



Land use/ Land cover Change Detection in Auranga River Basin, Jharkhand

Chandrakesh Maury¹ and V.N. Sharma²

¹ Research scholar, Department of Geography, Banaras Hindu University,

² Professor, Department of Geography, Banaras Hindu University,

(Corresponding author's email: chandra120797@gmail.com)

Abstract

Land use is a man-made dynamic process in which human uses land resource to fulfil their various economic, social and cultural needs and at the same time it also provides a base for development. The proper management needed for sustainable development of land can improve the eco-system and its productivity in a particular geographical region. The present study focuses on spatio-temporal changes in land use and land cover pattern in Auranga river basin of Jharkhand using geospatial approach. Supervised classification technique was applied in this study to detect land use/ land cover changes. The main objective of the study is to analyse temporal change of land use/ land cover pattern during 1996, 2007 and 2018 using various dataset as well as other ancillary data. The result reveals both increase and decrease of the different land use/ land cover classes from 1996 to 2018.

Keywords: land use land cover, eco-system, supervised classification, accuracy assessment, Kappa Coefficient.

Introduction

Phyto-diversity is affected by natural and anthropogenic factors and in turn, plant diversity in the ecosystem gets reduced and destroy the native vegetation. Understanding the dynamics of land use /land cover is one of the key concepts in global environmental change research (Meyer et al. 1996; Alcamo et al. 1998; Lambin et al. 2001; Petit and Scudder 2001). Land use/ Land cover changes have direct influence on the vegetation morphology (Defries et al. 2002), biodiversity, land degradation and climatic conditions of an area. A rapid increase in human population during the past three centuries has significantly expanded cropland and grass land resulting in the loss of large areas of natural ecosystems and biodiversity (Myers 1980; Keys and McConnell 2005; Bouwman et al. 2006; Pongratz et al. 2008). Changes in land use followed by consequent transformation of land cover characteristics alter the interactions between the land surface and atmosphere (Kabat et al. 2004; Davin et al. 2007) that brings changes in climate. A major phenomenon of deforestation occurs due to land use/ a land cover change is the process of deforestation. Deforestation has many ecological, social and economic consequences

including loss of biological diversity. Large-scale deforestation can affect on the regular climatic conditions, especially on the rainfall patterns. In considering land use and land cover changes, this work highlights the direct and indirect drivers of changes such as socio-economic, biophysical and climatic factors. The objectives of this study are to analyse the patterns and dynamics of the land use/land cover and impact of human interaction in Auranga River basin.

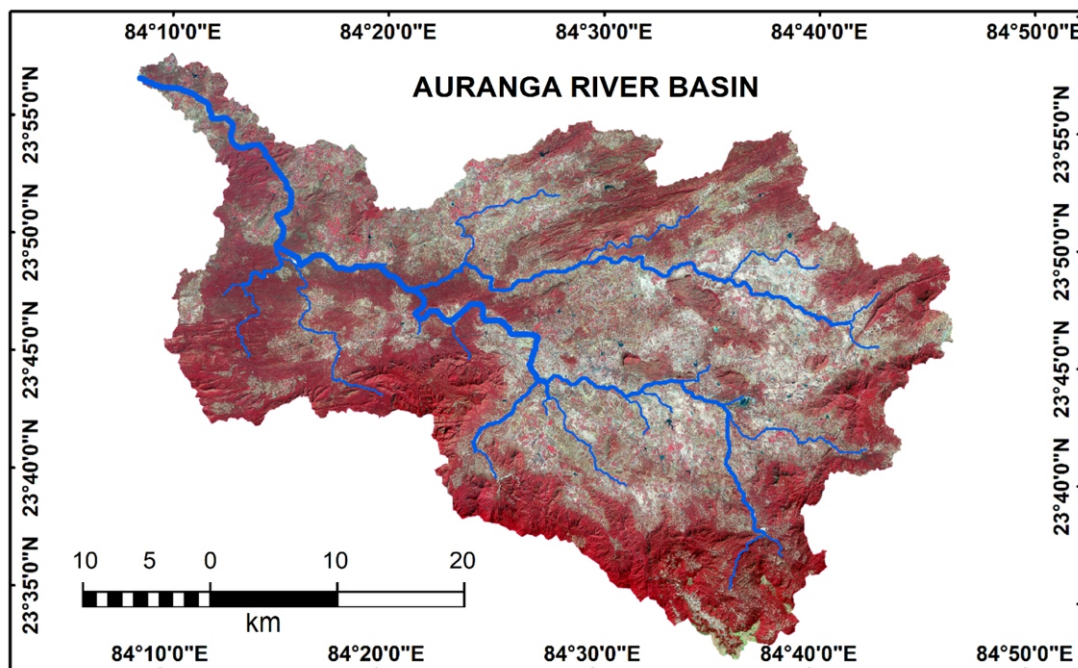


Figure 1: Location and extent of Auranga River Basin

Study area

The Auranga basin (23°35'N to 23°58'N latitudes and 84°08'E to 84°47'E longitudes) occupies a mid-western part of Chhotanagpur Highlands. The study comprises the main parts of Latehar District of Jharkhand. It forms the western most extension of stable Indian Peninsular Block and is separated from the Shillong Plateau by the Malda Gap. It is almost a parallelogram in shape, formed by the longer eastern and western sides and comparatively supporter of northern and southern contour parts. It lies between the water divides of Amanat valley of north-eastern and North Koel valley in south-western part of study area. The

present study area has been delineated with the help of river partings in the north by Satbarwa Range in southwest by the Murwai Range and north-east by Herhang Range. Its elevation varies from 200m to 1200m and its area is 1458.0 sq.km. The topography of the area is characterised with diversified features of the basin which includes a wide variety of geomorphological features. It is bounded by the administrative units of Lohardaga district in south, Chatara district in the north-east and Daltonganj district in north-western part of the study area.

Database and methodology

Geospatial approach is applied in this study

comprising large scale investigation based on satellite imageries. Data of geocoded imagery of February 1996 and February 2007 in form of FCC of LANDSAT-5, and February 2018 in form of FCC of LANDSAT-8, TM product with a standard colour combination of Blue, Green and Red (band combination 4,3,2) are used for the purpose. Google Earth data are also used for generating data about the area. This work has been done by digital image interpretation including digitizing in Arc Map 10.5 and Leica Geosystems ERDAS IMAGINE 2014. Various land use /land cover features (forest, cropland, fallow land, riverine, sandy area, water bodies, settlement) have been identified the basis of imagery (FCC's) with the help of elements of interpretation and interpretation keys. Supervised image classification and digitization of the features have been done satellite Imageries. Land use/land cover maps are prepared by visual image interpretation and annotation with the help of topographical sheets. Accuracy assessment has been done by ground truth validation.

Results and discussion

The land used / land cover classification is based on the colour/tone reflected on the scenes and proportion of their extent. The land use/land cover types are classified as fallows.

Dense forest

Dense forest can be identified by its brownish tone, irregular shape and rough texture in false colour composite imageries. The area of dense forest cover is usually associated with high relief presenting a prominent and distinct texture. It is difficult to identify the dense forest because there was rock impression on the image so dense forest was delineated including the rock impression. The area under the dense forest in 1996 was 57.12%, in 2007 was 34.24% and in 2018 was 31.38%.

Moderate forest

The hilly area having less vegetation is categorized under this class. Canopy cover was 20% to 25%. Moderate forest can be segregated from dense forest by the tonal different. These have a red colour interspersed with small white patches denoting deforested land. The Open forests were found in surrounding areas of dense forest. Area under this category in 1996 was 19.91%, in 2007 was 35.07% and in 2018 was 19.27%.

Barren land

This category of land use is generally seen in fringe of dense forest cover and settlements and covered less than one-third of its area with vegetation. Deserts, beaches, sand dunes, etc. are included in this category of land use. Very less area found under the barren land category in the study area. In 1996, 2007 and 2018 it was 0.23%, 0.43% and 0.75% respectively.

Crop land

These are the areas with standing crop as on the date of Satellite overpass. Cropped areas appear in bright red to red in colour with varying shape and size in a contiguous to non-contiguous pattern. They are widely distributed in different terrains; prominently appear in the irrigated area irrespective of the source of irrigation. It includes *kharif*, *rabi* and *zaid* crop lands along with areas under double or triple crops. Most of the area was seen covered under the crop land category. In the imageries of 1996, 2007 and 2018 the area under this category is measured 17.05%, 21.71% and 44.73% respectively. It denotes that agricultural area was expanded continuously by the farmers.

Fallow land

In another terms these are the lands, which are taken up for cultivation but are temporarily allowed to rest, un-cropped for one or more seasons, but not less than one year. Area under the fallow land category was 2.34% in 1996, 5.21% in 2007 and 2.47% in 2018.

Riverine sand area

Riverine area appears in white patches along the Auranga River in the form of false colour composite. Riverine sands are those that are seen as accumulations in the flood plain as sheets which are the resultant phenomenon of river flooding. It is resultant of terrain deformation due to water erosion which occurs widely in all agro-climatic zones. Gullies are formed as a result of localized surface run-off affecting the unconsolidated material resulting in the formation of perceptible channels causing undulating terrain. They are mostly associated with stream courses, sloping grounds with good rainfall regions and foothill

regions. These are the first stage of excessive land dissection followed by their networking which leads to the development of riverine land. Ravines are basically extensive systems of gullies developed along river courses. These were found in very less area under the sandbar that was 1.77% in 1996, 1.34% in 2007 and 0.45% in 2018.

Water bodies

This category comprises areas with surface water in the form of river, ponds lakes, tanks and reservoirs in the blue texture as regular shape and size. In streams there are major rivers named Auranga and other tributaries Sukri, Bagdagga, Ghaghri, Siramkhar, Gowa,

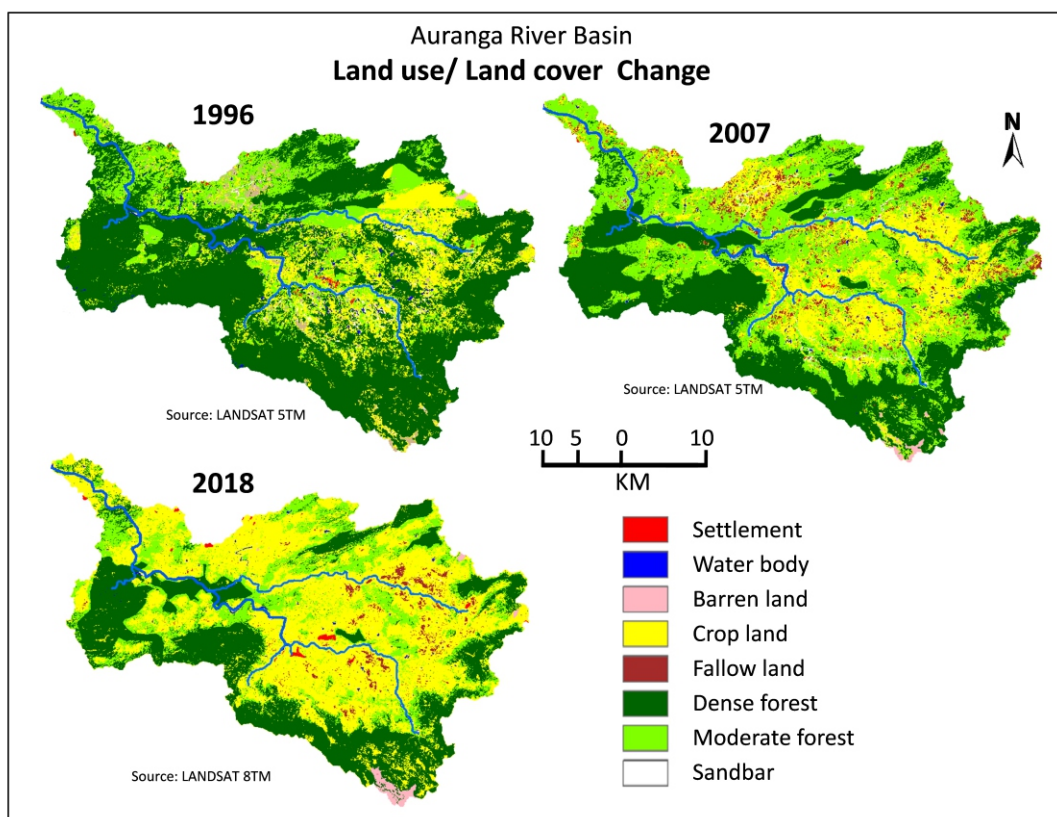


Figure 2: Spatio-temporal distribution of land use/ land cover in the study area

Source: Analysed by authors with the help of Arc Map 10.5 and Leica Geosystems ERDAS IMAGINE 2014.

Dhardhari, Jalma and Jawa River. The total area under this category was calculated 1.43% in 1996, 1.26% in 2007 and 0.88% in 2018 from imageries.

Settlement

It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication structures, utilities in association with water, vegetation and vacant lands. Latehar is the main compact settlement, situated near river Auranga in the center of the map that can be seen in skyblue tone. Several settlements are concentrated around river and

its tributaries due to availability of resources i.e. fertile land, good amount of water and forest. The area under this category was calculated 0.17% in 1996, 0.73% in 2007 and 1.28% in 2018 from imageries. From 1996 to 2018, area under settlement was increased by 1.10% (Table 2) due to increase in population.

Change in land use/land cover

The changes can be observed with the help of maps and Google earth images. Increasing agricultural land and decreasing forest are common phenomena that can be seen in the images. In 1996, high hill areas were covered by dense forest and the lower areas of mounts

Table 1: Total area under various Land Use/Land cover categories

Land Use / Land Cover Categories	Area 2018		Area 2007		Area 1996	
	km ²	%	km ²	%	km ²	%
Settlement	20.29	1.28	11.38	0.73	2.68	0.17
Water Bodies	13.68	0.88	19.60	1.26	22.25	1.43
Barren Land	11.68	0.75	6.61	0.43	3.50	0.23
Crop Land	694.94	44.73	337.26	21.71	264.55	17.03
Fallow Land	38.31	2.47	80.99	5.21	36.32	2.34
Dense Forest	484.34	31.18	531.93	34.24	887.38	57.12
Moderate Forest	299.32	19.27	544.86	35.07	309.35	19.91
Sandbar	6.93	0.45	20.88	1.34	27.48	1.77
Total	1553.49	100.00	1553.49	100.00	1553.49	100.00

Source: Computed by the author

lie under moderate forest. But now, area under dense forest is decreasing due to forest cutting. There was a continuous decrease in the area under dense forest from 1996 to 2018 due to the exploitation of forest resource in the region. But the same trend was not seen in the area under moderate forest. From 1996 to 2007 area occupied by moderate forest was increased by

15.16% (Table.2). Data reveal that some areas under dense forest faced deforestation and converted into moderate forest, but later on, due to the population pressure and overexploitation, moderate forests were also decreased by 15.81% from 2007 to 2018.

Land under crops was increased continuously from 1996 to 2018. The imageries

show that almost half of the region (44.73%) was dominated by agricultural land in 2018. Population again played a key role here in land use change. Moderate forest was cleared by human intervention and used for agricultural activities. Trend of increase was also found in case of barren land but the change was not as significant as in case of earlier two. During 1996 to 2007 2.88 % area in fallow land was increased, but in 2018 it was decreased because some land had become barren and some were converted into cropped land with the help of fertilizers and good irrigation facility. In 1996, total area under water bodies was 22.25 sq. km. that was decreased by 0.17% in 2007. In 2018, it

had been 13.68 square km with a decrease of 0.38%. Water bodies like ponds were shrinking in the area due to the overuse of water resource for agricultural and domestic uses. During 1996 to 2018 area of settlement was increased by 1.10% (Table.2) at the cost of moderate and dense forests.

Accuracy assessment

Accuracy assessment is used to evaluate the quality of information of land use / land cover maps generated from the remotely sensed data. It is more essential in digital image classification to verify classified maps by comparing the classification output with some ground reference data like, ground truth

Table 2: Decadal changes under the land use/land cover categories (in %)

LU/LC Class	(2007-1996)	(2018-2007)	(2018-1996)
Settlement	0.56	0.55	1.10
Water Bodies	-0.17	-0.38	-0.55
Barren Land	0.20	0.33	0.53
Crop Land	4.68	23.02	27.70
Fallow Land	2.88	-2.75	0.13
Dense Forest	-22.88	-3.06	-25.94
Moderate Forest	15.16	-15.81	-0.65
Sandbar	-0.42	-0.90	-1.32

Source: computed by the authors

collected from the field, aerial photographs and reference land use / land cover map obtained from secondary sources. The land use / land cover map of 2018 is verified with field collected data. Due to unavailability of ground data of 1996 and land use / land cover, the maps are verified with present data. The land use / land cover classification results are evaluated by employing accuracy assessment technique provided in ERDAS Imagine 2014 software. The errors matrices are plotted as cross-tabulation of information obtained from classified maps versus the GPS data. Hence, overall accuracy, user's and producer's

accuracy and the kappa statistic are estimated from the error matrices (Table 3,4, and 5).

Conclusion

Changes in the land use / land cover of Auranga river basin was caused by mainly anthropogenic intervention. The expansion of the agricultural land, reduced forest cover, increased settlements, shrinking water bodies, increased barren land and other changes are observed by the interpretation of the imageries. Accuracy assessment shows 87.50 % accuracy and kappa coefficient is 0.8571 in 2018, while in 2007 over all accuracy has been calculated 87.50 % kappa coefficient 0.8571, in 1996 over

Table 3: Accuracy assessment (2018)

	Settlement	Water Bodies	Barren Land	Crop Land	Fallow Land	Dense Forest	Moderate Forest	Sandbar	Total (User)	User Accuracy (%)
Settlement	12	0	0	0	0	0	0	0	12	100.00
Water Bodies	0	10	0	0	0	1	1	0	12	83.33
Barren Land	0	0	11	0	0	1	0	0	12	91.67
Crop Land	0	0	0	9	0	1	2	0	12	75.00
Fallow Land	0	0	0	1	11	0	0	0	12	91.67
Dense Forest	0	0	0	1	0	10	1	0	12	83.33
Moderate Forest	0	0	0	0	0	0	12	0	12	100.00
Sandbar	0	1	0	0	2	0	0	9	12	75.00
Total (Producer)	12	11	11	11	13	13	16	9	96	
Producer accuracy (%)	100.00	90.91	100.00	81.82	84.62	76.92	75.00	100.00		
Overall accuracy	87.50%									
Kappa coefficient	0.8571									

Source: Computed by the authors

Table 4: Accuracy assessment (2007)

	Settlement	Water Bodies	Barren Land	Crop Land	Fallow Land	Dense Forest	Moderate Forest	Sandbar	Total (User)	User accuracy (%)
Settlement	11	0	0	0	0	0	1	0	12	91.67
Water Bodies	0	9	0	3	0	0	0	0	12	75.00
Barren Land	0	0	9	2	0	0	1	0	12	75.00
Crop Land	0	0	0	12	0	0	0	0	12	100.00
Fallow Land	0	0	0	0	12	0	0	0	12	100.00
Dense Forest	0	0	0	0	0	12	0	0	12	100.00
Moderate Forest	0	0	0	0	0	1	11	0	12	91.67
Sandbar	0	0	0	2	1	0	1	8	12	66.67
Total (Producer)	11	9	9	19	13	13	14	8	96	
Producer accuracy (%)	100.00	100.00	100.00	63.16	92.31	92.31	78.57	100.00		
Overall accuracy						87.50%				
Kappa coefficient						0.8571				

Source: Computed by the authors

all accuracy is 75.0 % and kappa coefficient is 0.7143. It shows that the analysis is reliable because maps are prepared in the satisfactory range of kappa coefficient.

Land use / land cover changes, identify several problems in Auranga river basin mainly related with land resource, forest resource and water resource. Therefore, these resources should be considered in the planning. Agriculture is the dominant land use in the

region followed by forest cover. Forest occupies 50.45% of the total area but has decreasing trend due to expansion in agricultural area because existing land is losing its fertility. Therefore, it is essential to manage the fertility of cultivable land. This will prevent the land from being infertile and barren and also prevent deforestation. Area is rich in forest resource so there is need of conservation for sustaining the ecosystem of the area. Very less

Table 5: Accuracy assessment (1996)

	Settlement	Water Bodies	Barren Land	Crop Land	Fallow Land	Dense Forest	Moderate Forest	Sandbar	Total (User)	User Accuracy (%)
Settlement	7	0	0	1	0	0	4	0	12	58.33
Water Bodies	0	7	0	1	0	0	3	1	12	58.33
Barren Land	0	0	9	1	2	0	0	0	12	75.00
Crop Land	0	1	0	11	0	0	0	0	12	91.67
Fallow Land	0	0	1	1	9	0	0	1	12	75.00
Dense Forest	0	0	0	0	0	9	3	0	12	75.00
Moderate Forest	0	0	0	1	0	0	11	0	12	91.67
Sandbar	0	0	0	3	0	0	0	9	12	75.00
Total (Producer)	7	8	10	19	11	9	21	11	96	
Producer accuracy (%)	100.00	87.50	90.00	57.89	81.82	100.00	52.38	81.82		
Overall accuracy						75.00%				
Kappa coefficient						0.7143				

Source: Computed by the authors

percentage of area covered by settlements shows a rural environment. Rural infrastructure such as transportation, residential facility and agro based industries on barren land can be planned for the development of the area. In order to conservation of water resource, water body should be protected from pollution and siltation. Thus, analysis of land use/land cover may provide a base for the consideration of regional development of Auranga River basin.

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