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LAND USE AND LAND COVER AREA ESTIMATION FOR NAGPUR CITY, MAHARASHTRA USING REMOTE SENSING AND GIS TECHNIQUES

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Abstract: Land Use and Land Cover mapping is of great significance in scientific, scholarly research, planning and management. Regional land use pattern reflects the character of interaction between man and environment and the influence of distance and resources based on mankind's basic economic activities. Remotely sensed satellite images provide a synoptic overview of the whole area in a very short time span. This leads to quick and truthful representation of the real world in the best possible manner. It provides an insight to coordinate relationship among transportation, residential, industrial and recreational land uses, besides providing broad-scale inventories of natural resources and monitoring environmental issues, including land reclamation, mangrove restoration, disaster relief, water quality and planning economic development. Land Use Land Cover features have been precisely captured through on-screen visual interpretation and digitally on fused very high resolution (0.60 m, Quick Bird) and medium to coarse resolution (LISS IV, LISS III) satellite imagery. Provision of such maps helps town planners in effective and best possible utilization of its resources besides providing a comprehensive view of the total area. The present study focuses on the role of remote sensing and geographic information system (GIS) in assessment of changes in land use land cover area of Nagpur, Maharashtra, India. Extracting land use/land cover information is an indispensable exercise for agricultural land. This information is beneficial for decision support system, planning and development in land use. This information can be collected through visual interpretation and classification process of satellite data. The proposed system use the features of existing widely used classification system that are amenable to data derived from remote sensing sources.

Keywords: Land Use Land Cover, Remote Sensing, GIS. Resource utilization

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INTRODUCTION

Land use /Land Cover resources are the bases for various development activities on earth. Land use /Land cover assessment is one of the most important parameter to have meaningful plan for land resource management. Land use land cover inventories are increasing important in various resource sector viz. agricultural, forestry, industries and mining perspective study. Land use /land cover changes permits identification of long term trends anticipation of the problems that accompany change in land use.

Information on Land use / Land cover is the basic prerequisite for land resource evaluation, utilization and management. A considerable degree of land transformations is being witnessed as a result of growing population pressure and manmade activities on the finite land resources consummating in deterioration of the environment. As a precursor, it is necessary to understand the cause and effect of the transformations through scientific studies. In the present study, the Land use / Land cover analysis is performed using remote sensing satellite data and GIS Techniques to know about the land use / land cover pattern of the Nagpur City. The visual Interpretation and digital image classification techniques are used for analysis.

Study Area

The main objective of the study is to prepare base map, land use/land cover database for the period of 2011 using satellite data and to create GIS database for further analysis. Area of the study is Nagpur, Maharashtra State, India in figure-1. The co-ordinates of the study area are 21^0 08'40.95"N latitude and $79^0$05'31.63" longitude Nagpur City in central part of India. The city of Nagpur enjoys a very dry or semi-humid climate throughout the year excepting the monsoon months of June and September. The climate of Nagpur can be broadly divided into three important seasons of summer, winter and monsoon. With a population of 2,405,421 (2011) Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. It has also recently been ranked as the cleanest city and the second greenest city of India.

Remote Sensing & GIS technique is used for the present study. It provides useful data for Land use/Land cover. The technique is more reliable and reasonably accurate estimates on a near real time basis. IRS-P6 LISS-III satellite data, is used (shown in figure-3) in the technique. Topographical map on 1:50,000 scale, part of Toposheet No.55O4, were referred for Base Map Generation, Georeferencing of image and as collateral information during classification. ArcGIS10 and ERDAS Imaging were used to precede the task.

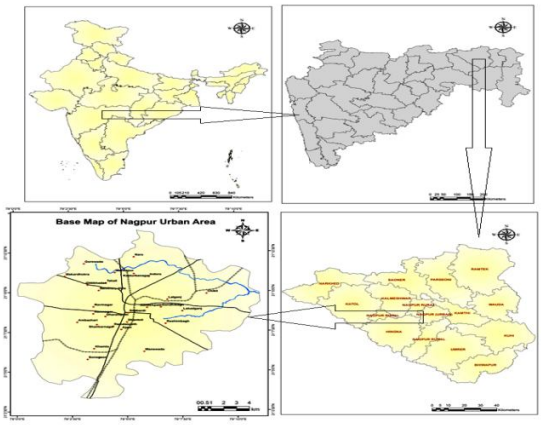

Fig 1. Study area map of Nagpur Urban area

Materials and Method:

Data Used

a) Toposheet Approved by Survey of India Having 1:50000 (550/4)

b) IRS P6 LISS III Data (23.5m Resolution)

Path: 099 Row: 057

Date of Pass: 09Jan2011

c) ERDAS Imaging Remote Sensing Software

d) Arc GIS Software

Methodology

The land use / land cover map is prepared from the digitally enhance and geo-referenced satellite imagery IRS-P6 LISS-III using the visual classification and digital classification techniques. Classification has been performed based on Land Use / Land Cover classification system. The land use statistics for visual classification and digital classification is generated for the study area. Image classification can be carried out in two different and most popular ways e.g. digital classification and visual interpretation. In the present study both digital and visual interpretation techniques are for classification. The visual or on on-screen interpretation is done using image interpretation characteristics / keys and the digital classification using Maximum Likelihood Classification is performed. The land use / cover classification scheme is

referred during the classification. During digital classification process training sets for different classes are defined on to the satellite imagery in different spectral response pattern. Based on these training sets satellite imagery is classified into different classes using maximum likelihood classifier. The on-screen modification is done mainly for built-up areas, mining areas and the classes which was not having desired spectral separablility.

The objective of the classification is to interpret the image visually or categorize the image pixels digitally for theme preparation. The multispectral satellite data is used to perform the classification. The spectral pattern present within the data for each pixel is used as the numerical basis for categorization in digital image classification. The main objectives of the multi-spectral data can be so as to highlight additional features. The main objectives of the designing classifies is to enable decision making regarding regions, which correspond to a specific or thematic class and the construction of the classifier so that it would identify any pixel belonging to the class corresponding to the decision region. Spatial pattern recognition involves the categorization of image pixels surroundings them. Digital image classification techniques are grouped into two types, namely supervised and unsupervised.

A supervised classification algorithm requires a training sample or different signatures for each class i.e. a collection of data point knows to have for from the class of interest. There are number of power full supervised classifiers based on the statistics which are commonly used for various applications. A few of them are a minimum distance to means method, maximum likelihood method, and Mahelanobis distance. The digital classification is performed using maximum likelihood classifier algorithm.

One of the simpler classification strategies that can be used in application are spectral classes which are close to one another in the measurement space and also have high variance. The mean or average, spectral value in each band for each category is determined. These values comprise the mean vector for each category. By considering the two channel pixel values as positional coordinates, a pixel of unknown identity may be classified by computing the distance between the values of the unknown pixel and each of the categories means. After computing the distances, the unknown pixel is assigned to the “closest” class. If the pixel were farther than a defined distance from any categories mean, it would be classified as ‘unknown’.

Flow Chart Showing Methodology for Mapping Land Use / Land Cover through Visual and Digital Classification Interpretation) Techniques

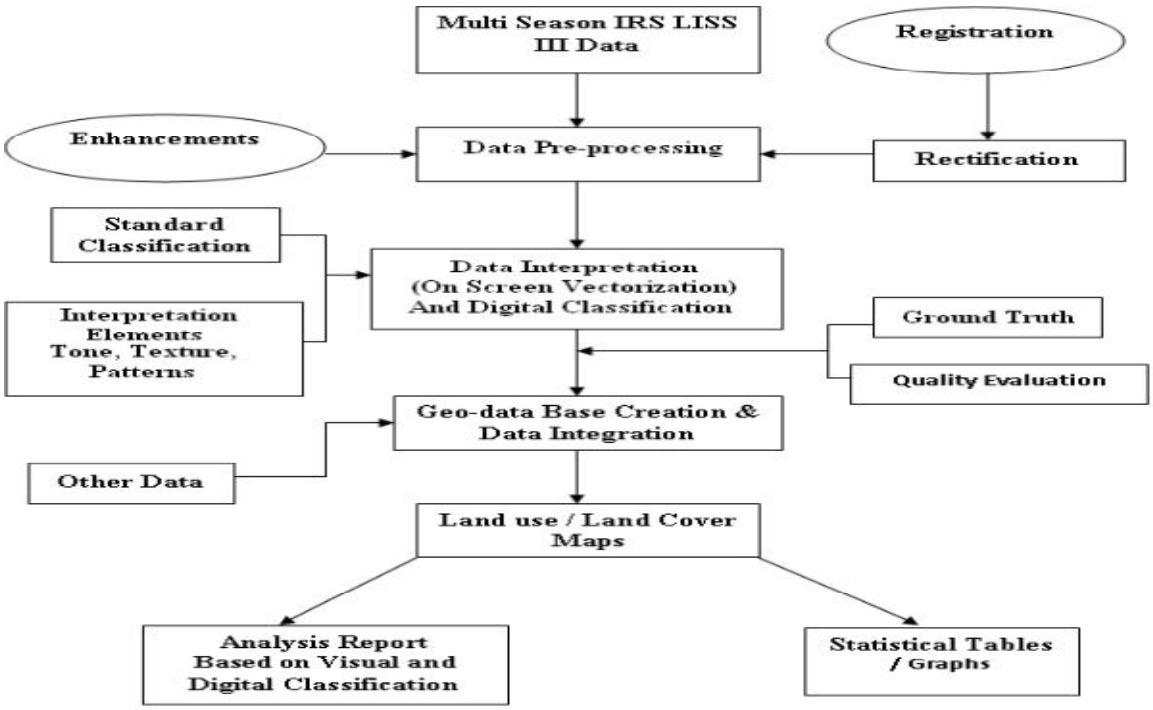

Fig 2. Flow Chart Showing Methodology Interpretation

A) Digital Elevation Model

Digital elevation models suggest the most widespread methods for extracting important elevation and topographic information. DEMs are used for visual analysis of topography, landscapes and landforms other than modeling of surface processes (Welch 1990). Currently Digital elevation models (DEMs) is considered as the main resource for the extraction of various geomorphologic and topographic features depending on their elevation, spatial distribution and deviations (Felicisimo 1994).

Nagpur Urban area is plane territory area having no high elevation difference the high elevation of Nagpur is 374 meter and low elevation of Nagpur urban area is 257 meter above the mean sea level area shown in **Fig.2**

B) Watershed

A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, scientist geographer, put it best when he said that a watershed is:"that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community." In the Nagpur Urban area there is sub watershed having Best, Moderate, Good and Poor shown in **Fig. 6**

C) Slope Map

Slope map simultaneously shows the aspect (direction) and degree (steepness) of slope for a terrain (or other continuous surface). Aspect categories are symbolized using hues (e.g., red, orange, yellow, etc.) and degree of slope classes are mapped with saturation (or brilliance of color) so that the steeper slopes are brighter. This will result in a map that has the colors shown to the right. There are two types of Slope

a) Percentile Slope b) Degree Slope

Nagpur urban area is purely human develop area there is large percentage in habitation mask out of these there is some slope like 1-3% , 3-5%, 5-10%, and 10-15% shown in **Fig.3**

D) Land Use Land Cover of Nagpur Area

Remote Sensing technology has emerged as a powerful tool in providing reliable information on various natural resources at different levels of spatial details, it has played an important role in effective mapping and periodic monitoring of natural resources including environment.

The maximum likelihood classifier quantitatively evaluates both the variance and co-variance of the category spectral response patterns when classifying an unknown pixel. To do this, assumption is made that the distribution of the cloud of points forming the category training details Gaussian (normally distributed). The assumption of normality is generally reasonable for common spectral response distribution. The distribution of a category response pattern can be completely described by the mean vector and the covariance matrix. We may compute the statistical probabilities of a given pixel value being a member of a particular land cover class. The resulting belt shaped surfaces are called probability density functions and there is one such function for each spectral category. The probability density function is used to classify an Unidentified pixel by computing the probability of the pixel value of the belonging to each category. After evaluating the probability in each category, the pixel would be assigned to the

most likely class (highest probability value) or labeled unknown if the probability values are all below a threshold set by the analyst.

Unsupervised classifier does not utilize training data as the basis for classification. Rather, this family of classifiers involves algorithms that examine the unknown pixels in an image and aggregate them into a numbers of classes based on the natural grouping or clusters present in the image values. The basic premise is that value within a given cover type should be close together in the measurement space, whereas data in different classes be comparatively well separated. There are numerous clustering algorithms that can be used to determine the natural spectral grouping present in the data set. **Fig.8** Shows the satellite image of Nagpur urban area in three bands which is Red, Green and Blue color and interpretation of the satellite data is shown is **Fig. 9.** Land use land cover of Nagpur Urban area. In the land use land cover there is six types of classes are shows they are Water body includes River showing Blue and Dark blue colour in the satellite image, Crop Land which is vegetation in the agricultural land showing pinkish or light red in the satellite image, Bulit up land (Human activities area) is showing greenish colour in the satellite image. All the interpretation of these classes are shown in **Table 1**

Table 1: Land use/Land cover statistics based on Digital Classification

Sr. No.	Land use/Land cover Classes	Area in Hectares	Area in (%)
1	Water Body	339.32	1.62
2	City Vegetation	2674.79	12.81
3	Crop Land	1658.55	7.94
4	Fallow Land	5011.47	24.00
5	Built Up Land	10989.5	52.62
6	Waste Land	209.14	1.00
	Total	**20882.8**	**100**

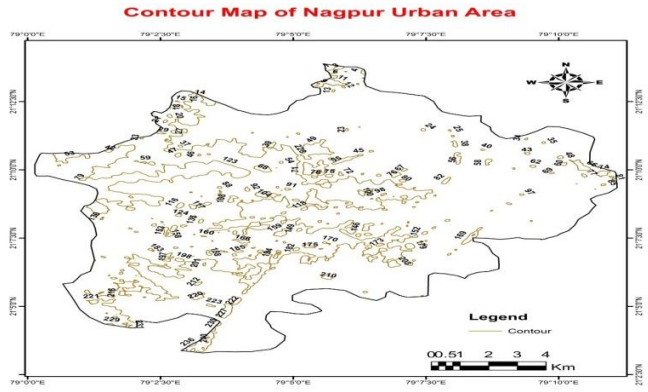

Fig.1 Contour Map of Nagpur Urban Area

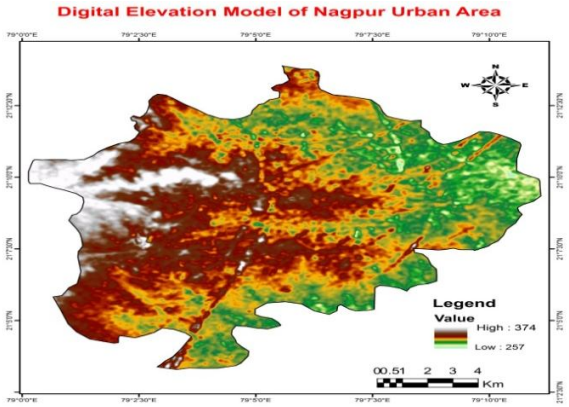

Fig.2 Contour Map of Nagpur Urban Area

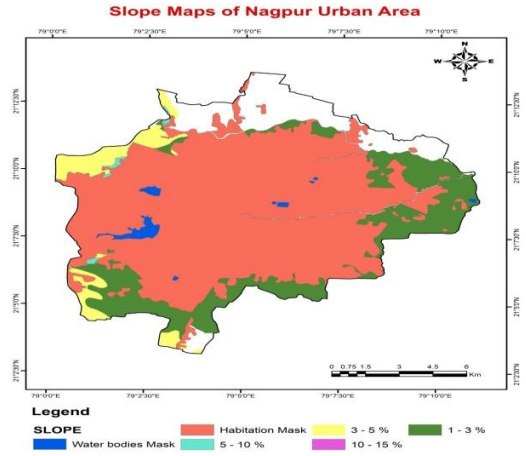

Fig.3 Slope Map of Nagpur Urban Area

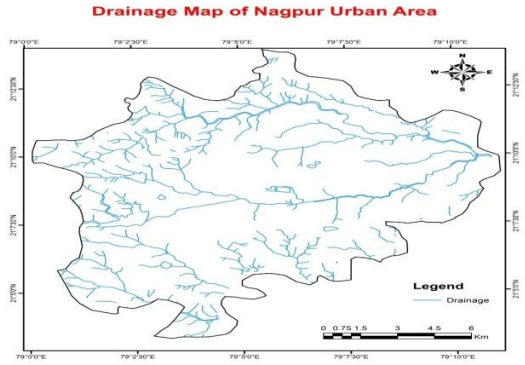

Fig.4 Drainage Map of Nagpur Urban Area

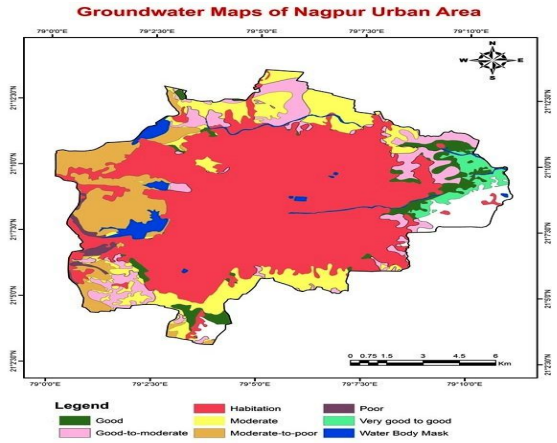

Fig.5 Groundwater potential map of Nagpur Urban Area

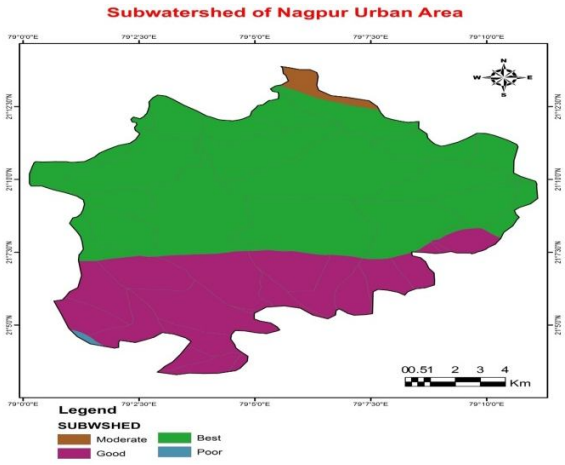

Fig.6 Sub watershed Map of Nagpur Urban Area

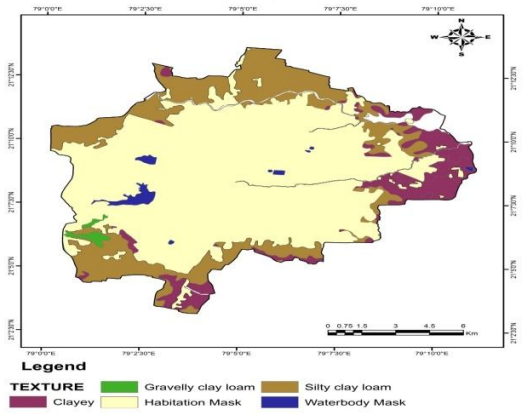

Fig.7 Soil Texture Map of Nagpur Urban Area

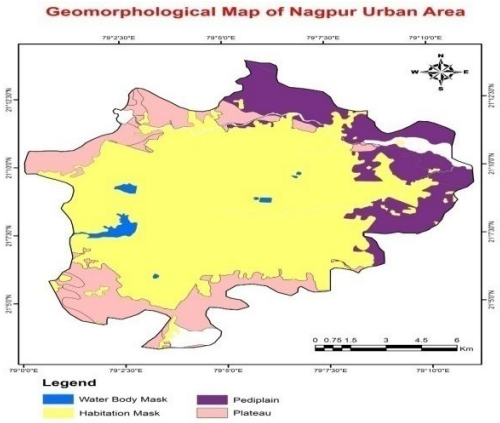

Fig.8 Geomorphological Map of Nagpur Urban Area

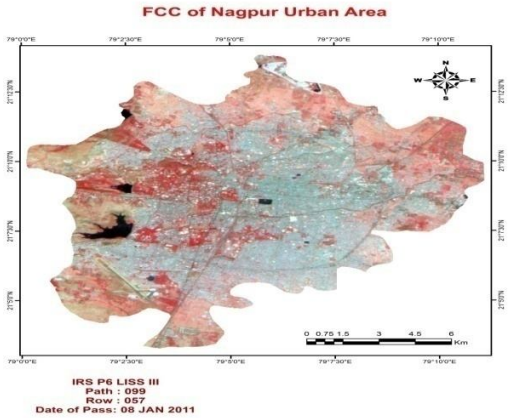

Fig.9 Satellite Image of Nagpur Urban Area

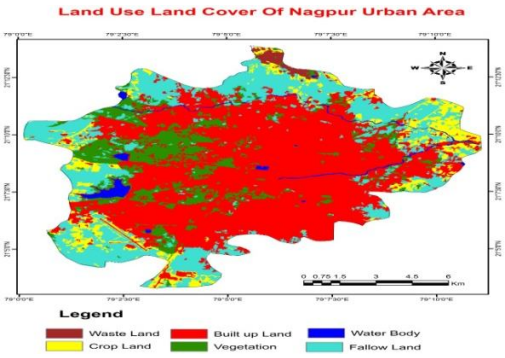

Fig.10 Land Use/ land Cover map of Nagpur Urban Area

CONCLUSIONS

Total area of Nagpur urban area is 20882.8 hectare. Here we have observed that 1658.55 hectare area is occupied in crop land while 5011.47 hectare area is fallow land. Such a land is harmful in agriculture so it should be utilized in agriculture or any other purpose for better crop production. Built up area or Human utilize area is 10989.5 hectare area occupied and waste land shows 209.14 hectare area. The study provides one year statistics of cultivation so it should be planned for next year to utilize such a land and to improve crop production.

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