Assessment of Land Use/Cover Changes in Lower Tesua Subwatershed in Chhattisgarh through Remote Sensing and GIS

Ajay K Singh

Department of Forestry, Wildlife & Environmental Sciences, Guru Ghasidas University, Bilaspur, Chhatisgarh, INDIA

ABSTRACT

In this study, remote sensing and geographical information system (GIS) was used to assess spatial changes in the land use/cover (LULC)changes of lower Tesua subwatershed by using Landsat7 ETM+ data between 2000 and 2009. The LULC change detection analysis for year 2000 and year 2009 indicates that Agricultural land with crop and Agricultural land without crop have been increased 18.78 km^2 (13.22%) and 0.55 km^2 (0.38%). The settlement area has been also increased 5.38 km^2 (3.78%). But the Scrub land, Waste land, Water bodies and Standing trees have been found decreased 2.06 km^2 (1.45%), 11.56 km^2 (8.18%), 4.56 km^2 (2.66%) and 6.66 km^2 (4.32%) respectively. This study concluded that illegal logging, grazing, population increase and encroachment causes LULC changes in the subwatershed.

Keyword-- (GIS) was used to assess spatial changes in the land use/cover

I. INTRODUCTION

In the watershed, land use/cover pattern has changed from traditional subsistence farming to high yielding variety of cash crops, vegetables and fruits. These changes are primarily responsible for degrading the quality of environment and vegetation pattern in a system. Land use/cover and its changes is a key to many diverse applications such as environment, forestry, hydrology, agriculture and geology. The changes in LULC occur naturally in a progressive and gradual way, however sometime it may be rapid and abrupt due to anthropogenic activities (Giriraj et al., 2008). Remote sensing helps in acquiring multi spectral spatio-temporal data through space borne remote sensors. It provides multi-spectral, multi-temporal and multi sensor data of the earth surfaces (Lillesand and Kiefer, 2000; Choudhary, 1999; Diaz, 2006; Tzoraki, 2007; Latron, 2008). Digital image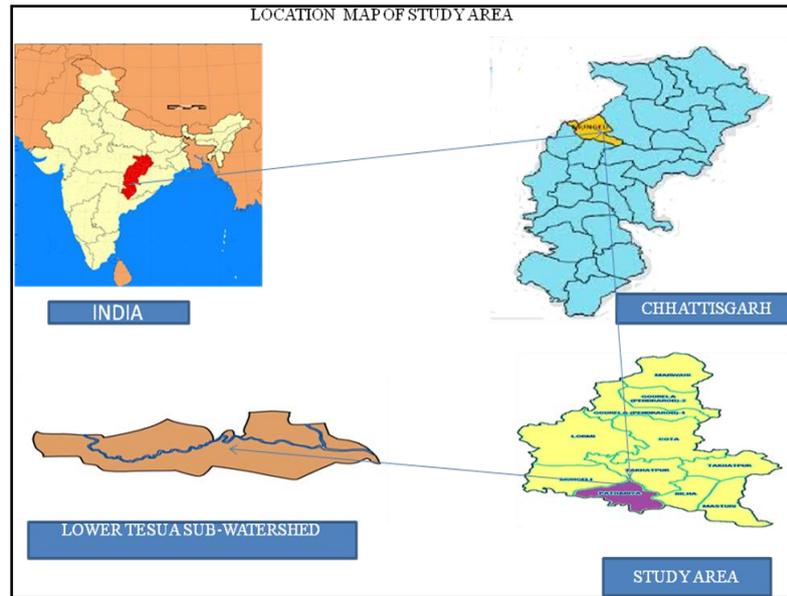 processing techniques helps in analysing the dynamic changes associated with the earth resources such as land and water using remote sensing data (Weng, 2001; Al-abed et al., 2005). Remote sensing and GIS play an important role in watershed management and helps in planning water resources development in the watersheds (Tripathi et al., 2010). One of the big advantages of using Remote sensing data for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain (Saraf, 1999).

This study made use of remotely sensed data and GIS techniques to evaluate qualitatively and quantitatively outcome of lower Tesua subwatershed land use/cover distribution. Obtaining results were compared with each other, visualised and analysed in Geographical Information System.

II. STUDY AREA

Lower Tesua sub watershed is situated in latitude $81^0 50^{'} 14.93$" E and longitude $22\ ^0 00'55.92$" Nin Pathariya tehsil of Mungeli district in Chhattisgarh, India (fig 1). Tesua river (a tributary of Maniyari river) originates from Setganga village 30 kms away from Mungeli and meets into Maniyari river near Bhakhuridih village in Mungeli district. River flows from west to east direction. The total area of the sub watershed is 142 km2. The most of the subwatershed area falls under an average elevation of 288m and extended between 13 villagesnamely, Bidbida, Lohda, Lakhuadih, Kacharbod, Piparlod, Hathkera, Torla, Bhakharidih, Sanwa, Salfa, Khapri, Dhamni and Sargaon.There is no any forest patch is found in the subwatershed. Paddy is the major crop cultivated in the area with pulses and vegetables. The aagriculture activities are limited to only kharifseason but some areas are irrigated through open wells and bore wells. . The official language in the area is hindi and chhattisgarhi.

Fig. 1. Location map of Lower Tesua subwatershed

The lower Tesua sub watershed experiences tropical monsoon type of climate receiving moderate to high rainfall. Rain fall occurs mostly in rainy season from mid June to mid September. The total rainfall from July to September varies from 962.5 to 1425.5 in mm.

The temperature varies according to the relief and elevation of the sub watershed. The temperature increases from February in whole sub watershed. January is the coolest month, the minimum monthly temperature is 11.2^0C and 30.3^0C is the maximum temperature recorded in the sub watershed. May is the hottest month, minimum monthly temperature is 18.1^0C and 47.3^0C is the maximum temperature recorded in the sub watershed. The soil of the sub -watershed is pre dominant residual. Fine loamy soil is found more than 45% area of the sub watershed Fine skeleton, Clay, Fine mixed soil are found as 30%, 20%, 5% area respectively.

III.   MATERIALS AND METHODS

The present study is based on secondary sources of information of the sub watershed area under different land use and were collected from statistical department of Pathariya block of Mungeli district. LULC change detection were analyzed by using satellite data of Landsat 7 ETM+ (path/row: 144/42) of year 2000 and 2009. The Survey of India topographic sheets no. 64-J/13 and 64- K/1 ofscale 1:50,000 has been used as a base reference map for the study. Preliminary information about the hydro-geomorphology, geology of the study area were collected through literature review which served the basis to carry out the reconnaissance in the study area. Ground truth verification was done by conducting various field trips in the study area for collecting information that is used either to corroborate or update the existing thematic data and to generate subsequent themes for decision making. Climate data like rainfall and temperature was collected from various meteorological stations located in the study area. The entire digital processing task was carried out using ERDAS Imagine software, while analysis work was carried out in ArcGIS environment. The study area was mosaic and generated from the georeferenced topographic maps. Base layers like sub-watershed boundary along with drainage and contours with 20 m interval were delineated from the topographic map mosaic. These base layers are later integrated for the computation of Drainage, Water Bodies, Agriculture, Road and LULC. Multi-temporal remote sensing images were georeferenced and rectified with the help of georeferenced topographic maps. Various radiometric and spectral enhancement algorithms were employed to remove the noise and to enhance the interpretability of the data. In order to cut the areas outside of the study area boundary the images were clipped using the basin boundary AOI extracted from the georeferenced topographic sheets. The remote sensing data then visually interpreted with the help of various visual interpretation indicators, like, shape, size, pattern, tone/color, texture and association. Based on a two level classification schema various land use and land cover feature classes have been interpreted and mapped accordingly. Subsequently, seven LULC classes viz; agriculture land with crop, agriculture land without crop, scrub land, waste land, water bodies, standing trees and settlement were computed for comparison analysis. Intensive field checks were conducted in the study area for ground truth verification.

IV.   RESULTS

Drainage pattern analysis:

The Tesua river has so many tributaries which eventually form an alternate drainage pattern. The drainage network within the sub watershed is delineated from the catchment area grid. The major tributaries are

perennial to semi perennial in nature and the rest of them are smaller and adventitious stream (fig 2). The subwatershed as different types of drainage pattern like

dendritic, superimposed, antecedent and trellis. The tributaries of sub watershed provide water to the main river system is distributed mostly both side of the river.
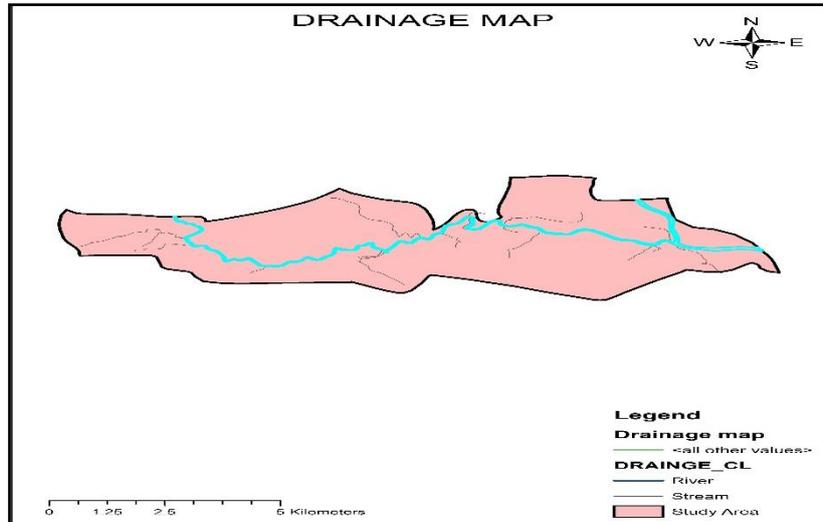

Fig. 2. Drainage map of lower Tesua subwatershed

Spatio- temporal LULC analysis

      Land use/cover defined as all land bearing vegetation, surface, water, settlement etc. The LULC of the subwatershed has been broadly categorized into seven classes viz; Agricultural land with crop, Agricultural land without crop, Water bodies, Waste

land, Standing trees, Settlement area and Scrub land. The final data of the Land Use/Cover status of Lower Tesua sub watershed in two years has given in table 1:

Table 1: Spatial and Temporal variation in LULC for year 2000 and 2009

LULC Classes	2000	2009	Change detection (2000-2009)	
	Area (in km2)			
			Area (in km2)	%age
Agricultural land with crop	38.41	57.19	(+) 18.78	(+)13.22
Agricultural land without crop	18.12	18.67	(+) 0.55	(+) 0.38
Scrub land	7.96	5.90	(-) 2.06	(-) 1.45
Waste land	23.03	11.47	(-) 11.56	(-) 8.14
Water bodies	26.90	22.34	(-) 4.56	(-) 3.21
Standing trees	14.57	7.91	(-) 6.66	(-) 4.69
Settlement	13.94	19.32	(+) 5.38	(+) 3.78
Total	142	142		

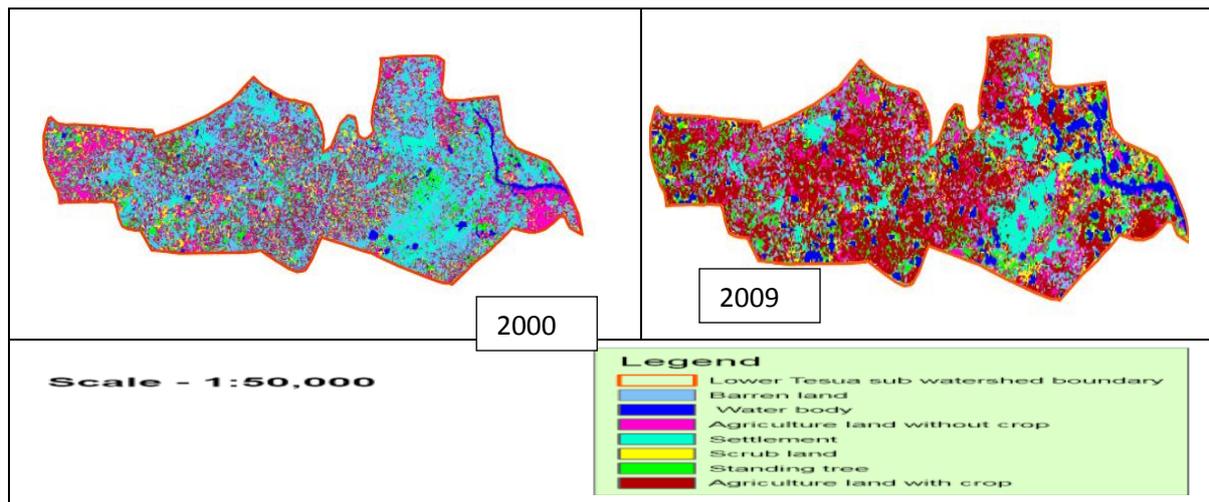Note: (+) sign indicates increase and(-) sign indicates decrease

Fig. 3. Supervised classification map of lower Tesua subwatershed

The table 1 and fig 3 summarizes the land use/ land cover of Tesua sub watershed. During 2000, the agriculture with crop area was recorded as 38.41 km^2 (27.04%), agriculture land without crop as 18.12 km^2 (12.76%), scrubland as 7.96 km^2 (5.6%), wasteland as 23.03 km^2 (16.12%), water bodies as 26.90 km^2 (18.3%), standing trees as 14.57 sq kms (9.85%) and settlement area as 13.94 km2 (9.81%). During 2009, the most extensive scrub land, wasteland, water bodies and standing trees area changed into agricultural land which covers 57.19 km2 (40.04%), followed by water bodies area of 22.34 km2 (15.64%), settlement area as 19.32 km2 (13.53%), waste land as 11.47 km2 (8.03%). The LULC change detection analysis for year 2000 and year 2009 indicates that Agricultural land with crop and Agricultural land without crop have been increased18.78 km^2 (13%) and0.55 km^2 (0.38%). The settlement area has been also increased 5.38 km^2 (3.72%). But the Scrubland, Waste land, Water bodies and Standing trees have been found decreased 2.06 km^2 (1.45%),11.56 km^2 (8.18%), 4.56 km^2 (2.66%) and 6.66 km^2 (4.32%) respectively.

V.   CONCLUSION

Watershed management is a mechanism that ensure land resources are preserved, conserved and exploited sustainably now and for future generation. The watershed management approach integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences. It is a continuous and participatory process that involves people and aim to improve their livelihoods. A watershed approach can be coordinating framework for management that attempts to focus public and private, community and individual efforts towards addressing high priority land use and water related issues within the hydro logically defined geographic area (FAO report, 2010). Lower Tesua sub watershed has play a vital role to shaping and supporting diverse cultures and professions. Specific characteristics of streams and river reflect an integration of countless physical and biological processes providing long-term influences of environmental conditions. Rainfall over the land surface provides input for recharging the soil with water, replenishing groundwater reservoirs and providing run-off in streams and rivers. The socio-economic condition of the local population of the sub watershed is completely depends on agriculture. Most of the population comes under poor living and there is no any alternative source of income is available for them. So, income and employment generation is the basic priority and challenge in lower Tesua sub watershed.

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