Asian Resonance

Gis and Remote Sensing Application in Change Detection Mapping of Bhandewadi Area of Nagpur District, Maharashtra.

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Abstract

The land use and cover change (LUCC) study under the International Geosphere Biosphere Program (IGBP) has taken many initiative in above context. Remote sensing data efficiently provides detailed information regarding forest cover, vegetation type and land use/land cover changes on regional scale. These were analyzed using Survey of India Topographical Map (1972), IRS-LIIS –III 2000 and 2006 satellite data and ground truthing of study area for a part of Bhandewadi Area of Nagpur District, Maharashtra. The land use/land cover map were prepared in order to study land cover dynamics using large scale (1:50,000) map. Supervised and unsupervised classification procedure adopted for digital classification satellite data. Change detection means finding changes in the earth surface feature related to the past in the same geographic area. Global changes, Environmental changes are some of the causes for change pattern in a small area. Change detection includes analysis of landuse/landcover pattern changes, geomorphological landform change, environmental impact changes, etc.

Keywords: Change detection , Remote sensing , GIS

Introduction

Enormous pressure of growing population, increased demand for food, fuelwood and shelter combined with industrial activities have essentially led to drastic change in land use/land cover patterns. Information on existing land use/land cover, its spatial distribution and change are essential prerequisite for planning (Dhinwa et al., 1992) Land use planning and land management strategieshold key for development of any region (Anon, 1992). Land use data are needed in the analysis of environmental process and problems that must be understood if living condition and standards are to be improved or remained at current level (Anderson et al., 1976). Space technology has emerged as an efficient and powerfool tool in providing reliable information on various natural resources of a region in a spatial format. Such spatial format is essential for planning (Roy et al., 1991, Joshi, et al., 2001). The present study area is part o Nagpur District is situated in the eastern part of the state of Maharashtra and famous for its orange production. Remote Sensing tehchnology can play a vital role in providing accurate and reliable landscape detail with lower cost and lesser time compared to other methods. In the present study, IRS LISS-3 digital data were used to delineate existing land use/land cover types for 2000 and 2006 for the monitoring the change detection.

Study Area

Nagpur District is situated in the eastern part of the state of Maharashtra and famous for its orange production. The entire district is covered in the Survey of India degree sheet number 55 K, L, O and P, and bounded in between Latitudes 20° 35′:21°44′N and 78°15′:79°40′ E Longitudes. The total geographical area covered is about 9931 sq. km and the district is bounded by Chhindwada District of Madhya Pradesh on the north Bhandara District on the east, Chandrapur District of South and Wardha and Amravati District of Maharashtra on the west side (DRM 2001). For the present wastewater management studies approximately 40 sq. km area of Nagpur district falling in between the Latitudes 20°35′:21°44′ N and 78°15′:79°40′ E Longitudes of Survey of India (SOI) toposheet No. 55 O/4 is considered

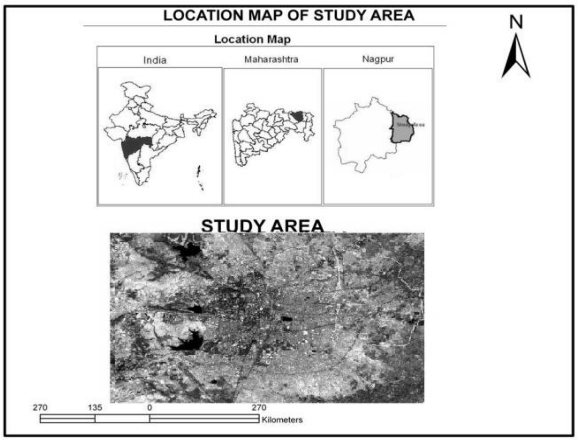


Fig.1 : Location Map of Study area

Landuse/Landcover Classification Scheme

American Planning Association "land Based Classification Standard"

The most comprehensive hierarchical classification system for urban / suburban landuse is the land based classification standard (LLBCS) which is under development by the American Planning Association (1999). The standard updates the 1965 standard landuse coding manual (Urban Renewal Administration, 1965), which is cross reference with the 1987 Standard Industrial Classification (SIC) manual (Bureau of the budget, 1987) and the updated North American Industrial Classification Standard (NAICS). The LBCS requires extensive input from in situ site surveys, aerial photography, and satellite remote sensor data to obtain information at the parcel level on the following five characteristics viz.: Activity, Function, Site development, Structure and ownership (American Planning Association, 1999). The LBCS does not provide information on landcover or vegetation characteristics in the urban environment, as it relies on the federal geographic data committee standards on this topic. The LBCS is still under development. Users are encouraged to keep abreast of the LBCS and to utilize it for intensive urban studies that require detailed commercial or industrial classification codes.

U.S. Geological Survey

"landuse/landcover classification system for use with remotely sensed data"

The U.S. Geological Survey "landuse / Land cover classification system" was originally designed to be resource-oriented (landcover) in contrast with various people or activity (land use) oriented systems, such as the standard landuse coding manual. The USGS rationale was that although there was an obvious need for an urban oriented landuse classification system whose primary emphasis would be remaining 95% of primarily by the interpretation of remote sensor data obtained at various scales and resolution and not data collected in situ. The USGS system addresses this need with eight of the nine level 1 categories treating land area that is not in urban or built-up categories. The classification system was initially developed to include landuse data that was visually photo interpreted, although it has been widely used for digital multispectral classification as well.

While the USGS landuse landcover classification system was not originally designed to incorporate detailed urban attribute information. It nevertheless has been used extensively for more than two decades for urban landuse studies. Embellishing the classification system with detailed study level 3, 4 and 5 urban class definitions usually perform this. The utility of the modified system is that it may be adopted to include as many levels as desired yet is upwardly compatible with all the USGS Level 1 and 2 landuse and landcover data compiled by neighboring cities, countries, states or nations.

Application of Remote Sensing Techniques for Landuse/Landcover

Remote sensing techniques provide reliable and accurate information for landuse mapping. Generalised delineation of land use classification for large areas and spatial distribution of landuse categories is possible by satellite imagery because it provides a synoptic view. Remote sensing techniques are helpful to study changes at regular intervals. Small and medium scale landuse mapping for State and National series on 1:1,000,000 pr 1:25,000 or 1:50,000 is possible by satellite remote sensing techniques.

Satellite remote sensing techniques provides land resources data in the form of digital magnetic tapes and in different bands of electromagnetic spectrum. We can also have coverage of the same area on different dates. We can obtain imagery from these tapes on different bands and also combine them to produce a colour composite. Availability of such data in different band makes it very useful for delineating different landuse/landcover classes distinctly.

Landuse/landcover mapping by both visual interpretation and digital analysis is possible form satellite remote sensing techniques. Monitoring of changes in landuse/landcover can be studies at real time as RS data has receptivity.

Updating of information and hence change monitoring will be much faster as the earlier data is compatible for digital analysis.

Application of Gis In Landuse / Landcover

Modern techniques of Geographical Information Systems (GIS) along with conventional techniques have been effectively used in natural resources management including mapping and monitoring. The benefits as compared to the conventional approach are mainly in terms of timeliness, speed, cost, reliability, and flexibility both in mapping and monitoring of changes.

The landuse/landcover map and statistics generation required as input in the preparation of land management plan preparation would typically take 4-5 months for an area more than 2000 sq.km. this is much faster than the time required by conventional approaches, which required around 2-3 years.

Reliability of maps generated by using GIS would be higher than any other conventional method. Eliminating subjectively and scope for human errors.
Accurate location of sample plots which aid in making more comprehensive and realistic plans.
Qualification of land use or misuse and its precise location.

The updating of information and hence change monitoring will be much faster than the earlier data.

The GIS based database once established would facilitate analysis of various alternatives before arriving at the operational management model.

Change Detection Algorithm

Selection of appropriate change detection algorithm is based on analysis of several important factors. The analyst must know the cultural and biophysical characteristic of the study area. It is imperative to know the precision with which the multiple data imagery is registered. One should be aware of the change detection algorithm alternatives, their degree of flexibility and availability.

Five general classes of algorithm are :

a) Image differencing
b) Image rationing
c) Classification comparison
d) Comparison of preprocessed imagery.
e) Change vector analysis

Image differencing:

Image differencing involves subtracting the imagery of one data from that of another. The subtraction results in positive and negative values in areas of reliance changes and zero values in areas of no change. In 8-bit analysis with pixel values ranging from 0 to 255, the potential range of difference values is -255 to +255. The results are normally transformed into positive values by adding a constant, c, the operation expressed mathematically as -

$$\Delta x\ ijk = BV\ ijk\ (1) - BV\ ijk\ (2) +$$

Where, Δx ijk = Change pixel value
BV ijk (1) = Brightness value at time 1
BV ijk (2) = Brightness values at time 2
C = a constant (eg. 235)
i = No. of lines
j = No. of columns
k = a single band

This procedure yields a differenced distribution for each band approximately Gaussian in nature, where pixel of no brightness value change are distributed around means and pixel of change are found in the tails of the distribution. A critical element of the image differencing method is deciding where to place threshold boundaries between change and no change pixels displayed empirically to determine if changes were accurately monitored. The procedure has also become interactive, wherein an analyst familiar with the tries various thresholds until optimum ones are identified.

Image rationing:

Change is viewing conditions (eg. Shadows, seasonal reflectance due to sun angle, etc.) degrades the ability of a classifier to identify materials correctly. Fortunately, ratio transformations tend to remain invariant when changes result from such factors. These ratios are especially useful for change detection when several dates of imagery are used in an analysis because they can reduce the effect of environmental and system multiplicative factors present. The better these factors are controlled, the higher the probability that accurate change detection will take place.

$$\Delta r\ ijk = \frac{BV\ ijk\ (1)}{BV\ ijk\ (2)}$$

Where Δr ijk = bib-normalized change pixel value
BV ijk (1) = brightness value at time 1
BV ijk (2) = brightness value at time 2
i = No. of line
j = No. of column
k = a angle land

Basically, a pixel that has not changed in land cover will have the same brightness value on both dates, yielding a ratio value of 1.0 that can be scaled to produce a middle gray tone. Areas of change in the multiple date imagery will have value either higher or lower than 1.0 thus, as with the image differencing method, a change histogram is produced with the tails of the distribution containing the change information. The selection of thresholds is again based on empirical judgement.

Pixels that did not change in brightness value between dated were allocated a middle gray tone (i.e. RGB = 127,127,127). I areas of change that had value either higher or lower than 1.0 were displayed in either light or dark tones that were directly proportional to the spectral intensity of the change that look place. Therefore, the lighter or darker a pixel appeared, the more the digital value changes between the two dates.

Classification comparison

Several change detection alternatives evaluates land use classifications produced either from each separate date of imagery or from the two dates of imagery or from the two dates of imagery as a set.

Post Classification Comparison:

Post classification comparison identifies change by comparing two independently produce classification maps. An algorithm simply compares the two classification maps utilizing class pairs specified by the analyst and generates a map indicating areas of change. By property coding the classification results for date 1 and date 2, the analyst can produce change maps that show a complete matrix of change. Therefore, it is possible to identify not only the pixels that have changed between the dates, but also the nature of that change. The results of post classification comparison present study were considered a priori to be the superior change detection method and used as the standard for evaluating the results of other method. This method produces poor results unless extremely accurate classifications of the individual dates are made. The accuracy of the method depends on the accuracy of the initial classification, and any errors are compounded. Another thing is that the heterogeneity of urban land use produced many mixed pixels, which lowered the accuracy of the individual classification maps. A symptom of the problem was that too much change was consistently identified.

Spectral / Temporal Change Classification

Spectral / Temporal Change Classification alternative detects change by performing a single classification on a multiple data set. In present study Liss III data are used the four bands of data for each of two dates are analyzed at one time using pattern recognition techniques. The method may employ supervised classification techniques, in which case the analyst selects training sites that are used to determine signatures for desired classes or unsupervised classifications techniques, in which case like phenomena are clustered into similar classes based on their statistical properties. In either case, change classes should have significantly different statistics from non-change classes. That method gives output into 5 categories, such as increase, some increase, unchanged, some decrease and decreased. In this method we can use only one band at a time. So the output can not be identical / statistical measurement, for specific class.

Comparison of Preprocessed Imagery

Principal component analysis applied to multispectral data produces a series of linear transformation of the observed variables that result in a new, smaller set of mutually orthogonal variables. Because each consecutive new variable accounts for the maximum amount of variability within the original data, the transformation provides uncorrelated variables, with the first to enter component generally containing 90 to 95% of the variance. Thus, principal component analysis may reduce the dimensionality of the change detection problem without losing useful information.

Process using PCA

The means and variance of a sample of observations from a given sub scene were obtained.
Eigen values and eigenvectors were extracted. The entire population was transformed using the matrix obtained n step 1.

Histograms were analyzed using image differencing techniques and decision rule applied.
We can found that component I represented primarily the unchanged land cover as measured by the infrared bands. It was also a good indicator of terrain topography and roughness. Components, 2 represented unchanged land cover measured in the visible region. Components 3 and 5 contained change information, 6 to 8 contained random noises (Lansat TM 7 bands). Principle component analysis provides an effective way of identifying areas in which has occurred between two four-channel multispectral scanner images.

Change Vector Analysis:

When land undergoes a change or disturbance, its spectral appearance may change, if two spectral variables are measured for the area both before and after change occurs and then plotted on the same graphic. The vector describing the direction and magnitude of change from the first to the second data is a spectral change vector. The decision that a change has occurred is made if a threshold is exceeded.

Preprocessing To Improve Change Detection:

Many change detection studies preprocess the remotely sensed data prior to suing it in one of the change detection methods just discussed.

Low Frequency Filtering :

One type of preprocessing is image smoothening where a spatial moving average enhances area of homogeneity at he expense of high frequency details. For example, LISS II data were (1) smoothed using a 3x3 moving average filter, or (2) smoothed using a boundary preserving algorithm. The new images were then differenced and mapped.

High Frequency Filtering :

It is possible to apply filters that enhance high frequency detail in the scene. For example, a Laplacian enhancement may be applied to each local neighborhood. Such enhancement produces a sharp visual image but contain more noise than the original. This, there is a trade-off in deciding to what extend edges should be enhanced. By this method result may be less accurate than using simple image differencing of LISS III 1, 2, 3 bands.

Texture Transformation:

Texture is very important in the human interpretation of change in aerial photography and therefore offers the potential of improved accuracy when used as an element in machine-assisted change detection. Basically, it is possible to preprocess the remotely sensed imagery to yield multiple date texture images. These images can then be analyzed using any of the change detection procedures described previously. The 2004 and 2007 texture images were differenced and the histogram analyzed to produce a change map showing areas where texture changed dramatically between 2004 and 2007.

Accurate Rectification:

Accurate spatial registration of at least two images is essential for digital change detection. The images may be raw remote sensor data obtained on two different dates or two classification maps produce from imagery obtained on two different dates. This necessities the use of geometric rectification algorithms that register the image to each other or, even better, to a standard map projection. Rectification should result in the two images or maps being within one forth to one half a pixel of registration one to another.

Spatial Resolution :

The spatial resolution of the sensor system is important because the instantaneous field of view (IFOV) governs, the size of the area over which radiant flux will be integrated and recorded. The size of the pictures element represents the minimum-mapping units.

Temporal Resolution :

The sensor system should record an image of the same area at regular intervals and at the same time of day. Anniversary dates are often used because they minimize differences in reflectance caused by seasonal vegetation changes, soil moisture variation, or sun angle differences.

Data Use And Methodology

Landuse/landcover mapping and change-detection studies based on the digital processing of remotely sensed data need careful planning of various activities. Different land use/land cover categories were identified based on the image characteristics like tone, texture, size, shape, pattern, location, association, etc. Geo-database creation and statistics generation for land/use cover and changes is done in GIS environment. The following activities preparatory to digital processing are particularly relevant to successful transformation of remotely sensed data into land use/land cover categories.

Database

The present study is based on the remote sensing spatial data as well as the non-spatial data available from the various sources for different periods. The Indian Remote Sensing Satellite IRS 1C and 1D multiresolution sensors as Panchromatic (PAN) and Linear Imaging Self Scanner (LISS-III) imageries with ground resolution of 5.8 and 23.5 meters respectively have been acquired for two periods for the study area. So, the spatial digital data is comparatively more useful than other methods of data collection especially for urban land cover/land use change detection studies.

The analogue scanned images of the Survey of India (SOI) toposheets on the scale of 1:50,000 and 1:25,000 have also been used for the study are. Whereas the non-spatial data as agricultural land, forests and wastelands have been obtained from the various sources as the NEERI (National Environmental Engineering Research Institute) & MRSAC (Maharashtra Remote Sensing Application Central).

The Geographic Information System (GIS) and Remote Sensing (RS) tools have been applied to find out the land use/land cover changes over periods in the Nagpur city. Such as the Arc/Info, ArcView, and ERDAS have been used for geographical analysis, integration, and presentation of the spatial and non-spatial data for landuse/landcover change detection. So, these tools are more effective for monitoring and modeling for urban landuse/landcover changes as well as for the sustainable environment and urban development in the Nagpur city.

Supervised Classification of FCC Images:-

For Land Use Land Cover mapping adopted the supervised classification method for few classes. Such as Crop Land, Dense Forest, Open Forest, Barren Land etc. That class signature is clearly identical. Some times signature mixed within classes mismatch for those classes adopted another method to classify those classes. Identification of the signature depends on the image interpretation keys that is shape, size, tone, texture, color, association, pattern, site, shadow etc.

Supervised classification is usually appropriate when few of the classes have to be identified or when training sites have been selected that can be verified with ground truth data, or when to identify distinctly, homogeneous regions that represent each class. Certain features like settlement have been visually interpreted from satellite images, generated bitmap masks and latter added to the classified output. Gupta, Ravi P. (1998).

Vectorisation of Base Layers

The base layers like settlement, river, water bodies, road, forest boundaries, green wash etc, are digitized from the existing maps like toposheet and later updated using LISS III images.

Raster to Vector Conversion for Lu / Lc Maps

The final output would be in raster format, for better representation, raster classified image needs to be converted into vector format. On vector format we can calculate statistics, different cartographic method by various data that is attached to the vector file, Polygons or features are identified by the code which is given when image is classified (each class attach one unique code), vector (coverage) data attachment. That total work was performed in Erdas Imagine 9.1

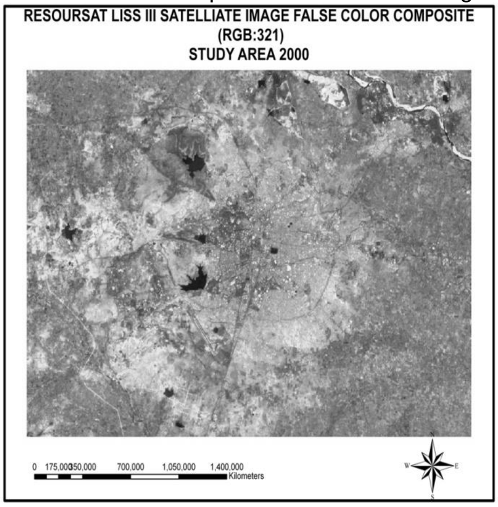


Fig.5.2: FCC Image of Study Area (2000)

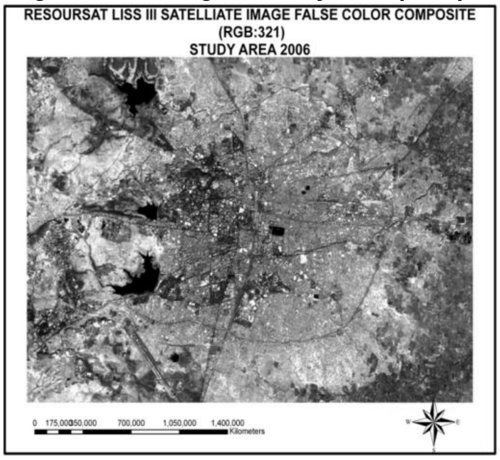


Fig. 5.3 : FCC Image of Study Area (2006)

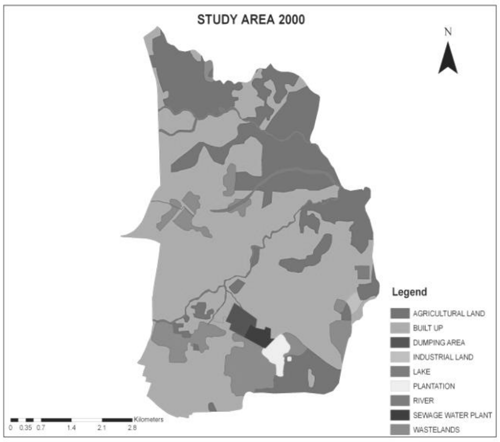


Fig. 6.1: Landuse/Landcover Map of Study Area (2000)

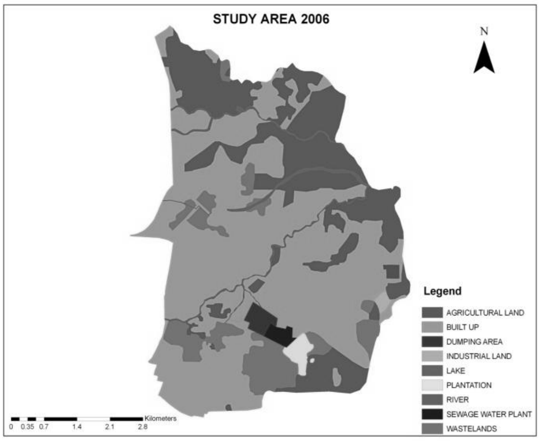


Fig. 6.1: Landuse/Landcover Map of Study Area (2000)

Change Matrix Generation:-

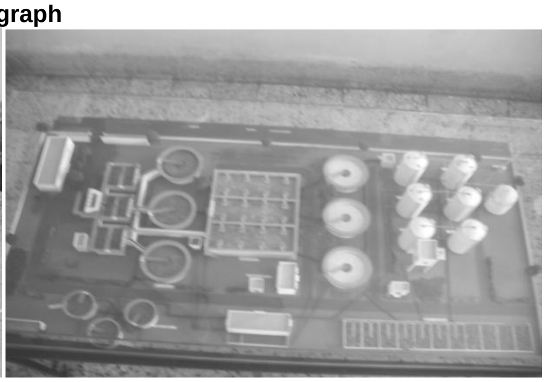
The output of the change matrix has total number of combination between the class as of 2000 and 2006. This output has been recoded into logical change classes and the final change map has been generated.

Statistics Computation:-

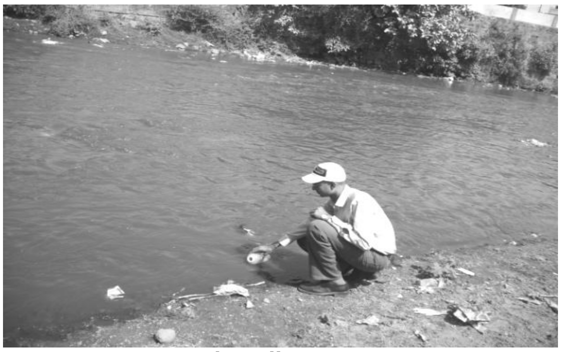
In all three outputs have been generated a) 2000-Land use/Land cover b) 2006 Landuse/landcover and c) change in Landuse/landcover between 2000 and 2006 period. Each class area is computed in ERDAS software for both time periods and changes in land use / land cover.

Field Photograph

Dumping ground, Bhandewadi



Model of STP, Bhandewadi.



Sample collect at Punapur.

Wastewater of Bharatwada.

Agriculture using Sewage Treatment Plant water

Bharatwada and Bhandewadi.

Results and Discussion

The study of change detection in the Bhandewadi area of Nagpur district has shown slightly change which may be of great important in the urban planning and management programmes. The comparative assessment of satellite imagery for the year 2000 and 2006 in the study area in terms of density or the floral and faunal assemblages shows changes in the urban areas over a period of time. The study area is situated in Bhandewadi, Punapur and Bharatwada which is covering the East part of the Nagpur city. The total geographical area under study is 30.70 sq. km. During the course of analysis the study areas has been classified into Nine classes such as agricultural land, built up, dumping area, industrial and lake, plantation, river, sewage water plant wasteland. In some part of the study area remarkable changes in the landuse/landcover have been observed which is supposed to be the outcome of human interference in the natural environment. According to the above studies of the landuse/landcover of Bhandewadi, Punapur, and Bharatwada villages of East part of Nagpur city showing the study area of 30.70 sq.km. The comparison of two assessment figure shows the statistically changes in the following classes of year 2000 and 2006.

Table 6.1 Inventory of LULC In The Study Area 2000-2006

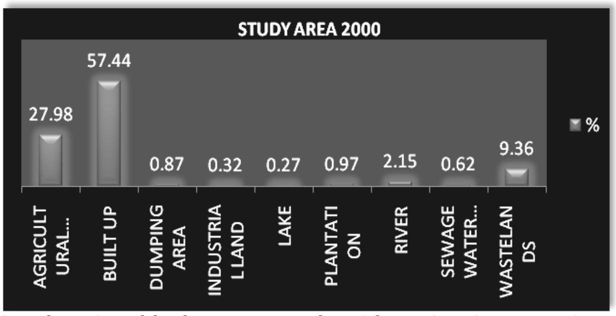
LU/LC Classes	2000 year	2006 year	Change detection 2000-2006
Agricultural Land	27.98%	27.29%	0.69%
Built up	57.44%	58.26%	0.82%
Plantation	00.97%	00.94%	0.03%
Wasteland	09.36%	09.25%	0.11%

1. Out of 30.70 sq.km. of study area 27.98% of Agricultural Land comes under the image 2000 year and 27.29% of agricultural land comes under the image 2006 year and hence at shows the change detection of 0.69%
2. 57.44% built up area comes under the image 2000 year and 58.26% of built up area comes under the image 2006 year and hence at shows the change detection of 0.82%.
3. 00.97% plantation comes under the image of 2000 year and 00.94% of plantation comes under the image of 2006 year and hence it shows the change detection of 0.03%.
4. 09.36% wasteland comes under the image of 2000 year and 09.25% of wasteland comes under the image of 2006 year and hence it shows the change detection of 0.11%.

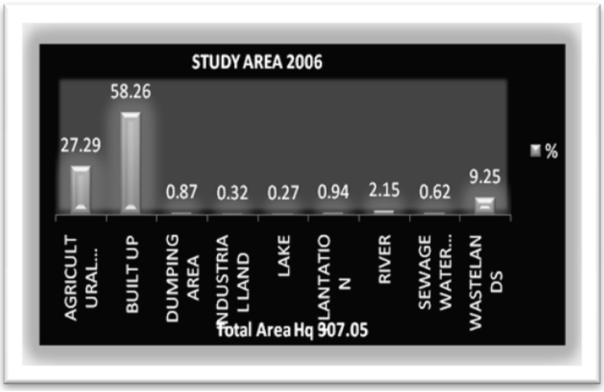
and the remaining classes like dumping area, industrial land, lake, river and sewage water treatment plant shows no change in their change detection analysis.

Table 6.5 :
Landuse/Landcover statistics of study area 2000

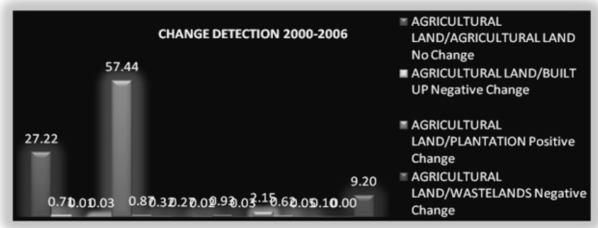
Frequency	D2000	Area Sq. Mtr.	Area Ha	% To Total
21	Agricultural Land	8590697.791812	85.90698	27.98
13	Built Up	17638462.367764	176.3846	57.44
1	Dumping Area	268260.877377	2.682609	0.87
1	Industrial Land	99538.394614	0.995384	0.32
1	Lake	83581.895805	0.835819	0.27
2	Plantation	298699.730757	2.986997	0.97
3	River	661295.347729	6.612953	2.15
1	Sewage Water Plant	191866.894044	1.918669	0.62
13	Wastelands	2872634.371973	28.72634	9.36
	Total	**30705037.671870**	**307.0504**	**100**



Graph I : Graphical Representation Of LULC DISTRIBUTION OF YEAR 2000



Graph Ii : Graphical Representation Of LULC Distribution Of Year 2006



Graph III: Comparisons of LULC distribution of year 2000 and 2006

Table 6.6 : Landuse/Landcover statistics of study area 2006

Frequency	2006	Area Sq. Mtr.	Area Ha	% To Total
21	Agricultural Land	8379983.534653	83.79984	**27.29**
13	Built Up	17889882.649487	178.8988	**58.26**
1	Dumping Area	268260.877377	2.682609	**0.87**
1	Industrial Land	99538.394614	0.995384	**0.32**
1	Lake	83581.895805	0.835819	**0.27**
2	Plantation	289983.849129	2.899838	**0.94**
3	River	661295.347729	6.612953	**2.15**
1	Sewage Water Plant	191866.894044	1.918669	**0.62**
13	Wastelands	2840644.229035	28.40644	**9.25**
	Total	**30705037.671870**	**307.0504**	**100.00**

Conclusion

Combination of digital topographic map and aerial photos is useful procedure to prepare land use map, especially for last decades. Digital maps have different layers including roads, rail way, residential area, forest and etc. Interpretations of these maps have done as digital under Micro Station computer software. The contemporary aerial photos interpretation revealed this result. The urban land cover and existing land use have been dynamic in nature over the periods in the Nagpur city. There are number of implications of urbanization on the landuse/landcover changes as the landscape's physiological destruction, illegal land encroachment etc. Due to rapid increase in population the land values have gone high in and around Nagpur city. The district's urban centers must grow in harmony to share the population pressure of the Nagpur city. So, it is expected that during the urban development process the agricultural land converted into the built up land result to increase in land value which can be used for financing of the urban development. Spatial regional planning in general and landuse/landcover planning in particular are important tools to guide the sustainable urban and environment development. In order to achieve sustainability, industrial and urban growth is economical desirable consequently, there is a need for the development of Spatial Data Infrastructure (SDI), which play an important role in the decision making process for the spatial growth of urban centers and the diffusion of economic activities for the sustainable environment and urban development. Actually there are slightly change detection occur in between the study of 2000 and 2006 years respectively. The changes which occur that we show in above reading. Actually such changes obtained due to the increases in a urbanization i.e. because of increasing high population. Due to this people are still agreed to live near the area like dumping area, beside Nag Nalla. This is only reason of increasing (urbanization) population in Nagpur city.

According to this study the city has immediate demand of 300 MLD (wastewater) sewerage treatment plant over 300 MLD sewerage water that unnecessarily goes into Nag River. The Nag river becomes highly polluted at Bharatwada and Punapur village and also result in environment harm. To avail the benefits from 300 MLD sewerage water that unnecessarily goes into drain and with a view to generate source of water, for wastewater management required proposed to set up new STPs (Sewerage Treatment Plnat) including 80 MLD at central Nagpur and two each will 100 MLD capacity at north zone and south zone.

Poorly managed water supply and sewerage services threatens public health and environmental harm to ensure that these services managed a significant legislative and regulatory framework must be complied with by those responsible for the provision and management of these services it is important that planners are aware of the legislative and regulatory framework relating to (water supply) and sewerage services.

This study seek to answer all these issues through use of R.S. and GIS for assessing and improving the sewerage infrastructure of an unban area.

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Frequency	Cng-00-06	Indicator	Area sq.mtr.	Area hq	% to total
21	Agricultural Land/Agricultural Land	No Change	8358380.554399	835.8380554	27.22
28	Agricultural Land/Built Up	Negative Change	219217.605930	21.92176059	0.71
1	Agricultural Land/Plantation	Positive Change	3942.624865	0.394262486	0.01
5	Agricultural Land/Wastelands	Negative Change	9157.006619	0.915700662	0.03
13	Built Up/Built Up	No Change	17638462.367763	1763.846237	57.44
1	Dumping Area/Dumping Area	No Change	268260.877377	26.82608774	0.87
1	Industrial Land/Industrial Land	No Change	99538.394614	9.953839461	0.32
1	Lake/Lake	No Change	83581.895805	8.358189581	0.27
1	Plantation/Agricultural Land	Positive Change	5947.811202	0.59478112	0.02
2	Plantation/Plantation	No Change	284790.920717	28.47909207	0.93
2	Plantation/Wastelands	Negative Change	7960.998838	0.796099884	0.03
3	River/River	No Change	661295.347729	66.12953477	2.15
1	Sewage Water Plant/Sewage Water Plant	No Change	191866.894044	19.1866894	0.62
5	Wastelands/Agricultural Land	Positive Change	15655.169052	1.565516905	0.05
6	Wastelands/Built Up	Positive Change	32202.675797	3.22026758	0.10
1	Wastelands/Plantation	Positive Change	1250.303547	0.125030355	0.00
13	Wastelands/Wastelands	No Change	2823526.223578	282.3526224	9.20
	Total		**30705037.671874**	**3070.503767**	**100.00**