Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 11(X), 2023:
http://dx.doi.org/ 10.7770/safer-V11N1-art2377

Land use / land cover change detection analysis through geospatial technology in Jhansi district of Bundelkhand region

Análisis de detección de uso de la tierra / cambio de cubierta de tierra a través de tecnología geospacial en el distrito de Jhansi de la región de Bundelkhand

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ABSTRACT

The term Land Use relates to the human activity associated with specific of land for example areas under settlement, agriculture, forest, vegetation etc. The cumulative pressure on land for food and wood, the natural balance of soil and environment is affected by deforestation activities which causes serious problem of land degradation. The present study is focused on the changing Land Use / Land Cover practices. "These land use and land cover data are very important for land resource management, planners, and decision makers" (Ndukwe, 1997). In this study has been studied Land use / Land cover change detection of Jhansi district over a period of 12 years. Landsat TM and Landsat ETM + data from U S Geological Survey (1996, 2008) and Survey of India toposheets (2006) have been used for the delineation of classes and district boundary. A study of spatial and temporal changes in Land use / Land cover (LULC) is conducted using Remote Sensing and GIS techniques. ArcGIS 9.3 and ERDAS Imagine 9.2 interface were used for preparing LULC and change detection. The study area is categorized into eight foremost LULC classes viz., built-up land, cropland, fallow land, dense forest and open forest, barren land, sandbar, water bodies. Land use / land cover is very important aspects of land management and development planning of any region. There for, it has broadly been explained and considered as a very imperative element of physical input for agricultural development and land use sustainability.

Keywords: Bundelkhand, Land Use / Land Cover, Sustainability and Geospatial Technology.

RESUMEN

El término Uso de la tierra se refiere a la actividad humana asociada con áreas específicas de la tierra, por ejemplo, áreas de asentamiento, agricultura, bosques,

vegetación, etc.La presión acumulada sobre la tierra para obtener alimentos y madera, el equilibrio natural del suelo y el medio ambiente se ve afectado por las actividades de deforestación que provoca un grave problema de degradación de la tierra. El presente estudio se centra en las prácticas cambiantes de Uso del suelo / Cobertura del suelo. "Estos datos sobre el uso del suelo y la cobertura del suelo son muy importantes para la gestión de los recursos del suelo, los planificadores y los responsables de la toma de decisiones" (Ndukwe, 1997). En este estudio se ha estudiado la detección de cambios en el uso del suelo / cobertura del suelo del distrito de Jhansi durante un período de 12 años. Los datos de Landsat TM y Landsat ETM + de US Geological Survey (1996, 2008) y las hojas topográficas de Survey of India (2006) se han utilizado para delinear las clases y los límites del distrito. Se realiza un estudio de los cambios espaciales y temporales en el uso de la tierra / cobertura de la tierra (LULC) utilizando técnicas de teledetección y SIG. Se utilizaron las interfaces ArcGIS 9.3 y ERDAS Imagine 9.2 para preparar LULC y la detección de cambios. El área de estudio se clasifica en ocho clases principales de LULC, a saber, tierra construida, tierras de cultivo, tierras en barbecho, bosque denso y bosque abierto, tierra estéril, banco de arena, cuerpos de agua. El uso de la tierra / cobertura de la tierra es un aspecto muy importante de la planificación de la gestión y el desarrollo de la tierra de cualquier región. Por eso, ha sido ampliamente explicado y considerado como un elemento muy imperativo de insumo físico para el desarrollo agrícola y la sostenibilidad del uso de la tierra.

Palabras clave: Bundelkhand, Uso del suelo / Cobertura del suelo, Sostenibilidad y Tecnología geoespacial.

INTRODUCTION

The environmental complications in India are growing rapidly. The accumulative economic development and a hastily growing population that has taken the country from 300 million people in 1947 to more than one billion people today is putting a strain on the environment, infrastructure, and the country's natural resources. Industrial contamination, soil erosion, deforestation, rapid industrialization, urbanization, and land degradation are all worsening problems. Over exploitation of the country's resources viz. land or water and the industrialization process has resulted in environmental degradation. Environmental pollution is one of the most serious problems that humanity and other life forms are facing on our planet today. In this context, "This is very useful to analyses the trend, rate, nature, location and magnitude of changes in land use and land cover" (Adeniyi et al, 1999). According to a study by the World Health Organization (WHO) conducted in the year 2007, India's per capita carbon dioxide emissions were roughly 3,000 pounds (1,360 kilograms) in 2007. That's a significantly small amount compared to China and the U.S., with 10,500 pounds (4,763 kilograms) and 42,500 pounds (19,278 kilograms) respectively in the same year. The report also said that the European Union and Russia also have more emissions

than India. India has been ranked as seventh most environmentally hazardous country in the world by a new ranking released by W.H.O. recently. Rapid, unplanned and unsustainable patterns of development sites are making focal points for many emerging environment and health hazards. Unsustainable patterns of transport and urban land use are root causes of a number of significant, and interrelated environment and health hazards faced by urban dwellers in developing countries. These health and environment linkages cut across a range of policy sectors and thus are often overlooked in policy making. It is the obligation of each generation to preserve the productive capacity of land, air, water and wild life in a manner which leaves its beneficiaries some choice in creation of a healthy environment. The physical environment is a dynamic, complex and interconnected system in which any action in one part affects the other. There is also the interdependence of living things and their relationship with land, air, and water. Planning for harmonious development distinguishes this unity of nature and man. Such planning is possible only on the basis of a comprehensive appraisal of environmental issues particularly ecological.

Land is most significant among natural resource on which all man's accomplishments are preformed and increasing population, pressure and human activities have amplified the demand of the limited land and soil resource both for agriculture and other uses. Clawson and Stewart (1965) define the land use as "man's activities and the various uses which carried on land" and land cover refers as "natural vegetation, water bodies, rock, soil, artificial cover and others resulting due to land transformation." The terms land use cover are closely related and interchangeably. Land use one of the basic and viable resource for agricultural operations. Therefore, it has widely been explained and considered as an important element of physical import for agricultural development since 1976. Land use information forms an important part of decision making at state level. For example, traffic models used to plain highway development at the state level requires land use data as input to estimates traffic generated by neighborhoods supply traffic to specific highway. At national level land use statistics is an important element informing policies concerning economic, demographic and environmental issues, international requirements for land use data also focus upon many of days major apprehensions considered at their broadest scale. To meet a cumulative demand of land for agriculture, and forest a consistent and comprehensive info regarding spatial pattern of present land use is prerequisite. One of the basic requirements for planning is availability of appropriate, accurate, and data information on land use at the possible time. It can be achieve from numerous satellite based high resolution remotely sensed data on a cost effective basis. Jhansi district lying high upland of Bundelkhand Plateau with undulating terrain. In this reference, it presents a wide scope to land use sustainability.

Application of Geospatial Technology for Land Use / Land Cover: Remote sensing mean attain information about an object without touching the object itself. Thus it can be

more broadly defined as the technique of acquiring information about an object by a recording device (sensor) i.e. not in physical contact with the object by measuring portion of the reflected or emitted EMR form the earth surface. Conventional methods of collection and mapping of land use data- 1. By aerial photos 2. By satellite imagery. The photograph taken from an aircraft or helicopter using a precision camera is termed as an Arial photograph. Satellite images is an illustrative representation of the earth captured by a sensor mounted on an earth-orbiting satellite.

MATERIAL AND METHODS

Study Area: Bundelkhand region includes seven districts of southern Uttar Pradesh and six district of northern Madhya Pradesh. Here, I have taken only Jhansi district for the case study. Jhansi District (24º 11' and 25º 57' N latitude and 78º 10' and 79º 25'E longitude) lies in the extreme south-western corner of Uttar Pradesh. It covers 2.07 percent area (5024 sq. km) of the state (5039 km^2 due to pixel size in satellite imagery) and is inhabited by 19, 98,603 persons (2011, census). It is bounded by as many as 8 districts of Uttar Pradesh and Madhya Pradesh. The northern boundary is shared by Jalaun district whereas Hamirpur district lies on the east. Its east-west length is 99 kilometers and the north-south width is 88 kilometers. In terms of area wise it is divided into four tehsils and 8 development blocks. The river Betwa flows in the study area for a considerable distance. Four districts of Madhya Pradesh form the southern, western and northwestern boundaries of the district respectively. The study area records an average rainfall of 850 mm (India: 1190 mm). The district retains two distinct physical units: (a) the comparatively level, low lying and fertile tract in the north and (b) the outlying scarps of the Vindhyan and gneissic hills in the south where the terrain is more elevated and rocky. From the point of view of geological structure the district Jhansi can be divided into two parts – a. Northern Eastern Plain: This part of the district is flat and fertile, which is made from the soil brought by regional rivers and Nullahs. This part is the border area of the Ganga Yamuna erected in Uttar Pradesh. This is a lower area compared to the southern western part. b. Southern and Southern Western Highland Territories: This part is the plateau and mountainous region. In this part, the hills of Vizavar and Vindhyramas are seen. Due to hill ranges, it is in the form of a state of highland, where there is copiousness of mountains, chandeliers and wild land. Rocks of Bundelkhand Granite Nice are found on most part of this hilly region. In this part of the district there are two series of irregular mountains. The first series starts from the river Betwa, from north to northeast, ie from Jhansi to Monnet. While the second series starts from Katera Village and goes northwards and ends near Magarwara and Kanchanava Village. The height of both hill ranges is approximately 185 to 233 meters. The maximum height of the Vindhyachal series in the southern terrain is 522 meters, which

gradually decreases towards the northern part. Its height is 307 meters in Babina and 274 meters in Jhansi. The general slope of the district is northeast from south west. (Figure 1)

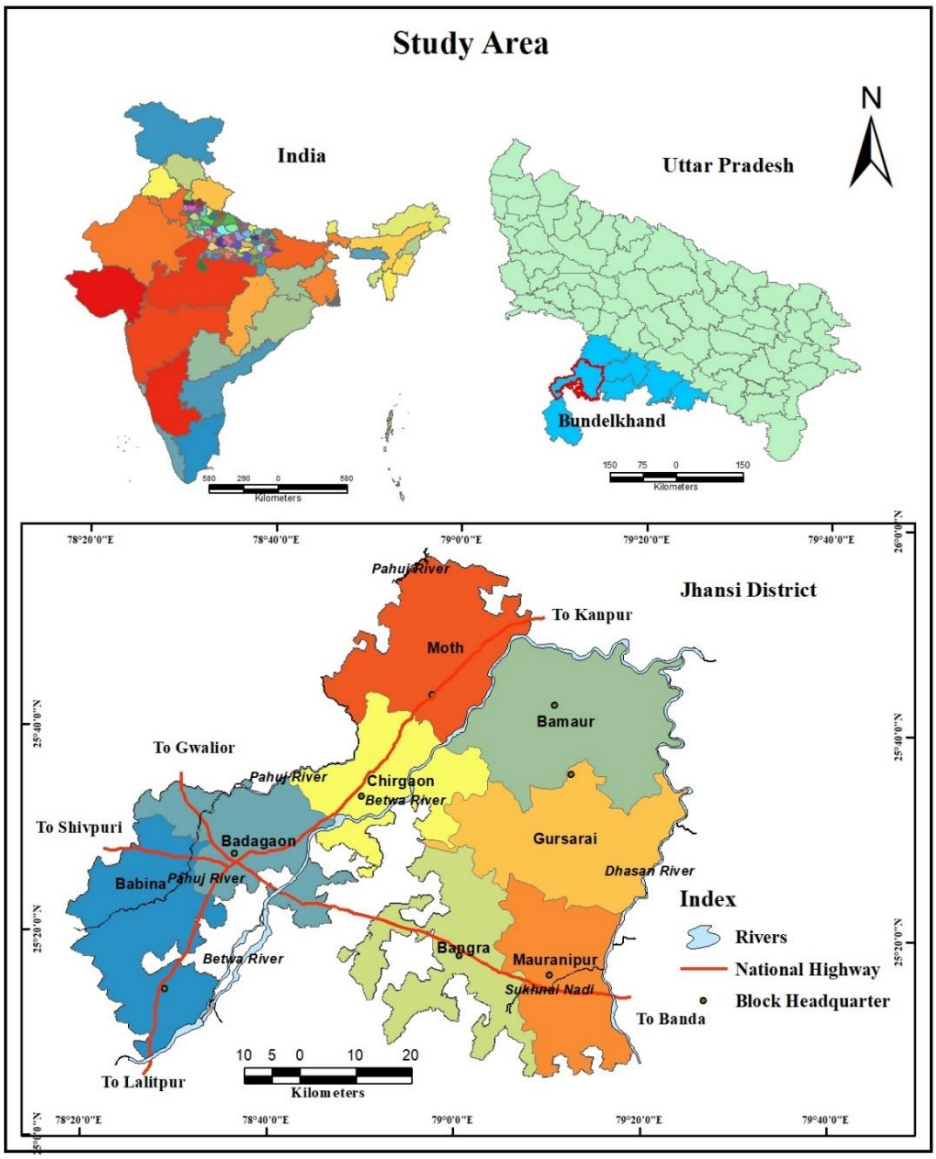

Figure 1: Location of Study Area.

Source: Prepared by the author with the help of toposheet of survey of India, 2006

Objective: The present study is an attempt to demarcating boundaries of different land use and land cover units from an analysis of different types of class registration of LULC as well as by digital techniques from satellite imageries. The major objectives of the study are: (a) to delineate the Land use/Land cover classification of Jhansi District. (b)To analyze the land use change detection and sustainability.

Data sources and methodology: The present study based on secondary data. Primary data has been extracted from the given satellite imageries. Generalized delineation

of land use classes and distribution of land use categories of this study area has done through satellite imagery because it provide a synoptic view of land use land cover mapping both by visual interpretation and digital analysis conceivable by satellite remote sensing techniques. Toposheet no G44M6, G44M7, G44M9, G44M10, G44M11, G44M12, G44M13, G44M14, G44M15, G44M16, G44N1, G44N2, G44N3, G44N4, G44N5, G44N6, G44N7 and G44N8 (2006, Survey of India) used for district boundary demarcation and Geocoded Satellite Imagery (Row -145, Path -42,43 with 30 meter resolution, 7 bands, 15th &16th November, 2006 (Landsat TM) & 2008 (Landsat ETM+) respectively with 0 % cloud cover) are used on green (band 2), red (band 3), infrared (band 4) spectral bands with a spatial resolution of 30 meters on 1:50,000 scale. Which were acquired from earth explorer interface of U.S. Geological Survey. This work done by visual image interpretation and digitizing in Arc Map 9.3 and Leica Geosystems ERDAS IMAGINE 9.2. Supervised classification method with maximum likelihood algorithm has been used to classify the images of two different time period. There are two basic ways of change detection used to evaluate the quality of information of LULC of the study area. In order to achieve the above mentioned objective the following methodology has been adopted both quantitative and qualitative methods of data analysis.

I. Georeferancing the toposheets for preparation for base map and overlay of study area.
II. Layer stacking of Landsat image and project by UTM, WGS, and 44N.
III. Supervised Classification (maximum likelihood method) with the help of appropriate class signatures.
IV. Preparation of image Overlay and other Land use/ Land cover.
V. Recoding of the classes with the help of Google earth image and majority filtering and final Land Use / Land Cover map.
VI. Extracting the change detection data from the classified image.
VII. Analysis of land sustainability.

RESULTS

Land Use / Land Cover Classes: Anderson (1976) explained aspirations and refined techniques and introduced land use classification systems. Many organizations like NATMO, AIS & LUS, and department of Agriculture & Statistics etc. have developed their own classification schemes for Land use and Land cover mapping. Therefore, NRSA, department of space has initiated the task of developing National Land Use / Land Cover classification system of India taking the views of several user department into consideration including the planning commission of India. Thus a standard Land use / Land cover classification was developed. To developed any Land use/Land cover classification system it is essential to consider certain criteria and limitation of satellite data as discussed below. The

classification should be suitable for using satellite data obtained at different period of the year. Assemblage of Land Use / Land cover categories must be possible. The minimum interpretation accuracy and reliability in the identification of Land Use / Land Cover categories from satellite data should be at least 85 to 95%. Due to small scale of satellite imagery certain Lund Use / Land Cover categories likes agriculture and different crops can be together under main head agriculture. Acquisition of data should be planned on the basis of prevailing use and level of details. (Table 1).

Table 1: Jhansi district: Change in Land Use / Land Cover, 1996 - 2008

S. No.	Land Use / Land Cover Class	Area (1996)		Area (2008)		Difference 1996-2008	Change (%) 1996-2008
		km^2	%	km^2	%	km^2	%
1	Built-up Land	53.32	01.06	93.12	01.85	39.81	74.66
2	Crop Land	1934.10	38.38	2263.45	44.92	329.35	17.03
3	Fallow Land	940.20	18.66	753.32	14.95	-186.89	-19.88
4	Dense Forest	211.09	04.19	201.71	04.00	-09.39	-04.45
5	Open Forest	1366.61	27.12	1318.41	26.16	-48.19	-03.53
6	Barren Land	383.06	07.60	237.05	04.70	-146.01	-38.12
7	Sand Bar	21.75	00.43	15.50	00.31	-06.25	-28.74
8	Water Bodies	129.04	02.56	156.61	03.11	27.57	21.37
Total District		5039.17	100.00	5039.17	100.00	0.00	0.00

Source: Computed by author from classified LANDSAT Imageries, 1996 & 2008

A multilevel system has been conceived for getting details of various categories of land use land cover to map through remote sensing products. The land use / land cover categories can be expanded or reduced to any degree and be made more responsible to the information the user needs. Supervised classified satellite imageries of the year 1996 and 2008 providing the highlights spatiotemporal changes in land use / land cover occurred in the district with in a period of 12 years. (Table 1) Present study of Jhansi district shows rapid change in the land utilization. The given map is an example of peculiar type of Land use / Land cover evolved from the governing effect of climate on region. There are a number of broad unit that contain several induction. They would not be separate because of their small extent. So maximum likelihood method has been adopted. These approximations are based on color, reflectance of EMR. Land use / land cover category is classified according to USGS classification system. Keeping this fact in view, the study area has been classified in eight major land use / land cover classes as follows- 1. Built-up land, 2. Crop land, 3. Fallow land, 4. Dense Forest, 5. Open Forest, 6. Barren land, **7.** Sand Bar and 8. Water bodies. (Figure 2).

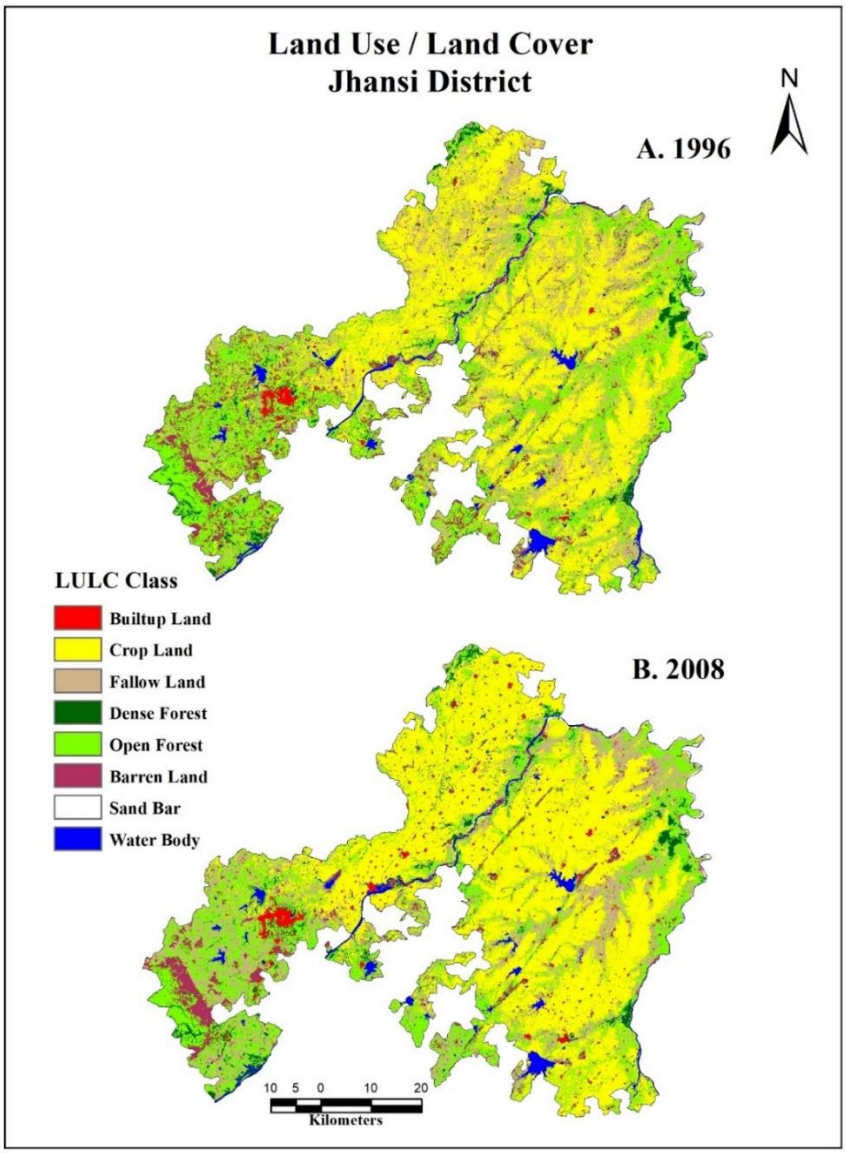

Figure 2: Land Use/ Land Cover of Jhansi District by Supervised Classification, 1996 & 2008.

Source: Prepared by author with the help of LANDSAT imageries of 1996 & 2008.

1. Built-up land: It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication utilities in association with water, vegetation and vacant lands. Web LULC map consists of 3 classes under built-up viz., urban, rural and mining. That area is founded surrounding agricultural land. Growing population and developing infrastructure are more emphasizing to built-up land. It has rapidly increased by 74.66 percent during 12 years. Whereas it was 53.32 km^2 (1.06 %) in 1996 and grew up to 93.12 km^2 (1.85 %) in 2008.

2. Crop land: These are the areas with standing crop as on the date of satellite overpass. They are extensively distributed indifferent terrains, prominently appear in the irrigated areas irrespective of the source of irrigation. It includes Kharif, Rabi and Zaid crop

lands along with areas under double or triple crops. This imagery is characterized by very high agriculture land (44.92%, 2008). This area experienced for crop land account 1934 km^2 (1996) and 2263 km^2 (2008). There is positive change in crop land, increased by 17.03 percent (329.35 km^2) during 12 years. Most of crop land founded northeast and east part of the district because of plain region. Lowest crop land concentrated in west and south-west part of the study area due to plateau region.

3. Fallow Land: An agricultural system with an alternation between a cropping period of several years and a fallow period. (Ruthenberg, 1980). 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 season, but not less than one year. This unit can be identified in small to irregular patches, throughout the scene, especially in central area. Fallow land account is 18.66 percent (940.20 km^2, 1996) and 14.95 percent (753.32 km^2, 2008)) of total land area of imagery. It is quit decreased by 19.88 percent during the gap of 12 years.

4. Dense Forest: The term forest is used to refer to land with a tree canopy cover of more than 10 % and area of more than 0.5 ha. Forests are determined both by the presence of tree and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 meter. The area of dense forest cover are usually associated with high relief presenting a prominent and distinct texture. There is one problem related to identify the dense forest because there is rock impression on the image so we delineate the dense forest including the rock impression. There is minute change in area under dense forest. It has decreased 4.45 percent from 1996 -2008. Most of forest cover concentrated in east and west part of the district and riverine area along rivers. Currently district Jhansi has 4 percent (201.71 km^2, 2008) area under dense forest out of total study area.

5. Open Forest: These are the forest areas which are generally seen at the fringes of dense forest cover and settlements, scrub and grass area also includes under this category, where there is biotic and abiotic interference probably. Most of times they are located closer to habitations. Forest blanks which are the openings amidst forest areas, devoid of tree cover, observed as openings of assorted size and shapes as manifested on the imagery are also included in this category. Open forest area also associated in hill, area less vegetation is considered under this unit. Canopy cover is 20% to 40%. These have a red color with small blanks. In the imageries (FCC) it is characterized by reddish tone. Most of these open forest are founded by west and east part of the district. Open forest shared 27.12 percent (1996) and 26.16 percent (2008) of the total study area. Its 3.53 percent area (48.19 km^2) converted into other land use classes such as agricultural land.

6. Barren Rocky: These area rock exposures of varying lithology, often barren are devoid of soil and vegetation cover. Broad patches of this unit can be identified at the west

middle, and south part of the district. Barren lands are color reflectance greenish blue to yellow brownish. In the imagery the greenish blue color reflectance is bar rock outcrop. Barren land accounted 7.60 percent (1996) and 4.70 percent (2008) of total area of district. Barren land include rocky area, uncultivable waste and land effected by stone mining and threshing. Riverine (non-vegetated) area also occurred under barren land. They are the resultant of terrain distortion 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 observable 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 reverinous (ravenious) land. Ravines are basically extensive systems of gullies developed along river courses.

7. Sandy Area: These area probably found in the course of river channel. Betwa river flow in the middle of the district, which is main source of sand. This also occur in coastal, riverine or inland areas (dumping sites). Riverine sands are those that are seen as accumulations in the flood plain as sheets which are the resultant phenomena of river flooding. Mining work probably developed along Betwa River cause of large amount deposition of sand. In the study area the sand bars area decreased by 28.74 percent from 1996 (21.75km^2) to 2008 (15.50km^2).

8. Water Bodies: This category comprises areas with surface water in the form of river, ponds lakes, tanks and reservoirs. In streams there are major Rivers are Betwa, Pahuj, and Dhasan River. During summer streams are reduced in almost all rivers because these all are plateau origin Rivers. There are so many small big water bodies in Jhansi district. Here only those water bodies & river shown in the Land use / Land cover map by supervised classification which is characterized by resolution of 30 x 30 meter. Such a large number of water tank indicate greater facilities regarding irrigational practices. There 2008 (156.61 km^2). The water levels in ponds are usually maintained by rainfall. Land is predominantly used for production of food and fishing farms and other commercial activities like that thermal power production in Pariccha Dam and etc.

DISCUSSION

Change Detection Analysis 1996 to 2008: This discussion is focused on the satellite data available in the month of November of land use variation are work out evidently classification of the unit is done as pre convenience. The dense forest appears in dark red to red color and associated with high relief. The foothills are occupied by grass and scrub unit registered in light red color. Another prominent unit of the scene is stony wasteland / barren land, which resemble as Greenish blue to yellow brownish to white. An extensive

area is covered by this unit and it appears much distinct form it surrounding. These are absolutely barren land having no vegetation. Many complications have been face during demarcation of units, e.g. some of land use / land cover unit have mixed type of color registration and this creates a lot of misperception. Land use change is an unremitting phenomenon in district. Change detection has been done in couple of ways, including image referencing, thematic land cover change and contextual change analysis. The present study highlights thematic land use / land cover analysis considering 12 years. Change matrix has been produced to display the changes that have occurred due to consequent growth. (Table 2 and Figure 2).

Table 2: Jhansi District: Change Detection Matrix of Land Use / Land Cover, 1996 - 2008

Year		2008								
	LULC Class	Built-up Land	Crop Land	Fallow Land	Dense Forest	Open Forest	Barren Land	Sand Bar	Water Bodies	Total
1996	Built-up Land	0	-14.42	-05.43	-03.27	-12.51	-04.66	-00.03	00.49	-39.80
	Crop Land	14.42	0	-439.74	14.09	78.40	-07.63	-0.34	11.45	-329.35
	Fallow Land	05.43	439.74	0	2.42	-142.14	-124.23	-01.65	07.33	186.88
	Dense Forest	03.27	-14.09	-02.42	0	23.72	-00.82	-00.03	-00.25	09.38
	Open Forest	12.51	-78.40	142.14	-23.72	0	-09.37	-00.83	05.86	48.20
	Barren Land	04.66	07.63	124.23	00.82	09.37	0	-02.41	01.73	146.01
	Sand Bar	00.03	00.34	01.65	00.03	00.83	02.41	0	00.95	06.25
	Water Bodies	-00.49	-11.45	-07.33	00.25	-05.86	-01.73	-00.95	0	-27.57
	Total	39.8	329.35	-186.88	-09.38	-48.20	-146.01	-06.25	27.57	

Source: Computed by author from classified LANDSAT Imageries, 1996 & 2008

Table 2. Showing the total change and conversion of land use classes one to another from 1996 to 2008. Where the row are presenting the account of the 1996 and column their corresponding value in 2008. During the past 12 years area under dense forest, open forest, barren, sand bar and fallow land have decreased by 9.39 km^2, 48.19 km^2, 146 km^2 and 6.25 km^2. Whereas area under built-up land, crop land, water bodies have increased by 39.81 km^2, 329.35 km^2 and 27.57 km^2 respectively. Built-up land has gained from almost all the classes in 2008 as compared to 1996 of the total of 53.32 km^2.

Area gained from cropland (14.42 km^2) followed by open forest (12.51 km^2), fallow land (5.43 km^2), barren (4.66 km^2) and dense forest (3.27 km^2). Cropping land converted

in to open forest (78.40 km^2), built-up land (14.42 km^2), dense forest (14.09 km^2) and water bodies (11.45 km^2) but it expanded cumulatively by 329.35 km^2 from fallow land (439.74 km^2), barren land (7.63 km^2) and sand bar (0.34 km^2). Fallow land decreased from 1996 to 2008. It converted by 439.74 km^2 to crop land, 7.33 km^2 to water bodies and 5.43 km^2 by built-up land and 2.42 km^2 to dense forest but it also gained of 142.14 km^2 area from open forest and followed by 124.23 km^2 area from barren land and 1.65 km^2 from sand bar. Same as dense forest converted by 23.72 km^2 to open forest and followed by 3.27 km^2 into built-up land. And gain 14.09 km^2 by crop land and followed by fallow land (2.42 km^2), barren land (0.82 km^2), water bodies (0.25 km^2) and sand bar (0.03 km^2). The area under open forest also decline by 48.20 km^2 from 1996 to 2008. It converted 142.14 km^2 to fallow land and followed by 12.51 km^2 to cropland and 5.86 km^2 to water bodies. It also gained 78.40 km^2 from crop land, 23.72 km^2 from dense forest, 9.37 km^2 from barren land and 0.83 km^2 from sand bar. Similarly barren land has been converted by124.23 to fallow land and followed by 9.37 km^2 to open forest, 7.63 km^2 to crop land, 4.66 km^2 to built-up land, 1.73 km^2 to water bodies and 0.82 km^2 to dense forest. Sand bar rapidly decrease and converted by 2.41 km^2 to barren land and fallowed by all land use categories. As for as water bodies are concerned there are rapid change in the area under water bodies. It gained 11.45 km^2 from crop land because irrigated field during November. And rest of area gained from 7.33 km^2 from fallow land prominently. The scale of the imagery (1:50,000) did not allow separation of each and every parcel of dissimilar registration. So such inclusion is summed under a broad unit. Present time it is very difficult task Land use/Land cover mapping by going in field.

Land Use Sustainability: Sustainable development is perhaps the most quoted word in the few decade especially after publication of "Our Common future". (A report on the world commission on environment and development by brundtland, 1987). The United Nations World Commission on Environment and Development coined a definition of sustainable development "The developments that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WECD, 1987). The United Nations defines sustainable land management (SLM) as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions". Sustainable Land Management is "The adoption of land-use systems that through appropriate management practices enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources". TerrAfrica (2005). (Figure 3).

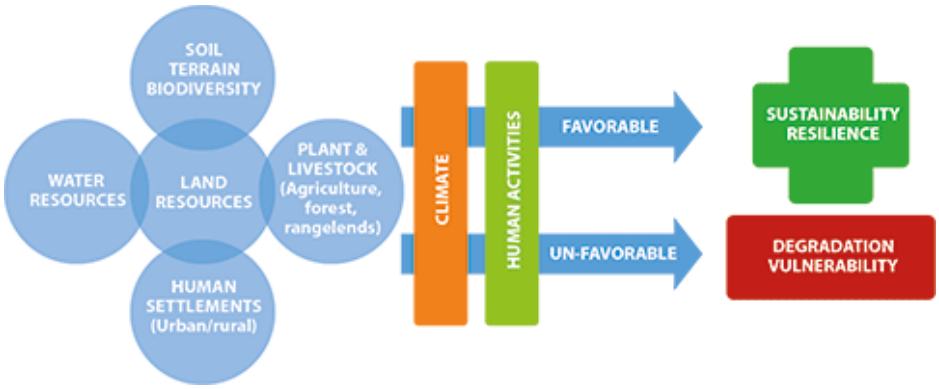

Figure 3: Sustainability and vulnerability of Land Resource.

Source: FAO, Climate - Smart Agriculture Sourcebook, Module B.7 Sustainable Soil / Land Management for Climate-Smart Agriculture.

The sustainability of a land-use system is determined by the interaction between land resources, climate and human activities. Sustainable land use and management (human activities) decide the sustainability / resilience or degradation / vulnerability of land resources. It is anticipated that the human footmark has affected 83% of the global terrestrial land surface and has degraded about 60% of the ecosystems services in the past 50 years alone. Land use and land cover (LUCC) change has been the most detectable indicator of the human footprint and the most significant driver of loss of biodiversity and other forms of land degradation. Whole discussion clarifying that land sustainability remaining in Jhansi district. There is a sequence in conversion of land utilization one class to another classes. Jhansi district is located in the Bundhelkhand upland which are drought affected area. Yet, it has been present a positive change in water body showing the sustainability of resource. There are several dams and weirs such as Pahari Weir (Dhasan River), Lakheri Dam (Lahheri River), Khappar Dam (Khappar River), Pahuj Weir (Pahuj River) and Parichha Weir (Betwa River), which are providing their valuable contribution for agricultural purpose, industrial demand and other local uses. Particularly in the face of climate transformation and variability, selecting the right land uses for given biophysical and socio-economic conditions, and executing SLM, are essential for reducing land degradation, rehabilitating degraded land, ensuring the sustainable use of land resources (i.e. soils, water and biodiversity) and maximizing flexibility.

Concluding Remarks & Future Perspectives: Detection of long term changes in land cover may reveal a response to a shift in local or regional climatic circumstances, the basis of terrestrial global monitoring. The change is usually detected by comparison between two multi- date images, or sometimes between an old map and an updated remote sensing image. A major phenomenon observed during LULC analysis is the process of deforestation. This paper shows the significance of remote sensing techniques serving as powerful tool of

modern scientific era. These techniques help in identification & demarcation of different unit along with their characteristics features and anomalies. Although remote sensing techniques provide reliable base line information for land use mapping but suitable there is lot of errors which effect the tone, and spectral signature on image. For example in forest cover mapping rock impression or tonal variation is affected. Actually the area of study is plateau and rocky. So this type of problems are prominent. Just like this there is a problem to delineate the crop conditions. So for remove this type of problem field check is necessary. Land use Land cover studies are multidisciplinary in nature and thus the participants involved in such work are numerous and varied, ranging from international wildlife and conservation foundation to government researches and forestry companies. Regional government agencies have an operational need for land cover inventory and land use monitoring, as it is with in their mandate to manage the natural resources of their respective regions. Soil Land Management incorporates established approaches such as soil and water conservation, natural resource management and integrated landscape management (ILM). It involves a holistic approach to accomplishing productive and healthy ecosystems by integrating social, economic, physical and biological needs and values, and it contributes to sustainable and rural development. The changing pattern of land use is initiating various forms of environment degradation for sustainable utilization of land ecosystem. It is indispensable to know the nature, characteristics, location of land resource, its quality, appropriateness, productivity and restriction for various Land use. Our legal framework on land, air and water pollution needs to be expanded to the community level. Urban local bodies, which are trusted with the accountability to protect the environment.

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Received: 11th January 2021; Accepted: 01th Jule 2021; First distribution: 09th September 2021