is highly demanded hardwood tree species. The other forest tree species found in this sub watershed is *Terminalia tomentosa, Adina cordifolia, Madhuca indica, Albizia procera, Pterocarpus marsupium, Beutia monosperma, Diaospyros melanoxylon etc.*

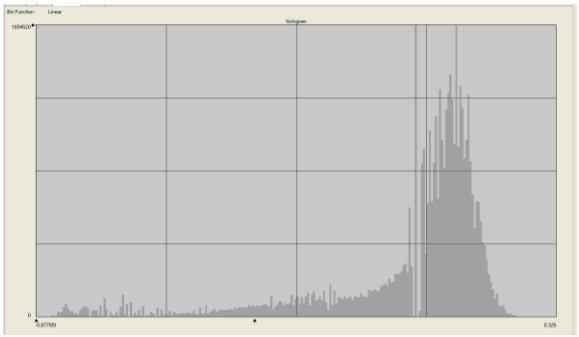

Fig. 4. NDVI value for Chornai sub watershed.

Results and discussion

Accuracy assessment

The error matrix and Kappa methods has been used to assess the mapping accuracy. The overall mapping accuracy only considers the correction of diagonal elements in the matrix, while the kappa method also takes the other elements in the matrix into account, which can compensate the disadvantage of the error matrix method (Smits *et al.*, 1999, Foody *et al.*, 2002). The overall accuracy 90% and kappa coefficient of 0.86 was achieved for LISS-III image.

Slope study

The elevation contours of 20 m interval were digitized from SOI topographical map on 1:50,000 scale and was used for slope study. The study reveals that 50-60% of forest land is having slope under 5% to 10% (Moderately sloping), which should undergo forest conservation and management practices and for the tribal settlement. 20-30% of forest land covers less than 5% slope (gentle sloping) is used for cultivation, grazing and settlement. The remaining part of land having slope of 10-15% (strong sloping) which have natural dense forest and different species plantation done by local forest department. The same type of study was done by Suryawanshi and Pendke (2009) in the Malegaon watershed in Nasik district of Maharashtra. According to Rao *et al.* (1997) in Neelkanthpuram watershed for the sustainable development planning the RS based slope and soil information is must. This provides the information for accurate land use planning and management.

Forest land use/land cover (FLULC) map

The forest land use/land cover map was classified considering five classes (Fig 2). The results have validated with the ground truthing data. The table 1 indicate the areas under different classes of forest land use/land cover.

The forest land use/land cover map (Table 1) clearly shows that area of water bodies 662.657 km2 (38.32%) is higher than others. The dense forest has 656.668 km2 (37.97%) area and it occupies second place, the non forest and open forest area occupies 217.385 km2 (12.57%) and 192.59 km2 (11.14%).

According to Balaselvakumar *et al.* in the land using mapping of Arjuna basin, Tamilnadu by using the same technique of study observe that dense forest land cover was 62.67 km2 (3.71%), open forest land cover was 65.6 km2 (3.88%). Mulder (1979) used the same technique for integrating water resource and land use planning in Logan, Utah. NRSA (1989) manual of nationwide also dictate the use of satellite imagery for land use land cover mapping for accurate result and proper planning.

The local population of the sub watershed are mainly depends on forest and its produces like Sal seed and timber (*Shorea robusta*), Mahua fruit (*Madhuca indica*), Bamboo (*Dendrocalamus strictus*), Mahul patta (*Bauhinia vahlii*), Tikhur (*Curcuma angustifolia*), Ashwagandha (*Withania somnifera*), Bach (*Acorus calamus*), Lemon grass (*Cymopogon flexuosus*), Safed musli (*Chlorophytum borvillinium*) etc.

The AWC and ALWC under non forest land use/land cover is one of the most important factors that have shaped the landscapes. The table 2 shows that ALWC is 135.983 km2 (62.56%) and AWC is 81.402 km2 area (37.44%) in the sub watershed. Paddy, maize and pulses are important agriculture crop in the sub watershed. The same study was done by (Bakker *et al*, 2005, Stoate *et al*, 2001, Sun *et al*, 2003, Jordan *et al*, 2005, Szilassi *et al*, 2006) for the agriculture land use cover assessment in the different parts of Europe and China.

NDVI analysis of the sub watershed area

Accurate quantitative information on the distribution and phenology of vegetation formations is limited, but is fundamental for the effective management of forest resources. The NDVI map of Oct 10, 2008 (Fig 3) shows the vegetation index value. The values of NDVI of the image range from –0.877 to 0.325 in this time (Fig 4). High vegetation cover area took shining white. Tucker *et al.* (1994) had analyzed the composite NDVI values of the Sahara desert during 1980 to 1992 to understand the vegetation variation. Meanwhile, Liu *et al.* (2001) estimated the Taiwan's forested areas from classified NDVI maps from NOAA AVHRR data.

The Fig 6 shows the NDVI value for Chornai sub watershed. The eastern part of the sub watershed showed a very high vegetative index value implying that the area is heavily forested. Besides the central

river valley region also showed a reasonably high index value.

The final forest land use/land cover data base developed as an outcome in this study offers the greatest benefits with respect to monitoring forest land use/ land cover in the Chornai sub watershed.

References

Anderson J, Hardy E, Roach J, Witmer R. 1976. A Land Use and Land Cover Classification Scheme System for use with Remote Sensor Data. U. S. Geological Survey.

Bakker MM, Govers G, Kosmas C, Vanacker V, Van Oost K, Rounsevell MDA. 2005. Soil erosion as a driver of land use change. Agri. Ecosys. Environ. **105**, 467- 481.

Balaselvakumar S, Kumaraswamy K, Srileka S, Jawahar N. Remote sensing techniques for land use mapping of Arjuna basin, Tamil Nadu. Gisdevelopment. net / application / natural resource management, 1-5.

Foody GM. 2002. Status of land cover classification accuracy assessment. Rem. Sens. Environ. **80**, 185-201.

Gibson P, Power C. 2000. Introductory Remote Sensing: Digital Image Processing and Applications, Routledge, 92 – 112.

Jensen J. 2007. Remote Sensing of the Environment: An earth Resource Perspective (2nd Edition), Pearson Education, Inc., 450.

Jordan G, Van Rompaey A, Szilassi P, Csillag, G, Mannaerts C, Woldai T. 2005. Historical land use changes and their impact on sediment flexes in the Balaton basin, Hungary. Agri. Ecosys. Environ. **108 (2),** 119-133.

Joshi PK, Singh S, Agarwal S, Roy PS. 2001. Forest cover assessment in western Himalayas, Himachal Pradesh using IRS 1C/1D WiFS data. Curr. Sci. (**80**), 8.

Kasischeke ES, Nancy HFF. 1995. Location and Estimation the Areal extent of wildfire in Alaska boreal forests using multiple season AVHRR NDVI composite data. Rem. Sens. Environ. **51**, 263-275.

Lambin EF, Turner BL II, Geist HJ, Agbola SB, Angelsen A, Bruce JW, Coomes O, Dirzo R, Fischer G, Folke C, George PS, Homewood K, Imbernon J, Leemans RX., Moran EF, Mortimore M, Ramakrishnan PS, Richards JF, Skånes H, Steffen W, Stone G, Svedin U, Veldkamp TA, Vogel C, Xu J. 2001. The causes of land-use and land-cover change: Moving beyond the myths. Global Environmental Change: Human and Policy Dimensions **11(4),** 5-13.

Liu GR, Lin TH, Kuo T H, Liang C. 2001. Estimation of Taiwan's forested areas from classified NDVI maps from NOAA AVHRR data. Paper presented: 22nd Asian Conference on Remote Sensing, November 5-9, 2001, Singapore.

Malplica JA. 2007. Hue adjustment to HIS Pan – Sharpened IKONOS imagery for vegetation enhancement. IEEE Geoscience and Remote Sensing Letters. **4(1),** 27-31.

Moran EF. 2001. Progress in the last ten tears in the study of land use/cover change and the outlook for the next decade. In A. Diekman *et al.* (eds.), Human dimensions of global change. Cambridge, MA, MIT Press.

Mulder J. 1979. Integrated water resource and land use planning, Logan, Utah water research laboratory, Utah state university, USA.

National Remote Sensing Agency (NRSA). 1989. Manual of Nationwide land use/land cover

mapping using satellite imagery, Part-I, NRSA, Hyderabad.

Pacific Meridian Resources (PMR). 1996. Luccas: land use and cover change analysis system. User's manual.

Prakasam C. 2010. Land use and land cover change detection through remote sensing approach: A case study of Kodaikanal Taluk, Tamilnadu. Int. J. Geom. Geosci. **1(2),** 150-158.

Rao KS, Pant R. 2001. Land use dynamics and landscape change pattern in a typical micro watershed in the mid elevation zone of central Himalaya, India. Agric. Ecosys. Environ. **86**, 113-123.

Rao BRM, Fayzee MA, Ravishankar T, Sujatha G, Venkataratnam L, Thammappa SS. 1997. Watershed development plan for sustainable development in tribal areas of Andhra Pradesh-a GIS approach. Proceeding of Remote Sensing for natural resources: A joint publication of ISRS and National Natural Resources Management System. 466-474.

Sarma K, Tripathi OP, Kushwaha SPS. 2006. Land use/land cover change analysis in coal mine affected areas in Jaintia hills district of Meghalaya, Northeast India using remote sensing and GIS techniques. Ind. J. Trop. Biodiv. **16(2),** 135-142.

Singh AK, Singh SS. 2010. Upper Hasdeo sub watershed status in Hasdeo river basin at Chhattisgarh. Proceeding of FIG Congress 2010, Sydney, Australia, 11-16 April 2010, 1-6.

Singh SS, Singh AK. 2011. Forest land cover variation and catchment status in the Bamni sub watershed of Hasdeo river basin in Central Ind. J. Biodiv. Ecol. Sci. **1(1),** 95-101.

Singh AK, Singh SS. 2011. Forest Vegetation Analysis and Land Cover Assessment in Tan Sub Watershed of Hasdeo River Basin, Chhattisgarh, India. Proceeding of FIG Working Week 2011: Bridging the Gap between Cultures. Marrakech, Morocco, 18-22 May 2011.

Smits PC, Dellepiane SG, Schowengerdt RA. 1999. Quality assessment of image classification algorithms for land cover mapping: a review and proposal for cost-based approach. Int. J. Rem. Sens. **20**(8): 1461-1486.

Steven MD, Malthus TJ, Baret F, Xu H, Chopping MJ. 2003. Intercalibration of vegetation indices from different sensor systems. Rem. Sens. Environ. **25,** 389-408.

Stoate C, Boatman ND, Borralho RJ, Carvalho CR, De Snoo GR, Eden P. 2001. Ecological impacts of arable intensification in Eur. J. Environ. Manage. **63,** 337-365.

Suryawanshi SL, Pendke MS. 2009. Development of land use/land cover and slope map using remote sensing and geographical information system techniques. IE (I) Jour-AG. **90**, 24-27.

Sun B, Zhou S, Zhao Q. 2003. Evaluation of spatial and temporal changes of soil quality based on geostatistical analysis in the hill region of subtropical China. Geoderma **115 (1-2),** 85-99.

Szillassi P, Jordan G, Van Rompaey A, Csillag G. 2006. Impacts of historical land use changes on erosion and agricultural soil properties in the Kali basin at Lake Balaton, Hungary. Catena **68(2-3),** 96-108.

Tucker CJ, Newcomb WW, Dregne HE. 1994. AVHRR data sets for determination of desert spatial extent. Int. J. Rem. Sens. **15**, 3547-3565.

Turner BL, Moss RH, Skole DL, (eds.). 1993. Relating land use and global land-cover change: A proposal for an IGBP-HDP core project. Report from the IGBP-HDP Working Group on Land-Use/Land-Cover Change. Joint publication of the International Geosphere-Biosphere Programme (Report No. 24) and the Human Dimensions of Global Environmental Change Programme (Report No. 5). Stockholm: Royal Swedish Academy of Sciences.

Zubair A. 2006. Change Detection in Land Use and Land Cover using Remote Sensing Data and GIS: A Case Study of Ilorin and its Environs in Kwara State: GIS Development Journal.