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Study for Accuracy Assessment of land use and land cover classification of New- Delhi, North India

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ABSTRACT
Classification of satellite images are defined as the clustering of meaningful pixels in the required category. Remotely sensed data provides the variety of information without any compromise with quality and quantity which helps us out in research work and further essential parameters. Acquisition of the satellite images is the non-stoppable process with huge amount of data. Therefore, the proper classification of the pixels helps the researcher to get the appropriate information. The various classes have been defined to show the difference in the nature of land and its use. Image classification is a multi-step process followed by the preprocessing of the acquired data. The pre-processing and accuracy analysis of the Landsat 7 ETM+ data have been done in ERDAS Imagine. There after the land cover and land use classification has been done followed by the proper mapping in ArcGIS. The analyses represented in this paper are based on the error matrix or the contingency matrix. The kappa statistics for each class and overall classification accuracy has been discovered.

Keywords:- Accuracy Assessment, Kappa, Pixels, land use land cover, Remote Sensing, Landsat.

I. INTRODUCTION

The remote sensing trends are increasing very fastly and have wide advantages of digital satellite images. Various remote sensing techniques have been adopted which make the use of accuracy assessment [1,3] necessary. For the monitoring and the management of the natural resources the remote sensing has become the essential tool. From the past few years, the remotely sensed data helps in mapping natural resources, infrastructures and environmental studies. Various kinds of remotely sensed data have been used in land cover/land use classifications. Land cover can be described as the earth's part which is utilized by water, vegetation etc. whereas the land use can be described as the way of utilizing the land by human for the habitat like industry, agriculture etc. Although land cover and land use are the interchangeable terms. For example, vegetation is cover weather it is being used for agriculture or forests; it reflects the land use component. Unwise, utilization of the land cause the wide variety of degradation unless for the utilization of ecosystem. Therefore, the land is classified according to its cover to improve the environment so that there is no further deteriorations. The classification can be done in any of the ways: supervised and unsupervised classification [8]. Adoption of method [9,11] depends upon the research and the requirements of the work. Here, the unsupervised classification is adopted for the land cover and land use classification. Additionally, the unsupervised approach [4] has potential advantage of revealing discriminable classes unknown to previous work. To achieve the optimal utilization and maintenance of the natural resources for better understanding of the causes and consequences of land use and land cover mapping and monitoring is done in the study area i.e. Delhi, India on which the current study is carried out. If we talk about the objective of the study then we can say accuracy assessment [7] is done to check wellness of the classification and for the better understanding for the interpretation and usefulness of the classified states. Accuracy assessment and kappa statistics are calculated, kappa statistics is one of the measures for the accuracy, it shows the difference between actual agreement and agreement expected by chance.

II. STUDY AREA

Delhi, the selected area of study is the capital of India located on the banks of Yamuna River. It is the one of the largest metropolitan city in the world. Geographically situated at latitudinal extent of 28°23′17″–28°53′00″ N and longitudinal extent of 76°50′24″–77°20′37″ E (shown in figure), it is a land-locked city. It covers an area of 1483 km^2 with average altitude 213–305 m above mean sea level. The important features of physiography of Delhi are the Yamuna flood plain

and the Aravalli ridge. Yamuna River passes from all its seven districts with length of 48 km. Aravalli Range's extension is Delhi ridge. Here, Yamuna meets at two locations in Delhi, in the north and the east. Between the Thar Desert and the northern Indian plains Delhi ridge act as a barrier. It also acts as a thermal moderator and cooling agent in the climate of Delhi. Delhi has an extreme climate with annual temperatures ranging from 3°C in winters (January) to 45°C in summers (June) and average rainfall from 400 mm to 600 mm, as per the records of the India State of Forest Report (FSI). Basically, there are four seasons in Delhi, i.e. summers (May–July), spring/rainy (August–September), autumn (October–November) and winters (December–February). Summers are long and extremely hot accompanied with frequent dust storms. Humidity level is high during the monsoon season, while the air is dry during the rest of the year.

Broadly, Delhi is divided into nine districts and twenty-seven sub-tehsils, for proper administration and management. According to the Census of India in 2011, the Delhi grew from 0.4 million people in 1901 to 16.75 million in 2011, having population density of 11,297 persons per km^2. Delhi accounted for urban population of 52.76% in 1901 that rose to 82.4% in 1951, 93% in 2001 and 97.5% in 2011. It is a hub of a range of governmental organizations, residential colonies, service and educational facilities and also industrial activities because it is the principle administrative city of India. India Gate, Delhi Cantonment, Rashrapati-Bhawan and adjoining areas and Central-North Delhi ridge forest are the healthy forest areas of Delhi. It represents semi-arid condition because of the thorny scrubs vegetation on the ridge. According to the FSI, the total forest cover of Delhi is 176.2 km^2 (11.88% of geographical area) and 120 km^2 tree cover (8.09% of geographical area).

Fig.1 Show the area of study in India

III. MATERIALS AND METHODS

A Landsat 7 ETM+ image acquired on 16 th May 2011 were used to calculate accuracy assessment over the study area. The image was acquired from the United States Geological Survey (USGS) was captured at 04:09 pm under clear atmospheric conditions (0% cloud coverage), the open source.

Table1. BAND INFORMATION

Band Number	Band width	Resolution
2	0.52-0.60	30m
3	0.63-0.69	30m
4	0.77-0.90	30m

At the time of image capturing the air temperature in Delhi was approximately 44ºC and the humidity was 39%. The wind speed at this time was approximately 6m/s. The maximum temperature recorded in Delhi on May 16, 2011 was 44ºC and the minimum temperature record was 21ºC. The fact is that the Landsat ETM+ image was captured under the clear conditions (0% cloud coverage), uniform atmospheric conditions within the images were assumed and no atmospheric corrections were applied. Not much geometric or radiometric distortion was needed. Now, the product is corrected, free from all earth, satellite and sensor distortions. The image is geometrically corrected and geo-referenced to

WGS1984 datum and Universal Transverse Mercator (UTM) zone 29N coordinate system. The stacking and sub-setting [10] of the image has been done to get the false color composite image, bands 4, 3 and 2 are used. The ERDAS IMAGINE tool has been used for the generation of land use and land cover overlay, by performing the un-supervised classification. The ArcGIS tool was used for the generation of the maps. Area generation of the land use and land cover shows the land occupied by the various classes which further helps in the sustainable development of the natural resources. Delhi as the capital of the country is a very vastly growing are which should be taken into the consideration so that our future generation can also enjoy all the prospects for the nature and its beauty. The results of the study will show which land cover should be focused more so that there is minimum deterioration of resources and maximum utilization of the land. The chart further shows the methodology adopted for the various parameters, which will be provided to the national green tribunals and non- government organizations to keep check at them.

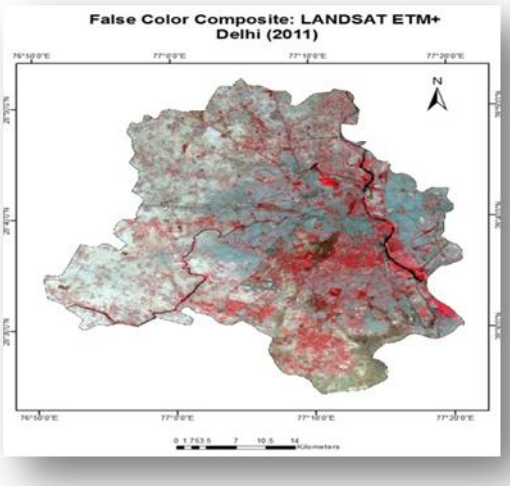
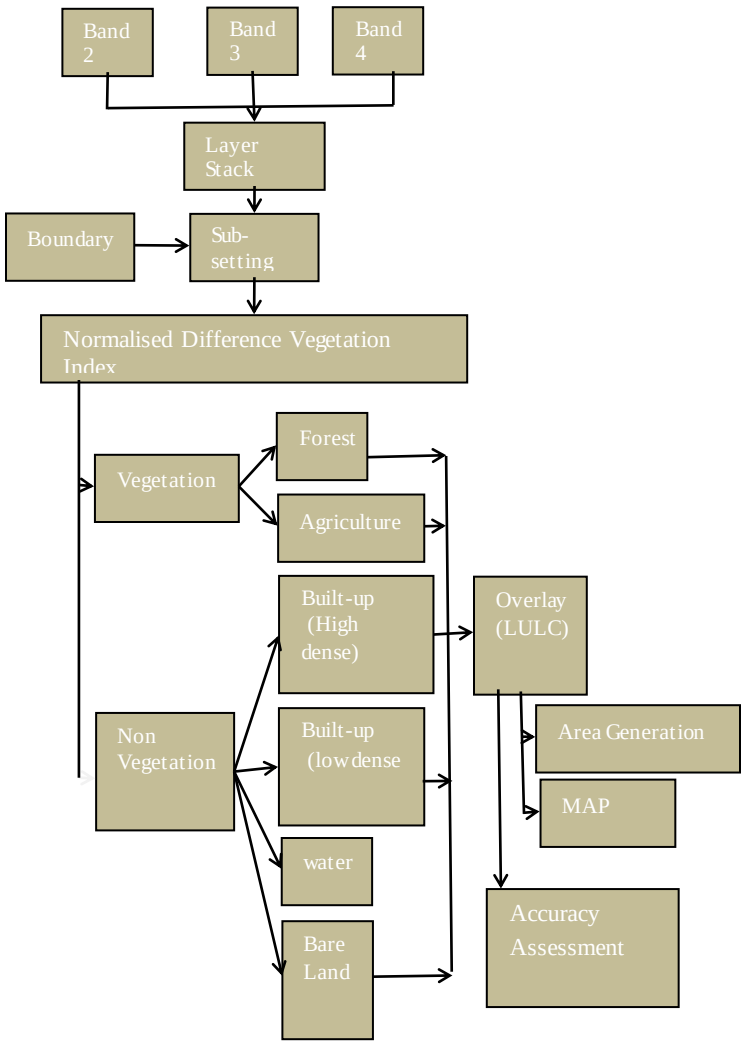


Fig.2 flow-chart of the complete work procedure



IV. RESULTS AND DISCUSSIONS

From the unsupervised classification of the satellite images, the LULC map has been taken out. The image of May,2011 is classified into six classes i.e. forest, agriculture, low dense built up , high dense built up, water and barren land have occupied the 68, 32, 500, 787, 16 and 180 sq. km respectively.

The error matrix, it has numbers as the quantity of sample unit for any particular quantity arranged in rows and columns i.e. square matrix where columns represent the referencing data while row represents the classification data, calculates the parameters like the producer's accuracy, user's accuracy, overall accuracy and the kappa statistics. The overall accuracy, which defines the total correct pixels (major diagonal's sum) is divided by the total number of pixels in the provided matrix, is 91.67% for the LULC overlay of May, 2011 of Delhi city. It is seen from the results that overall kappa coefficient is 0.896 which means 89% better agreement than by chance alone.

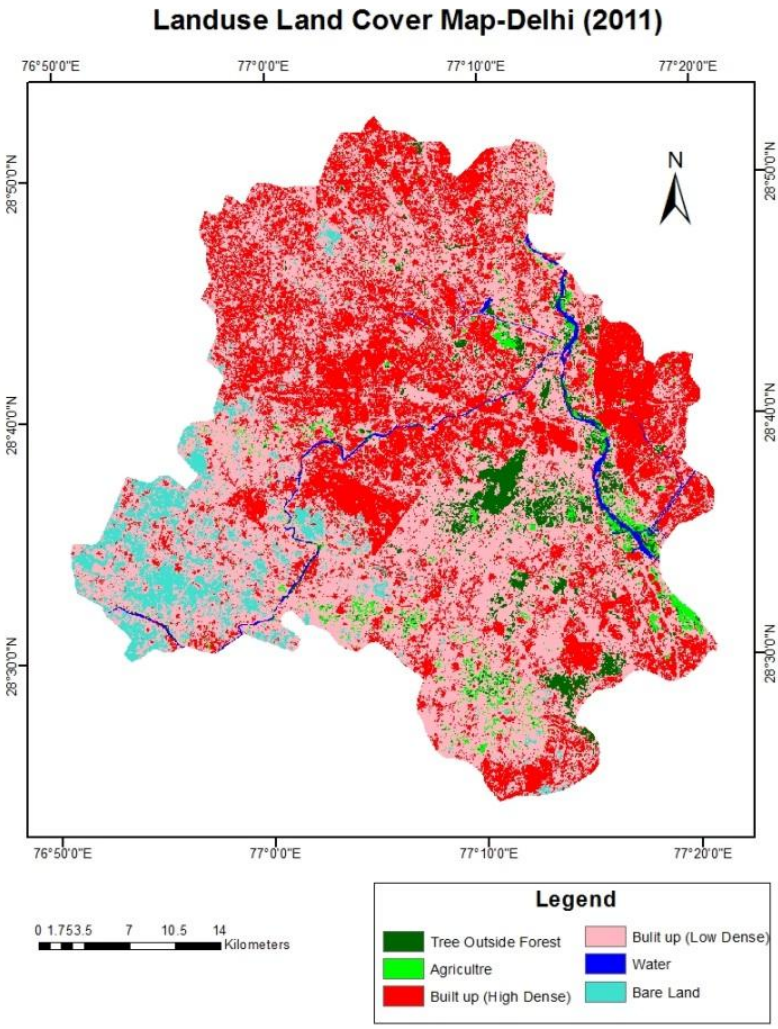


Table2. Shows the area occupied by each class

Class	Area (Sq Km)
Forest	68
Agriculture	32
Built-up (high dense)	500
Built-up (Low dense)	787
Water	16
Bare soil	80

Delhi 2011

ERROR MATRIX							
	Forest	Agriculture	Built up (High dense)	Built up (Low dense)	Water	Bare Land	Total
Forest	9	1	0	0	0	0	10
Agriculture	0	10	0	0	0	0	10
Built up (High dense)	0	0	8	2	0	0	10
Built up (Low dense)	0	0	1	9	0	0	10
Water	0	0	0	0	10	0	10
Bare Land	0	0	0	0	0	10	10
Total	9	11	9	11	10	10	60

Table2. Show the error matrix of un-supervised classification

	Reference Total	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Forest	9	10	9	100.00%	90.00%
Agriculture	11	10	10	90.91%	100.00%
Built up (High dense)	9	10	8	88.89%	80.00%
Built up (Low dense)	11	10	9	81.82%	90.00%
Water	10	10	10	100.00%	100.00%
Bare Land	10	10	10	100.00%	100.00%
Total	60	60	56		

Table3. Show the user's and producer's accuracy

Overall Classification Accuracy = 91.67%

Overall Kappa Statistics = 0.8963

Conditional Kappa for each Category.	
Class Name	Kappa
Forest	0.8824
Agriculture	1
Built up (High dense)	0.7647
Built up (Low dense)	0.8776
Water	1
Bare Land	1

V. CONCLUSION

This study shows that the data is indeed appropriate for performing the LULC assessment map from the multispectral satellite imagery using unsupervised classification technique, since it have an excellent quality and comparative good spatial resolution. The various methods used for the study of the 1483 sq. km. area of Delhi, which gives the generalized and accurately classified over the different LULC types like forest, agriculture, low built-up, high built up, water and barren land. The overall accuracy of the study is 91.67% and kappa coefficient is 0.89 which is near to one means having the better actual agreement. Therefore, it is easy to say that remote sensing is very useful for the periodical surveys and management and other essential information of land use/land cover changes and its distribution. Thus, the government should come into the role for the proper planning for the sake of economy and health of the people in near future.

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