Change Detection of Land Use/ Landcover Pattern in an Around Mandideep and Obedullaganj Area, Using Remote Sensing and GIS

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***Abstract* - As human and natural forces modify the landscape, resource agencies find it increasingly important to monitor and assess these alternations. For example changes in vegetation quality. These changes, in turn, influence management and policy decisions. Methods for monitoring change range from extensive analysis of remotely sensed data. While aerial photography can detect change over relatively small areas at responsible cost, satellite imagery has proven more cost effective for large regions. Land use/ land cover changes are very dynamic in nature and have to be monitored at regular intervals for sustainable environment development. Remote sensing data is very useful because of its synoptic view, repetitive coverage and real time data acquisition. The digital data in form of satellite imageries, therefore, enable to accurately compute various land use/ land cover categories and helps in maintaining the spatial data infrastructure (SDI) which is very essential for monitoring urban expansion and change detections studies. The study is to produce a land use Landcover map of areas in and around Mandideep and obedullaganj at different epochs in order to detect the changes that have taken place over a given period. The study work demonstrates the ability of GIS and Remote Sensing in capturing spatial-temporal data. Attempt was made to capture as accurate as possible the land use Landcover classes as they change through time. The LU/LC classes were distinctly produced for each study year. Anthropogenic activities affect the classes.**

***Keywords* - Land use/ Landcover, Change detection, Satellite data, Image Differencing.**

I. INTRODUCTION

Studies have shown that there remains only few landscapes on the earth that are still in their natural state. Due to anthropogenic activities, the earth surface is being significantly altered in some manner and man's presence on the earth and his use of land has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use/Landcover time.

The land use/Landcover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agriculture and demographic pressure. Hence, information on landuse/Landcover and possibilities for their optimal use is essential for the selection, planning and implementation of landuse schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of landuse resulting out of changing demands of increasing population.

Landuse/Landcover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on landuse/Landcover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources has become an important priority. Viewing the earth from space is now crucial to the understanding of the influence of man's activities on his natural resource base over time. In situations of rapid and often unrecorded land use changes, observation of the earth from space provide objective information of human utilization of the landscape. Over the past years, data from earth sensing satellites has become vital in mapping the earth's features and infrastructures, managing natural resources and studying environmental change.

Remote Sensing (RS) and Geographic information system (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analysis of earth-system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996).

Therefore, attempt will be made in this study to map out the status of landuse Landcover of areas in and around Mandideep and obedullaganj between 1967 and 2003 with a view to detecting the land consumption rate and the changes that has taken place in this statues using both Geographic information system and Remote Sensing data.

II. AIM AND OBJECTIVES

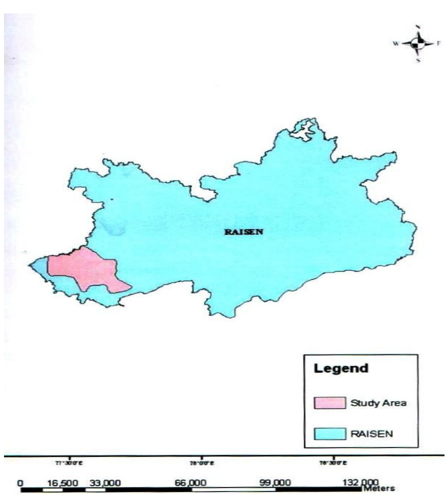
The aim of this study is to produce a landuse Landcover map of areas in and around Mandideep and Obedullaganj at different epochs in order to detect the changes that have taken place over a given period. The following specific objectives will be pursued in order to achieve the aim above.

- To create a Landuse/ Landcover classification scheme.
- To determine the trend, nature and magnitude of Landuse Landcover change.

III. STUDY AREA

Area in and around Mandideep and Obedullaganj is used as the study area; it is situated in Goharjanj Tehsil of Raisen district of Madhya Pradesh. The extant of study area is between latitudes 22^0 54'- 27.54" N and 23^0 08' 08.48" N, and between longitudes 77^0 24' 40.24'' E and 77^0 44' 03.17" E. it falls in the malwa plateau region. It has a good fertile soil cover, which encourages agricultural practices in the region. Agriculture has been a major occupation for the residents. The area is will connected to the other portions of the country by roads and railways. National highway 12 passes through the heart of the study area, thus giving it an excellent connectivity with the rest of the state. The main Delhi Bombay railway line also passes through the study are, thus giving it environment to the already booming industry and business of the area. The economy of the area is hence growing at a rapid rate, provision of employment to the local people are also good. Many of the developments have come up in the recent past, which have affected the area in a drastic way.

Therefore, the study area has an immense potential for the CHANGE DETECTION study to be carried out.



Map No.1 Study Area

IV. TOPOGRAPHY

The topography of Raisen district is variedly marked in different parts. The district may broadly divide into three physical divisions. These are as follows:-

1. The vindhyanchal range and its associated hills in the central region.
2. The Malwa plateau region in the north.
3. The plains of the Narmada valley in the Sothern part of the district.

The Vindhyanchal Range

The hill system is formed of two main groups:- (I) the trap hill and (II) the vindhyan sandstone hills. Almost the trap hills, the one situated on the west of jhamar in Garhi area is 775.4 meter height above mean sea level and is the third highest peak in the region. The highest peak is situated northeast of Siarmau measuring 626.8 meter. Some of the vindhyan sandstone hills too, attain almost the same height. The average elevation of the main chain, which is less in the south, is from 530 m. the Nagjhir peak near Mahalpur rises to 625.2 m.

The Vindhyan have always been ranked next to the Himalayas in impotence, as the southern boundary of the Madhya Pradesh.

The Parallel Ranges

In the Western part of Raisen, district the hills enclosing the narrow valleys of the Jamnar, the Barna, Chiklod Kalan and the Palakmati from hill ranges, alternating with these valleys and extending more or less in an east-west direction. These lie parallel to the main Vindhyan range north of it and the latter two of these also from the water parting line between the Narmada (through the Barna and its feeders) and the Ganga drainage systems.

The North-Western Hills

In the Northwestern part of the district, the Bhopal-Raisen road limits a hilly area lying on both sides of the narrow Betwa valley. These have been eroded to such an extent that their original lineations have been lost and it is difficult to trace joints with the main Vindhyan range without crossing a series of valleys. East of the Betwa, they show a south-to-north alignment, but west of it they extend south-west to northeast with the discussed cross-sections extending southeast to north-west like the legs of a caterpillar.

The Eastern Spurs

The spurs of the Vindhyanchal range are traceable in the eastern half of the District for long distances. The Garhi range starts from near Dehgaon and bifurcates near the northern boundary. The western branch extends in Vidisha district through Gyaraspur, Teonda and Pathari. The western branch extends along the northwestern boundary of Begamganj Tehsil and forms the Jalandhar –Jaruakhera range in Sagar Tehsil. The Godarpur –Sodarpur hills extend only upto Begamganj town in the north. The hills along the west bank of the Dhanas extend from Siarmau in the south to Tins and Sharma in the north. It also throws the Jaisinnagar Garhpahra range in the northeast.

The Southern Jaithrari Range

This is a broken low hill range extending across the low plain from east to west along the northern boundary of Udaipura Tehsil. This is crossed by the feeder streams of the Narmada from north to south, important among them being the Tendoni, the Begam, the Gazinda and the Guranch.

Malwa plateau

The plateau region is the eastern confines of the Malwa plateau and presents the familiar aspects, the rolling plains of the highly fertile black cotton soil under the vividly colored crops in the fields or the greenish yellow grass-lands obstructed by the rounded hills of trap or the scarped masses of sandstone, clothed with forests and the patches of soil at their feet.

The Narmada Valley

This lies to the south of the main Vindhyan range, covering the Udaipura Tehsil and the southern half of Baraily Tehsil. The semi-circular, hill-locked plain of Silwani Tehsil may also be considered part of the Narmada Valley but is of less fertility. The valley is between 300 and 360 m. in altitude, the slope being southwards towards the river.

Drainage

The district lies in the drainage basin of the two great rivers, the Ganga and the Narmada. The northern portion of the district is drained by the Betwa River and Bina River and three tributaries, which ultimately flow towards north and join the Yamuna. These water drains into the Bay of Bengal through the Ganga. The other series of streams is formed of those, which flow southwards to join the Narmada. The Narmada itself forms about half the southern boundary of the district. It contains a large amount of water throughout the year. Many tributaries in the district of which feed it, but the most important tributaries are the Sindor, the Tendoni and the Barna. The waters of the Narmada drainage area drain into the Arabian Sea.

The Narmada

The Narmada is one of the most sacred river of the state. Raisen in the Amarkantak hills it flows for about 88 Km. from east-northeast to west south-west along the southern boundary of the district. After flowing for about 1,000 Km. it forms estuary in the Bay of khambat. The Narmada touches the district in the south-west and forms about half the southern boundary of the district, and flows through a rich narrow valley.

The Betwa

The Betwa rise from the foot of Dhondi Dant located on the main vindhyan range. This is the extreme southern western point (23^0 2' N AND 77^0 20' E) of this district. The Betwa is the third largest river of the malwa plateau. The north of the Vindhyan watershed is watered by the Betwa and its tributaries, the Kaliyasot, the Ajnar, the Richhan, the Dabar, the Nion, and by the Bina, and its affluent, the Sameri, etc.

The Bina

The Bina and the Nion or Nihar rivers rise on opposite sides of the water dividing vindhyan spur, called the Garhi range, which cuts across the western part of Ghairatganj Tehsil in a north-south direction.

Forest

The district abounds in forest wealth, covering more than a third the total area of the district. Good soil and sufficiency of the rainfall have contributed to densely grown and wide spread forest. The forest supply the people with grazing and fodder for their cattle, building materials for their house, timber for agriculture implements and carts fire food etc. all development blocks of the district is about 1,16,424 hectare out of which about 105614.400 hectare forest lands in Goherganj Tehsil and fallowed by Silwani Tehsil which is about 25.5 thousand hectares. 62.26% of the forest area falls under reserved forest and 35.82% declared as protected forest area and the remaining 1.91% is schedule forest area.

Climate

The district has dry climate expect in the southwest monsoon season**.** The year may be divided into four seasons. The period from March to second week of June is the hot season. The southwest monsoon season constitutes from June to September. October and November constitutes the post monsoon season. The cold season is from December to the end of the February.

Agriculture

Agriculture is the main occupation of the district. About 70% population is engaged in crop growing activities. Agriculture activities are carried out in two season's namely rainy season (Kharif) and winter season's (Rabi).

Soil

The district is having different type of lands and soils, Red soils, light black soils, red-core sand and small stone in the hillocks are the main combination of soil type observed in the district. Red soil is hard in nature due to the presence of iron ore concentration and least capable of keeping the wetness for long time.

Software and data used

Software used

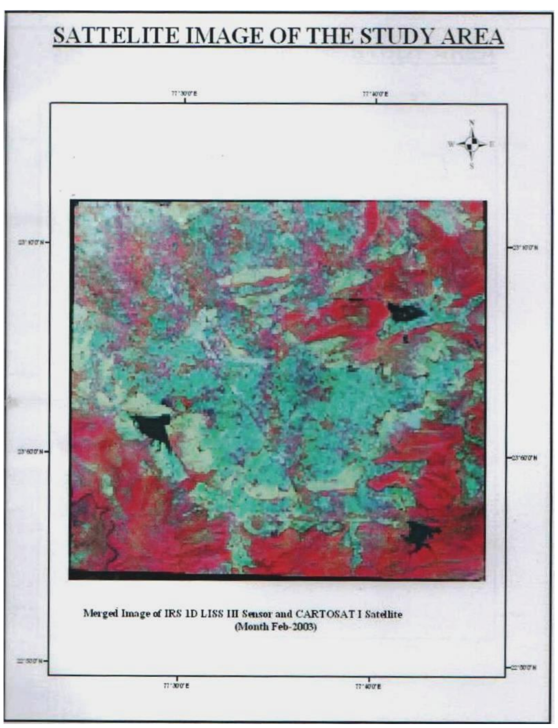
S. No.	Software	Use
1.	ERDAS Imagine 9.2	Image Processing, Analysis
2.	Arc-GIS 9.2	Analysis, database generation, Map composition
3.	Microsoft Word	Text editing

Table 1 Software used

Data used

S. No.	Data	Satellite	Type of Data	Date
1.	SOI toposheet No. 55E/5,8,9,12	-	Digital	1967
2.	Image	TM, LANDSAT 5	Digital	Mar-1992
3.	Merged Image	LISS-III,PAN IRS ID	Digital	Feb-2003
4.	Census Data	-	Digital	2001

Table 2 Data used



Map No.2 Satellite Image of the Study Area

V. METHODOLOGY

The procedure adopted in this research work forms the basis for deriving statistics of land use dynamics and subsequently in the overall, the findings.

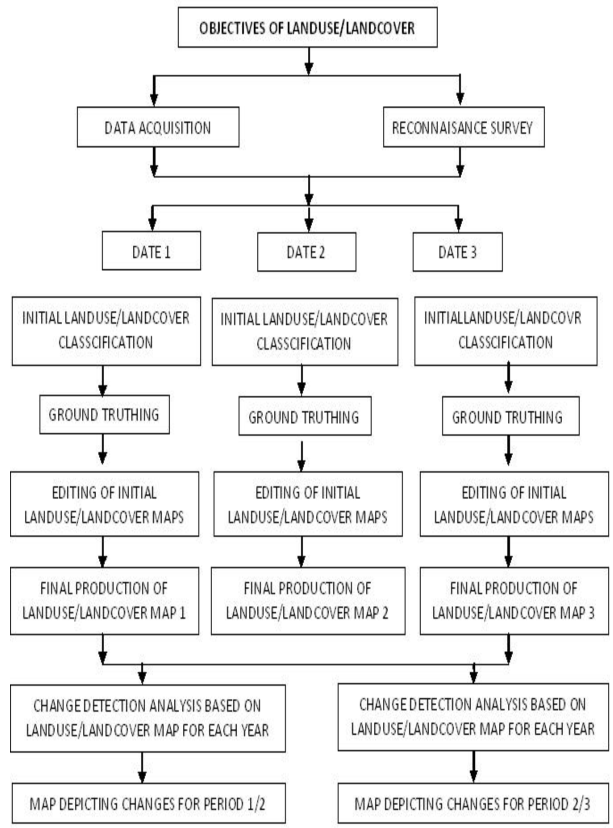
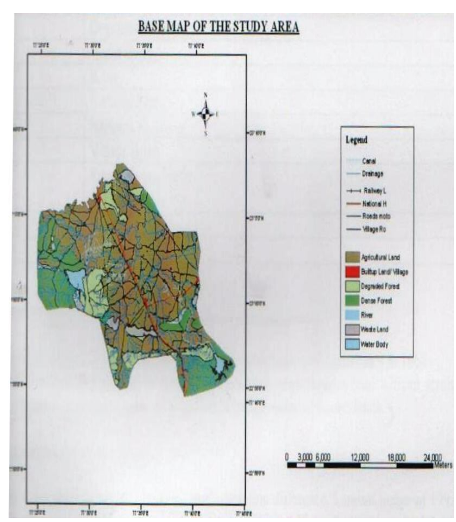


Fig. No. 2 Flow chart of Methodology



Map No.3 Base Map of the Study Area

VI. DEVELOPMENT OF CLASSIFICATION SCHEME

Based on prior knowledge of the study area for over 40 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification scheme was developed for the study area after (Anderson et al 1967). The classification scheme developed gives a rather board classification where the landuse Landcover was identified by a single digit.

CODE	LANDUSE/LANDCOVER CATEGORIES
1	Built-up Land/Village
2	Industrial area
3	Agriculture Land
4	West Land
5	Dense Forest
6	Degraded Forest
7	Water Body
8	River
21	Railway Line
22	National Highway
23	Village Road
24	Roads motorable in dry season
27	Drainage
28	Canals

Table No. 3 Landuse/Landcover classification scheme

The classification scheme given in table 3.2 is a modification of Anderson's in 1967 the definition of wasteland as used in this research work denotes land without scrub, sandy areas, dry grasses, rocky areas and other human induced barren lands.

VII. METHODS OF DATA ANALYSIS

Two main methods of data analysis were adopted in this study.

1. Calculate the area in hectares of the resulting landuse/Landcover types for each study years and subsequently comparing the results.
2. Overlay operations.

The methods above were used for identifying change in the landuse types. Therefore, they have been combined in this study. The comparison of the landuse Landcover statistics assisted in identifying the percentage change, trend and rate of change between 1967 and 1992, between 1992 and 2003, and between 1967 and 2003. In achieving this, the first task was to develop a table showing the area in hectares and the percentage change for each year (1967, 1992 and 2003) measured against each landuse/Landcover type. Percentage change to determine the trend of change can then be calculated by dividing observed change by sum of changes multiplied by 100.

(Trend) percentage change = observed change/Sum of change*100

Overlay operations identifies the actual location and magnitude of change. Many change detection algorithms can be employed in change detection analysis. In this study, 'image differencing' has been to carry out the analysis. Image differencing involves subtracting the image of one date from that of another. The subtracting results in the changes that have taken place over the period.

VIII. DATA ANALYSIS

The objective of this study forms the analysis carried out in this chapter. The results are presented inform of maps, charts and statistical tables. They include the static, change and projected landuse Landcover of each class.

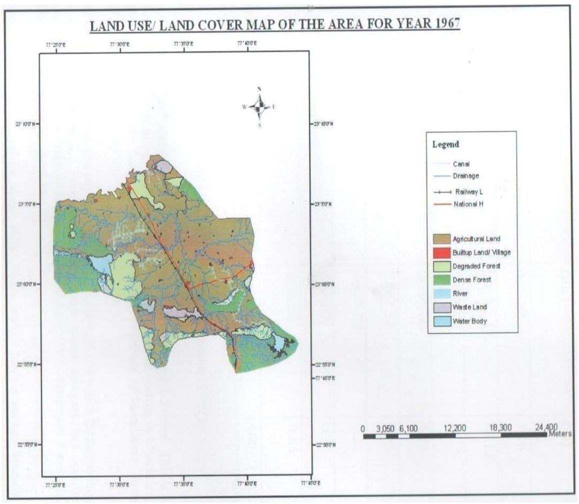
Landuse Landcover distribution

The static Landuse Landcover distributions for each year as derived from the maps are presented in the table below.

LANDUSE/LANDCOVER CATEGORIES	**1967**	
	Area (Ha)	**Area (Ha)**
Built-up Land/Village	362.61	0.89
Agricultural Land	28441.26	64.55
Waste Land	1617.32	3.67
Dense Forest	8276.68	18.74
Degraded Forest	4263.67	9.67
Water Body	970.09	2.2
River	124.07	0.28
TOTAL	**44055.7**	**100**

Table No. 4 Landuse/Landcover Distribution (1967)

The figures presented in table 4 above represents the static area of each landuse Landcover category for the year 1967. Less than 1% area under built-up land/village category depicts the natural nature of social structure of the study area in the year 1967. More than 64% of agriculture land shows the dependency of the population on agriculture for livelihood. The total forest cover (both dense and degraded) of the is about 28% which shows the presence of good natural habitat. Also the wasteland was very less (<4%). Water bodies covered around 2.2% of the total area. And the river occupied 0.28% of the total area.



Map No.4 LU/LC (1967) Map of the Study Area

In 1992, the built-up land/village category has grown by 1.5 times. This is due to the rise of population as well as due to the rise semi urban centers in Mandideep and Obedullaganj, which are the result of industrial development of Mandideep. Industrial area commands a handsome 0.84% of the total area.

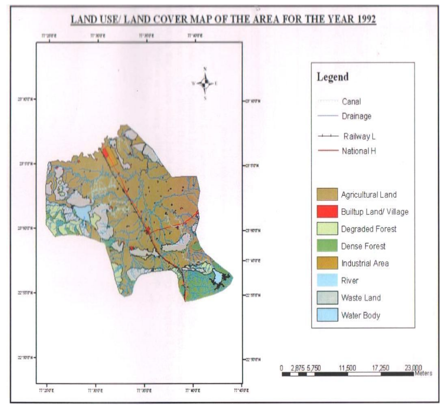
The agricultural land has also registered a growth of around 2%, which further strengthens the agrarian nature of the social structure. Dense forest category has registered a considerable dip in its share of the total area by about 10%. Degraded forest also has registered a cut down by about 3%.Wasteland has increased by about 10%. Water bodies have a meager increment of 0.07%.

LANDUSE/LANDCOVER CATEGORIES	1992	
	Area (Ha)	Area (%)
Built-up Land/Village	512.33	1.16
Agricultural Land	29155.12	66.18
Waste Land	6475.18	14.70
Dense Forest	3650.76	8.24
Degraded Forest	2787.17	6.33
Water Body	1000.82	2.27
River	124.07	0.28
Industrial Area	350.35	0.84
TOTAL	**44055.7**	**100**

Table No. 5 Landuse/Landcover Distribution (1992)

The figures presented in table 4 above represents the static area of each landuse Landcover category for the year 1992.

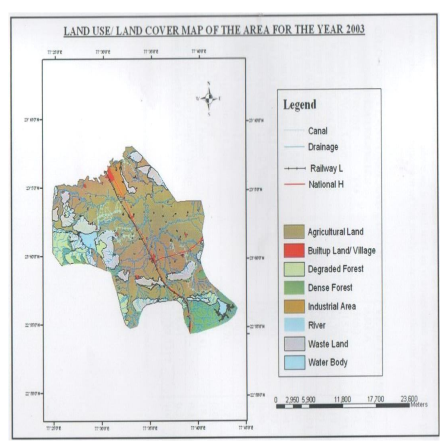
The pattern of landuse Landcover distribution in 2003 also follows the pattern in previous years. Agriculture land still occupies a major part of the total land but there exist an increase by 1% in the total industrial area. Still, water body maintains the least position in the classes whilst built-up land/village category occupies 1.33% of the total class. The forest area along with wasteland is almost stable.



Map No.5 LU/LC (1992) Map of the Study Area

LANDUSE/LANDCOVER CATEGORIES	2003	
	Area (Ha)	Area (%)
Built-up Land/Village	587.80	1.33
Agricultural Land	28708.20	65.15
Waste Land	6461.20	14.66
Dense Forest	3486.60	7.91
Degraded Forest	2875.11	6.55
Water Body	987.62	2.25
River	124.07	0.28
Industrial Area	825.10	1.87
TOTAL	**44055.7**	**100**

Table No. 6 Landuse/Landcover Distribution (2003)



Map No.6 LU/LC (1992) Map of the Study Area

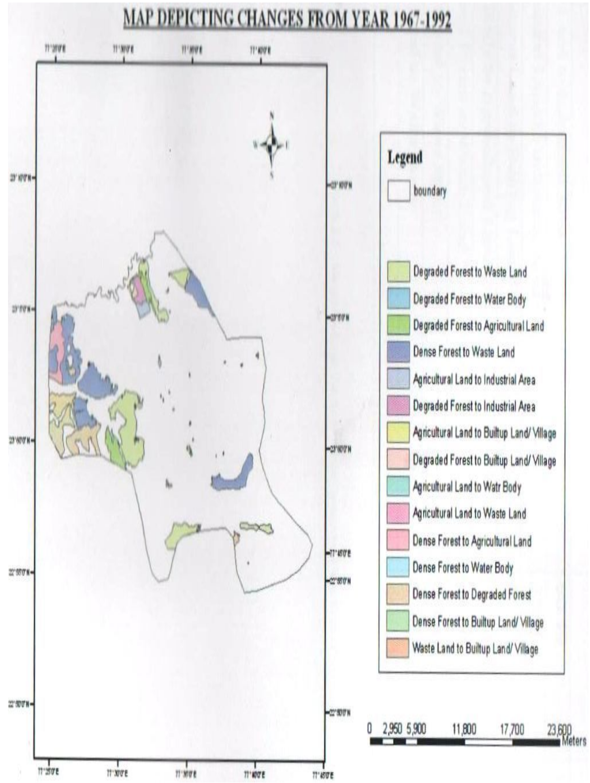
The figures presented in table 4 above represents the static area of each landuse Landcover category for the year 2003.

Nature and Location of Change in Landuse Landcover

An important aspect of change detection is to determine what is actually changing to what i.e. which landuse class is changing to the other. This information will reveal both the desirable and undesirable changes and classes that are "relatively" stable overtime. This information will also serve as a vital tool in management decisions. This process involves a pixel-to-pixel comparison of the study year images through overlay.

Changes in Landuse Landcover Categories From 1967 to 1992	Year-1967-1992	
	Area (Ha)	**Area (%)**
Degraded forest to wasteland	2157.93	27.81
Degraded forest to Water body	14.72	0.19
Degraded forest to Agricultural land	458.27	5.91
Dense forest to Wasteland	2716.32	35.01
Agricultural land to industrial area	160.80	2.07
Degraded forest to industrial area	189.56	2.44
Agricultural land to built-up land/village	56.40	0.73
Degraded forest to built-up land/village	65.42	0.84
Agricultural land to water body	13.92	0.18
Agricultural land to wasteland	0.0017	0.00
Dense forest to Agricultural land	486.70	6.27
Dense forest to water body	2.08	0.03
Dense forest to degraded forest	1409.41	18.16
Dense forest to built-up land/village	11.39	0.15
Wasteland to built-up land/village	16.41	0.21
TOTAL	**7759.3317**	**100**

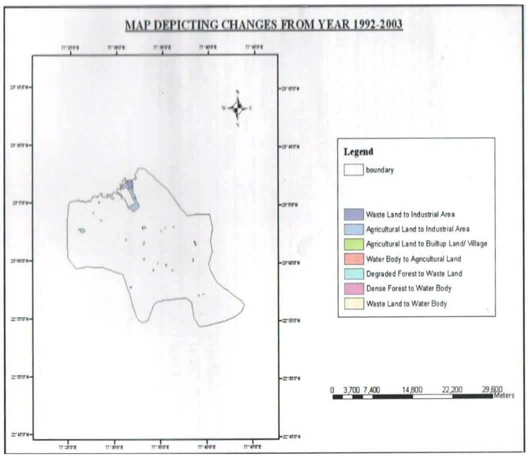
Table No.7 Changes in Landuse Landcover Categories from (1967 to 1992)



Map No.8 Change Detection Map (1967-1992) of the Study Area

Changes in Landuse Landcover Categories From 1992 to 2003	Year-1992-2003	
	Area (Ha)	**Area (%)**
Wasteland to industrial area	90.19	14.83
Agricultural land to industrial area	383.77	63.10
Agricultural land to built-up land/village	76.53	12.58
water body to Agricultural land	13.18	2.17
Degraded forest to wasteland	44.56	7.33
Dense forest to water body	0.0002	0.00
Wasteland to water body	0,0002	0.00
TOTAL	**608.2304**	**100**

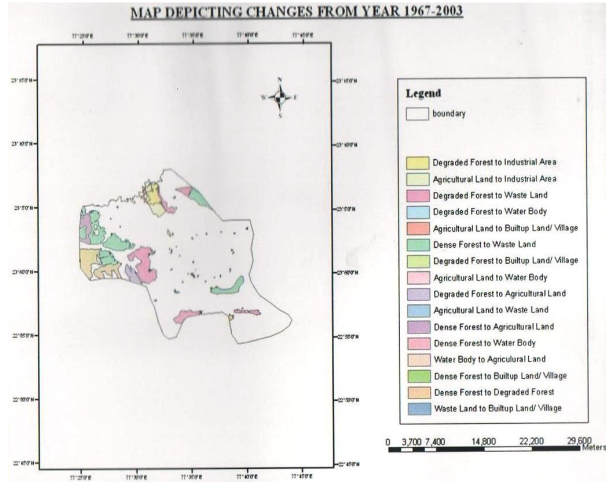
Table No.8 Changes in Landuse Landcover Categories from (1992 to 2003)



Map No.8 Change Detection Map (1992-2003) of the Study Area

Changes in Landuse Landcover Categories From 1992 to 2003	Year-1967-2003	
	Area (Ha)	**Area (%)**
Degraded forest to industrial area	421.81	5.11
Agricultural land to industrial area	402.51	4.88
Degraded forest to wasteland	2067.74	25.05
Dense forest to water body	14.72	0.18
Agricultural land to built-up land/village	132.84	1.61
Dense forest to wasteland	2792.53	33.84
Degraded forest to built-up land/village	65.42	0.79
Agricultural land to water body	13.09	0.16
Degraded forest to Agricultural land	316.20	3.83
Agricultural land to wasteland	0.0016	0.00
Dense forest to Agricultural land	486.70	5.90
Dense forest to water body	2.08	0.03
Water body to agricultural land	12.35	0.15
Dense forest to built-up land/village	11.39	0.14
Dense forest to degraded forest	1497.38	18.14
Wasteland to built-up land/village	16.41	0.20
TOTAL	**8253.17**	**100**

Table No.9 Changes in Landuse Landcover Categories from (1967 to 2003)



Map No.8 Change Detection Map (1967-2003) of the Study Area

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