

# Change Detection Analysis of Land Use/Land Cover in Aligarh District Using RS and GIS Techniques

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## ABSTRACT

Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use/land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. In this paper an attempt has been made to analysis of land use/land cover change in Aligarh district using geospatial technologies. Landsat 5 imageries of 1996 and 2011 have been used for analysis of land use/land cover. Supervised classification has been performed to delineate the seven classes, i.e. built-up land, agricultural land, fallow land, tree plantation, water bodies, wet lands and sandy area. The study of fifteen years shows that there have been tremendous changes in classes of land use/land cover. The built-up land has recorded a tremendous increase during these fifteen years from 2.59 percent in 1996 to 6.85 percent in 2011. The agricultural land also recorded positive changes whereas other classes registered negative growth in study region. This can be attributed to the sporadic growth of population and resulting expansion of agricultural activities.

## 1. Introduction

Land is the most important natural resource of the country. The proper use of land according to its capability is a matter of utmost concern ensuring the future need of the nation. The responsibility of the present generation is to use this vulnerable resource in such a manner that it could be safe for future generations.<sup>1</sup> Land use is a combined result of the natural set-up and human dynamism within the socio-economic set-up and technological development. The land use of a country at any particular time is determined by the physical, economic and institutional framework taken together.<sup>2</sup> Land cover is basic parameter which evaluates the content of earth surface as an important factor that affects the condition and functioning of the ecosystem. Land cover is therefore a fundamental component of global ecosystem one, that humans rely upon. The human beings obtain their basic and essential needs from the environment, so they have been modified the land. There are a number of factors such as social, economic and technical factors that affect the land use pattern over time and space. The change in land use and land cover has become an important component in current strategies for managing natural resources and environmental changes.<sup>3</sup> It also provides the information for managing dynamics of land use and meeting the demands of increasing human population. Land use/land cover is very essential for better understanding of land cover dynamics during a known period of time having sustainable management. In this paper, an attempt has been made to analyse the pattern of land use/land cover change in Aligarh district between 1996 and 2011.

## 2. Materials and methods

Toposheets of 1975, Survey of India on a scale of 1:50,000 have been used for delineation of the study area. Landsat 5 imagery for land use/land cover in the year of 1996 and 2011 has been downloaded from USGS/Earth explorer. These two images were taken on 8 February 1996 and 1 February 2011 with sensor mode SAM and BUMPER having WRS Path/Row 146/041 respectively.

The base map has been prepared from the Survey of India topographic sheets with the help of Arc-GIS 9.3 software assigning UTM, WGS 1984, 43° N zone projection systems and after that, the map has been geo-referenced and rectified. The geo-referenced map was subset from the Landsat imageries from USGS/Earth Explorer with the help of Erdas Imagine 9.3 software. After that, supervised classification method was used to avoid misclassification of land use/land cover with ground verification. Land use/land cover has been classified into major seven classes, i.e. built-up land, agricultural land, fallow land, tree plantation, water bodies, wet lands and sandy area according to study area based on National Remote Sensing Agency Scheme of classification. Thereafter, change matrix was run to assess the land use/land cover change during 1996 to 2011. Simple percentage method has been used to calculate the pattern and changes of land use/land cover.

## 3. Study Area

Aligarh district is located in the central part of the Ganga - Yamuna Doab region of Western Uttar Pradesh. It lies between latitudes 27°34' N and 28°11' N and between longitudes 77°29' E and 78°38' E. The total geographical area of the district is 3650 square kilometers. It is bounded by the district of Etah in the East, Mathura in the West, Bulandshahr in the North and Hathras in the South. The total population of the district accounted for 29,92,286 persons (Rural 2,456,698 persons and Urban 1,217,191 persons) and the population density in the region is 1,007 persons per km square (Census 2011) which is more than the state average. The district has been divided into five *tehsils*, namely Atrouli, Ghabana, Khair, Koil and Iglas. These *tehsils* are further subdivided into twelve blocks. They are Atrouli, Gangiri, Bijauli, Jawan, Chandaus, Khair, Tappal, Dhanipur, Lodha, Akrabad, Iglas and Gonda Aligarh district is made-up of fertile alluvium which is remarkable for its uniformity and a leveled surface and the region enjoys a tropical monsoon climate.

#### 4. Result and Discussion

##### LAND USE/ LAND COVER IN ALIGARH DISTRICT (1996-2011)

The study was carried out for fifteen years (from 1996 to 2011) in order to analyze the changes in land use. The share of various land use categories along with the total geographical area are shown in Table 1 and Figures 1 and 2. The change matrix Table 2 shows the movement of land between land use classes.

##### **Built-up Land**

Built-up land is an area of human habitation developed by non-agricultural uses, i.e. settlements, buildings, industrial area, highways, transportation and communication, other civic facilities and amenities. It is represented by the red colour on the imageries. It is evident from Table 1 that the area under built-up land was reported as 9507.77 hectares which was 2.59

percent to the total geographical area in 1996 and 25154.33 hectares which was 6.85 percent to the total geographical area in 2011. The remarkable growth has been observed under built-up land, i.e. an increase of 4.26 percent during 1996 to 2011. This remarkable growth of built up land has been recorded due to conversion of agricultural lands into urban areas and the cutting down of trees for the construction of shops, restaurants, dhabas along the roads and highways. Vacant land has been also converted into settlements around the city due to excessive pressure of population on land.

It is clear from Table 2 that a total of 9905.54 hectares of agricultural lands were transformed into the built-up land category. An important area under tree plantation, i.e. 1073.18 hectares was also converted into built-up land. Tree plantation appears more along the roads in the year of 1996 whereas built-up areas are seen along the roads in the year of 2011.

**Table: 1 Land Use/ Land Cover of Aligarh District, (1996 and 2011)**

Land Use/ Land Cover Classes	1996		2011		Changes from 1996 to 2011
	Hectares	Percentage	Hectares	Percentage	
<b>Built-up Land</b>	9507.77	2.59	25154.33	6.85	<b>4.26</b>
<b>Agricultural Land</b>	289428.20	78.86	300101.68	81.77	<b>2.91</b>
<b>Fallow Land</b>	7482.02	2.04	3103.21	0.85	<b>-1.19</b>
<b>Vacant Land</b>	31616.33	8.61	12601.41	3.43	<b>-5.18</b>
<b>Tree Plantation</b>	14441.73	3.93	12405.52	3.38	<b>-0.55</b>
<b>Water Bodies</b>	1860.75	0.51	2078.32	0.57	<b>0.06</b>
<b>Wet Land</b>	11381.98	3.10	8735.44	2.38	<b>-0.72</b>
<b>Sandy Area</b>	1300.34	0.35	2839.21	0.77	<b>0.42</b>
<b>Total</b>	367019.12	100.00	367019.12	100.00	<b>0.00</b>

Source: Landsat 5 data, 1996 and 2011

**Table 2 - Change Matrix of Land Use/Land Cover in Aligarh District (1996-2011)**

Classes	Built-up Land	Agricultural Land	Fallow Land	Vacant Land	Tree Plantation	Water Bodies	Wet Lands	Sandy Area
Built-up Land	<b>9271.74</b>	79.71	0.00	55.60	92.84	3.00	4.88	0.00
Agricultural Land	9905.54	<b>265482.85</b>	2889.48	4568.21	4950.70	67.22	1285.99	278.21
Fallow land	0.00	7130.82	<b>213.73</b>	0.00	137.47	0.00	0.00	0.00
Vacant Land	4073.62	18519.41	0.00	<b>7710.50</b>	652.79	33.00	472.75	154.26
Tree Plantation	1073.18	6376.03	0.00	263.68	<b>5695.21</b>	99.63	918.32	15.68
Water Bodies	17.21	175.49	0.00	3.42	119.80	<b>1151.82</b>	277.98	115.03
Wet Lands	796.56	2200.30	0.00	0.00	753.83	584.93	<b>5728.17</b>	1318.19
Sandy Area	16.48	137.07	0.00	0.00	2.88	138.72	47.35	<b>957.84</b>

Source: Computed by Researcher on the basis of Landsat 5 data 1996, 2011

##### **Agricultural Land**

Agricultural land is primarily used for cultivation of different crops including cereals, oilseeds, pulses and other horticulture and commercial crops. It is actually crop land. It is shown by the yellow colour on the imageries. Although agricultural land has been lost a large part of its area in Aligarh District, it has recorded positive growth during 1996-2011. It increased from 289428.20 hectares (78.86 percent to the total geographical area) in 1996 to 300101.68 hectares (81.77 percent to the total geographical area) in 2011. Agricultural land was increased by

2.91 percent during fifteen years. The main reason behind it is that the converted area of vacant land into agricultural land is more than the area of agricultural land converted into built up land. It is observed from Table 2 that 9905.54 hectares and 4568.21 hectares of agricultural land have been changed into built-up land and vacant land respectively. It was studied that agricultural land has been converted into vacant land around Aligarh city and other towns of Aligarh District. Agricultural land has also been changed into brick-kilns in the south-west part of Gangiri block and north-east of Akraabad block. About 150

brick-kilns have been located in agricultural land. A vast area of crop land has been lost in this area. The reason for it is availability of water from Kali river and soil is also suitable for making bricks.

Table 2 further shows that the total area lost by agricultural land is 23945.35 hectares whereas the total area achieved by the agricultural land is 34618.83 hectares out of which 18519.41 hectares area has been gained from vacant land and 6376.03 hectares from tree plantation. The increased area of agricultural is more than the reduced area, due to this reason; agricultural land recorded positive growth but there is no space for increasing agricultural land because vacant land has almost disappeared.

**Fallow land**

The National Remote Sensing Agency (1988-89) defined fallow land as “agricultural land which is taken up for cultivation but is temporarily allowed to rest un-cropped for one or more seasons, but not less than one year. These lands are particularly those which are seen devoid of crops at the time when the imagery is taken of both seasons.”

Out of the total geographical area of the Aligarh District, fallow land contributed only 2.04 percent in 1996 and 0.85 percent in 2011. It was declined by 1.19 percent from 1996 to 2011. The change matrix Table shows that 7130.82 hectares of fallow land has been changed into agricultural land and 2889.48 hectares agricultural land has been converted into fallow land by 2011. There are 137.47 hectares of fallow land which has been transformed into tree plantations.

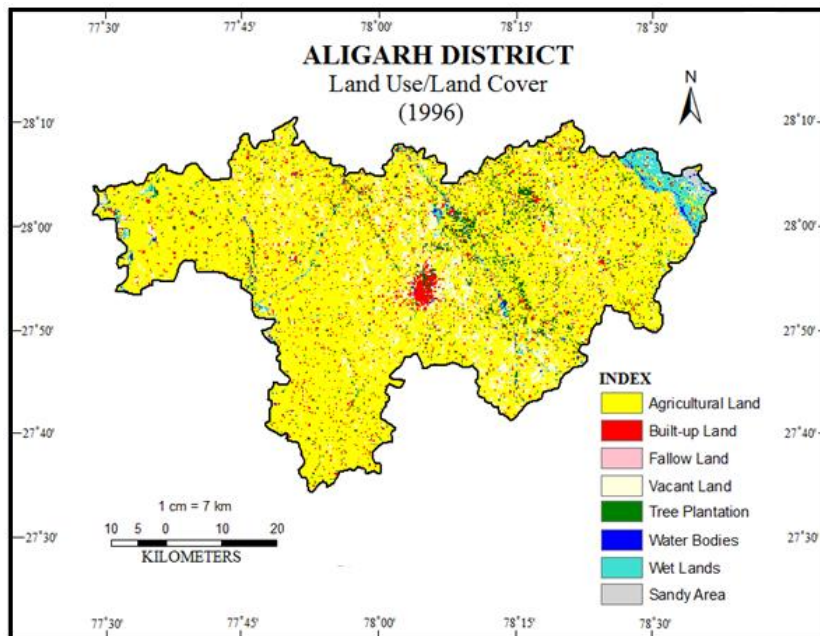


Figure 1

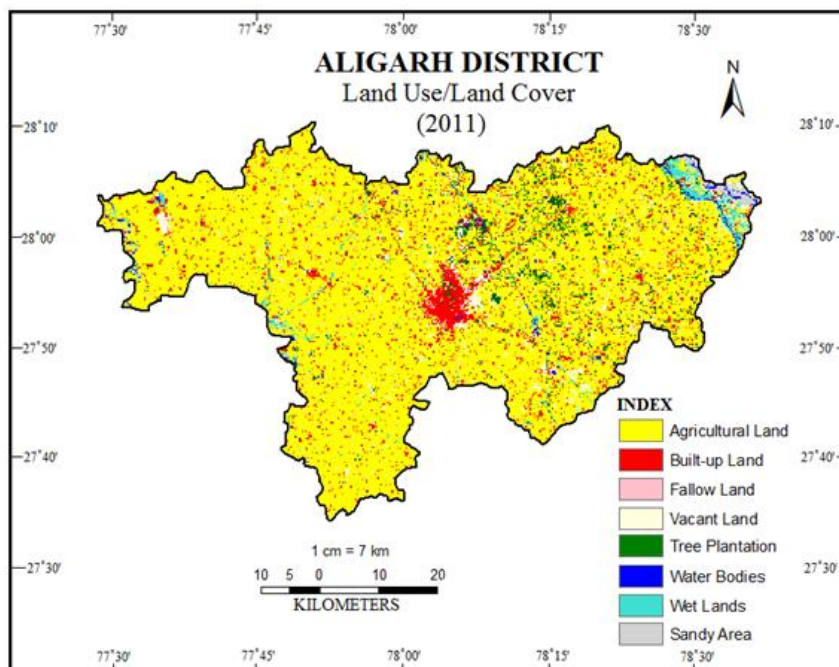


Figure 2

### **Vacant Land**

Vacant lands include no use of land. The land owners have kept vacant lands due to steeply rising land prices. The vacant land has been converted into built-up land around the city and towns whereas in other parts of the District vacant land (barren land) has been transformed into agricultural land.

It is seen from Figures that vacant land appears more in the central part of the District. Table 1 shows that vacant land comprised 31616.33 hectares (8.61 percent to the total geographical area) in 1996 and this reduced to 12601.41 hectares (3.43 percent to the total geographical area) in 2011. Vacant land declined by 5.18 percent during the span of fifteen years. It is evident from Table 2 that 4073.62 hectares (12.88 percent) of vacant land has been converted into built-up land whereas 18519.41 hectares (58.57 percent) of vacant land has been transformed into agricultural land by the year of 2011.

### **Tree Plantation**

It refers to areas under agricultural tree crops, trees and plantations adopting certain agricultural techniques. In Aligarh District, the proportion of forest area is negligible. The total area under tree plantation was registered as 14441.73 hectares (3.93 percent to the total geographical area) in 1996 whereas it was recorded as 12601.41 hectares (3.43 percent to the total geographical area) in 2011. It is clearly seen from Figure 1 and 2 that tree plantation appears more in the eastern part of the District in both years and is also seen along the roads and canals. Tree plantation recorded positive growth in the eastern part and negative growth in the western part of the District by the year of 2011. The positive growth in the eastern part is due to increasing mango and guava plantations. The Govt. of India has also launched a programme for high density planting and promotion of rejuvenation of senile, old and unproductive orchards of mango and guava. However, tree plantations have cleared for the construction of schools, colleges, shops, malls, among other uses along the highways or main roads. The change matrix Table 2 clearly indicates that 1073.18 hectares of tree plantation has been changed into built-up area while the other 6376.03 hectares of tree plantation area have been transformed into agricultural land.

### **Water Bodies**

This category comprises area with surface water in the form of ponds, lakes, tanks and reservoirs. The Ganga and the Yamuna are main rivers which flow in Aligarh District. Other seasonal rivers are Nim, Kali, Sengar and Karwan. The satellite images were taken in the month of February in 1996 and 2011. Therefore, the volume of waters is low due to seasonal values in February. They have large volumes of water in the monsoon season. It is seen from Figure 1 and 2 that the Ganga and the Yamuna rivers have changed their course during one and half decades. The Yamuna river is shifting from west to east. The area under water bodies seems more or less constant during the span of fifteen years. It accounts for a low proportion of geographical area of the District. It covered 1860.75 hectares (0.51 percent) in 1996 and 2078.32 hectares (0.57 percent) in 2011. Only 0.06 percent positive change has been recorded under water bodies. It can be seen from Figure 1 and 2 that the Upper

Ganga Canal passes through the middle part of the District. It crosses Jawan, Dhanipur and Akkrabad block. In Akkrabad block, it was bifurcated into two branches for irrigation purposes.

Table 2 shows that 1151.82 hectares of the area have experienced no transformation and the remaining areas of water bodies have been changed into other classes of land use, out of which a large proportion of water bodies (277.98 hectares) have been converted into wet lands.

### **Wet Land**

Wet lands are swampy areas which are situated on the margins of lakes, ponds, streams and rivers. The water level is high in these areas all around the year. It covered 11381 hectares area (3.10 percent) in 1996 which decreased to 8735.44 hectares (2.38 percent) in 2011. A large portion of wet land was observed in the east part of the District. It lies between the Ganga river and the Lower Ganga Canal. This area was either totally marshy land or cultivable land.

### **Sandy Area**

Sandy areas occur in coastal, riverine or inland areas. In Aligarh District, sandy areas are found along the Ganga and the Yamuna rivers. They are called riverine sands. Riverine sands are those that are seen as accumulations in the flood plain which are the resultant phenomena of river flooding. It is revealed from Table 3.1 that the total sandy area was 1300.34 hectares (0.35 percent to the total geographical area) in 1996 and registered 2839.21 hectares (0.77 percent to the total geographical area) in 2011. During 1996-2011, the sandy area increased by only 0.42 percent.

## **5. Conclusion and Suggestion**

During the period of fifteen years (1996 to 2011), positive changes have been noticed in built-up land, agricultural land and sandy area whereas negative changes have been observed in fallow land, vacant land, tree plantation and wet lands. It is interesting to note that agricultural land has recorded positive growth in the study area due to transformation of vacant land into agricultural land. The area under agriculture increased from 78.86 percent in 1996 to 81.77 percent in 2011. The built-up land has recorded a tremendous increase during these fifteen years from 2.59 percent in 1996 to 6.85 percent in 2011. It has received threefold growth over these years because of expansion of settlements and roads. The settlements have encroached upon the major area of agricultural land around Aligarh City and surrounding towns. Tree plantations disappeared in the western part of the District and along the roads while it appeared more in the eastern part of the District.

It is realized that the "horizontal" expansion of agriculture is not possible in the future in this region. However, there is enough scope for vertical expansion of agriculture by increasing cropping intensity through proper land utilization and management. The forest area should be planted on vacant land especially in the western part of the District to maintain the environmental equilibrium. Both the public and private sectors should participate in the tree plantation programme.

Private individuals could also grow various varieties of medicinal plants if they could be informed about their

commercial value.

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