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Land Use Land Cover Change Analysis Using Remote Sensing and GIS: A Case Study of Nagina Tehsil, Uttar Pradesh, India

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Abstract
The man environment interaction leads to certain desirable as well as undesirable changes. LULC (Land use/land cover) is an important component to monitor and simulate these changes. In this paper an attempt has been made to study the changes in LULC in Nagina Tehsil (Administrative unit of a district) over the period of fifteen years (2000-2015). The Study has been done through remote sensing approach where two time series data were used for supervised classification. For accuracy assessment classification error matrix was performed. Change detection between both the images for all the land use and land cover classes was computed. The study area is characterised with a decrease in forest area and an increase in agriculture and built-up area as a result of increasing population. The major change (-30.4%) identified, in the study, was in forest area followed by built-up area (+20.8). The present degree at which the forests are depleting will pose serious stress on the ecology, therefore, proper land use planning for effective management of forest resource is necessary for sustainable development of Nagina tehsil.

Keywords
Land use, land cover, Remote sensing, GIS, Nagina

I. Introduction

Population growth along with economic development have triggered rapid change to earths land cover over the last two centuries, the rate of this change is tend to increase in the future also (Ingram et al. 2012) Land cover change can affect the ability of land to sustain human activities. The rapid urbanization and pervasive LULC (Land use/land cover) change that are occurring in developing countries have been attracting increasing attention of scientific research community for substantive study of these changes (Dewan and Yamaguchi, 2009; Geymen and Baz, 2008)

Land cover change is one of the most important components of global change (Lambin et al., 2001) and affects many parts of human environment systems (Chase at al. 1999). The livelihoods are thereby affected by the changes in the condition and composition of the land cover (Vitousek et al. 1997). LULC change accompanied with natural/human modifications have resulted in deforestation, bio-diversity loss, global warming and increase of natural disasters (Dwivedi et al. 2005; Mas et al. 2004; Zhao et al. 2004) Therefore, available data on LULC changes can provide critical input to decision making of environmental management and planning the future (Prenzel 2004)

Conventional land use mapping methods are labour intensive, time consuming and are done relatively infrequently. In a rapid changing environment these maps soon become outdated. In fact according to (Olorunfemi, 1983) traditional methods of surveying don't provide adequate information for monitoring changes and time series analysis. The satellite remote sensing techniques and approaches that have been developed in recent years have added a new dimension to the understanding of these changes. Remote sensing techniques have been useful in the quantification of land use changes, especially from arable land to unproductive land (Milesi et al, 2003). Spatio-temporal dynamics in LULC can be monitored at regular intervals, using multi-temporal remote sensing satellite data such as Landsat TM images. Satellite remote sensing has been widely applied in detecting LULC change (Soulard and Wilson, 2013; Weng 2001). GIS provides a flexible environment for collecting, storing, displaying and analysing digital data necessary for change detection. Therefore remote sensing integrated with Geographical Information System (GIS) has become a very useful tool for the management of dynamic agricultural resource (Adeniyi, 1993; Bailey and Boryan, 2010) especially on the spatial distribution of LULC changes over large areas.

II. Study Area

Nagina is a sub division of district Bijnor (Fig.1). It is located in the western part of uttar Pradesh state between 29.45°N 78.45°E. The total geographical area accounts for 1269 sq km. The area supports a varied topography having an average elevation of 282 metres. It is one of the agriculturally prosperous tehsil of district Bijnor. The mainstay of the economy of the study area is agriculture. The cropping pattern of the district includes sugarcane, wheat and rice as main crops. The total population of the district is 569375 with a population density of 448 inhabitants /sq km (2015). The average annual temperature ranges between 240°C to 27°C. The average annual rainfall of the tehsil remains less than 60 cms (Indian Meteorological Department, 2013). Net irrigated area of the district accounts for 992 km^2. Different sources of irrigation like tube wells and canals are used for growing crops.

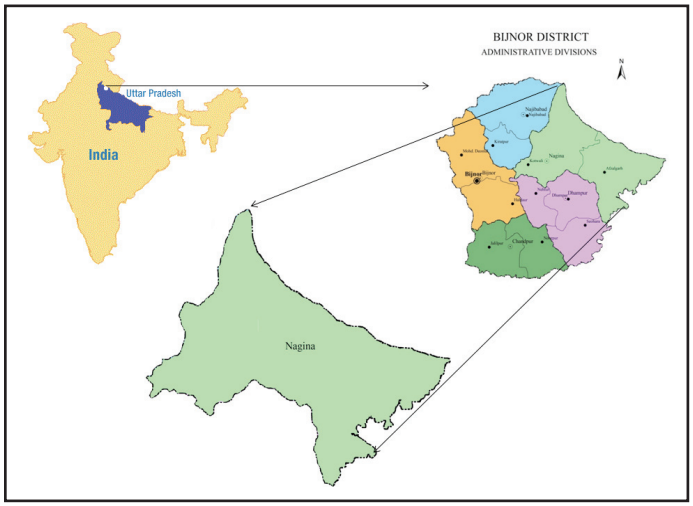

Fig. 1: Location map of the study area.

III. Materials and Methods

To identify the changes in the LULC multi-date satellite images were used that included two sets of Landsat-TM images. Table1 shows the specifications of data sources used. The administrative boundary of the study area was demarcated from Survey of India Topographical sheets on the scale of 1:250,000 and overlaid on the image to extract the entire pixels of the study area.

Table 1: Spatial data sources

Data	Month Of Observation	Spatial Resolution/ Scale
Landsat 5 TM	2000—February	30 m (Band 1-5)
Landsat 5 TM	2015—February	30m (Band 1-5)
SOI Topo-sheet	2003	1:250,000

Landsat 5 TM sensor offers spatial resolution of 30 meter with a swath width of 185 km which provide appropriate spectral characteristics for agriculture monitoring. This sensor has a repeat coverage of 16 days which is very useful for LULC analysis. The 30 meter spatial resolution is sufficient for the accurate identification of land use types (Mueller R, 2004). Landsat offers seven spectral bands which acquire data in the visible green, visible red, near infrared (NIR), short wave infrared (SWIR) and thermal infrared bands.

Supervised classification method was applied to access temporal LULC of Nagina. On the basis of the reflectance, samples pixels were selected from the image. Some pixels were wrongly classified due to the similarity of brightness value. These errors were minimized by the recoding of pixel of such locations on the basis of GPS data. Accuracy of supervised classification was assessed by analysing error matrix. The matrix is a means of reporting site-specific error (Campbell, 1987). The use of an error matrix has been recommended in the literature (Congalton, 199; Hasmadi M, 2009) to validate remotely sensed data against known ground data. (Story and Congalton, 1986) pointed out that a non site specific error assessment can lead to misleading results.

IV. Result and Discussion

A. Land use land cover change

Nagina was classified into five LULC classes. The classes used were (1) Agriculture (2) Built-up (3) Forest (4) Water body and (5) River bed. There has been a considerable change in the LULC of Nagina *tehsil*. Nagina is a hilly area with forest as the most abundant natural resource. The findings of the present investigation are shown in table 2 and fig. 2&3. The analysis of spatial change indicates that the expansion of agricultural land is taking place at the cost of forest land and other plantation. Day by day forest land is converted to built-up and agricultural land. The area under forest has decreased from 25.4 per cent in 2000 to 17.7 per cent in 2015 thus registering a decrease of 30.4 per cent. Built-up land includes settlements, roads and canals. The study points out that there has been an increase in Built-up area from 1.5 per cent in 2000 to 1.8 per cent in 2015 there by registering an increase of 20.8 per cent. Agriculture land occupies substantial area. Sugarcane, rice and wheat are the major agricultural crops. The percentage of area under agriculture has shown a gradual rise from 70.7 per cent in 2000 to 78.1 per cent in 2015, indicating an increase of 10.5 per cent. Water Bodies included lakes, reservoirs, ponds, rivers and streams. Major water bodies of the study area include river *Ramganga,* river *Khoh* and *Gadla* Lake. The area under water body was 1.5 per cent in 2000 which increased to 1.6 per cent in 2015 thereby representing an increase of 3.9 per cent. Whereas there has been a meagre decrease of 3 per cent in the river bed area.

Table 2: Temporal land use land cover change in Nagina

Class	Area in 2000		Area in 2015		Change in area	
	Hectares	Percentage	Hectares	percentage	Hectares	Percentage
Agriculture	89708.7	70.7	99092.1	78.1	9383.4	10.5
Forest	32254.2	25.4	22441.6	17.7	-9812.6	-30.4
Built-up	1865.0	1.5	2252.2	1.8	387.3	20.8
River body	1956.7	1.5	2033.7	1.6	77.0	3.9
River bed	1172.7	0.8	1137.6	0.9	-35.0	-3.0

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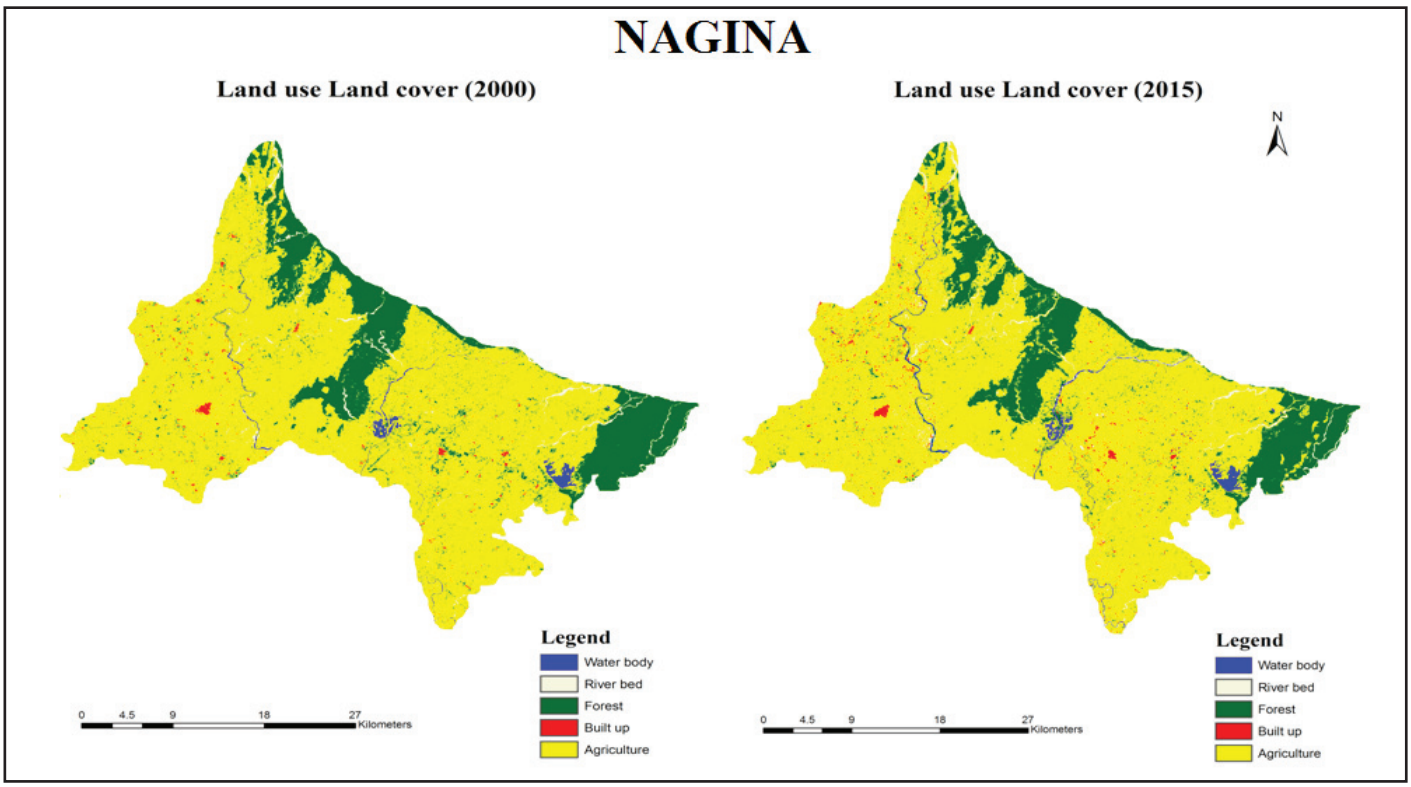

Fig. 2: Spatio-temporal LULC of Nagina *tehsil.*

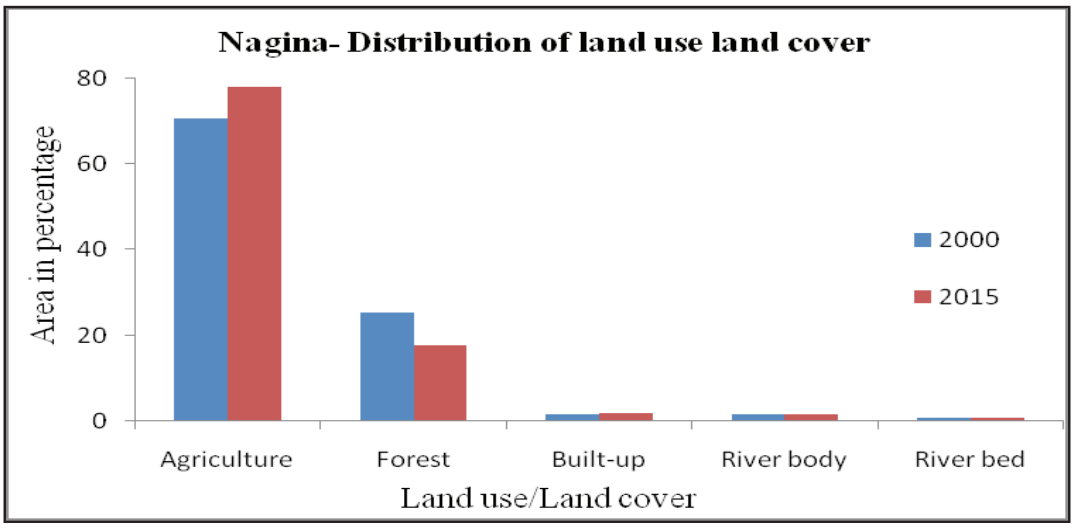

Fig 3: Distribution of LULC during the two periods in the study area.

The change matrix of LULC classes has been demonstrated in table 3. The analysis of the table shows that about 9815 hectares of forest land has been converted in to agricultural land. The built-up area has shown an increase of 387 hectares out of which 357 hectares agricultural area has been utilised. About 468 hectares of river bed area is also converted in to agricultural area. No major change is seen in case of water body. It should also be noted that classes having change less than 20 hectares were not considered significant as this can be attributed to the errors in classification. Error matrix was used to carry out the accuracy assessment of supervised classification. The matrix was calculated on category by category basis.

Table 3: Change matrix of land use land cover change in Nagina *tehsil*

Class	Agriculture	Forest	Water body	Built-up	River bed	2000
Agriculture	88798.1	268.4	65.1	357.7	219.4	89708.7
Forest	9815.0	22087.5	24.3	12.0	315.5	32254.2
Water body	10.9	4.9	1928.6	2.1	10.2	1956.7
Built-up	0.0	0.0	0.0	1865.0	0.0	1865.0
River bed	468.1	80.8	15.8	15.4	592.6	1172.7
2015	99092.1	22441.6	2033.7	2252.2	1137.7	126957.3

The overall accuracy was computed by dividing the total number of correctly classified pixels by the total number of reference pixels. The producer accuracies were calculated by dividing the number of correctly classified pixels in each category by the number of training set pixels of that category (the column total). User accuracies were computed by dividing the number of correctly classified pixels in each category by the total number of pixels classified in that category (the row total). Table 4&5 shows the percentage of accuracy of supervised classification in the year 2000 and 2015. Overall accuracy of LULC classification in the year 2000 was 94%, while overall accuracy in 2015 was calculated as 95%. The results thus indicate a good agreement between thematic maps generated from image and the reference data. Thus we can say that the pixels classified in all the five categories were very much closer to accuracy.

Table 4: Accuracy assessment of supervised classification (2000)

Classes	Water Body	Built-up	River Bed	Forest	Agriculture	Row Total	**User's Accuracy %**
Water Body	843	0	28	0	0	871	**97**
Built-up	0	1052	210	0	8	1270	**83**
River Bed	18	119	1513	0	8	1658	**91**
Forest	0	0	0	1020	84	1104	**92**
Agriculture	0	0	0	98	559	657	**85**
Column Total	861	1171	1751	1118	659	5560	
Producer's Accuracy %	98	90	86	91	85		90

** Overall accuracy calculated from diagonal total i.e. 4987*

Table 5: Accuracy assessment of supervised classification (2015)

classes	Water Body	Built-up	River bed	Agriculture	Forest	Row Total	**User's Accuracy %**
Water Body	1027	0	10	0	0	1037	**99**
Built-up	3	469	54	0	0	526	**89**
River bed	120	35	1079	0	0	1234	**87**
Agriculture	0	0	4	454	17	475	**96**
Forest	0	0	0	87	1045	1132	**92**
Column Total	1150	504	1147	541	1062	4404	
Producer's Accuracy %	89	93	94	84	98		93

** Overall accuracy calculated from diagonal total i.e. 4074*

The increase in population has a direct impact on the LULC change (Cohen, 1995) Population growth from 2001 to 2015 has significantly affected the LULC of the study area. The total population of Nagina increased from 412,171 in 2001 to 3569,375 in 2015 and thus registering an annual growth rate of 2.54 per cent. Table 6 reveals the steady change in demography from rural towards urban character. In 2001 the percentage of rural population was 71.43 per cent and which came down to 66.79 per cent in 2015, where as the percentage of urban population in 2001 was 28.57 per cent which increased to 33.21 per cent in 2015. The population density of the district also increased from 324 to 448 persons/km^2. A need to increase living area was felt, consequently agricultural area was converted into built up area.

Table 6: Demographic characteristics of Nagina *tehsil*

year	**Total Population**	**Urban Population**	**Rural Population**	**Percentage Urban**	**Percentage Rural**	**Density**
2001	412171	117757	294414	28.57	71.43	324
2011	516862	162398	354464	31.42	68.58	407
2015*	569375	189089	380286	33.21	66.79	448

Source: Census of India 2001, 2011 and authors estimation*

On the other hand more land is required for agriculture to feed the increasing population, thus forest was cleared and intensive cropping methods were applied to increase the agricultural production. The increase in agricultural area further supports the view that economic growth and population increase has accelerated land use in Nagina during this period.

V. Conclusion

The dynamic land use system undergoes significant changes with the changing socio-economic and natural environment. These changes are largely related either with the external forces or the pressure within the system. The present study shows the extent of LULC change in Nagina *tehsil* during 2000-2015 as a consequence of natural increase in population and migration from rural to urban areas. Forests have been converted into agriculture and built-up basically to fulfill ever-increasing demand of food and shelter. The depleting forests pose a serious threat to natural ecosystem, through accelerated soil erosion and reduction in ground water recharge. The increase in agricultural land is an encouraging trend despite occurring at a slower rate, however emphasis should be

given to agricultural intensification rather than clearing forests for agricultural use. It is, therefore, essential that planners and policy makers evaluate and monitor LULC changes from time to time in order to ensure that this transition does not harm the man environment relation.

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